[0018] **As shown in FIGS. 1, 2, and 3**, the device **100** can be configured in many ways. In one embodiment, the device comprises the following components: a feed auger assembly **110**; a filter bed housing **120**; a microwave chamber **200**; at least one gas inlet **330**; a residue extraction auger assembly **130**; and at least one catalytic chamber. As shown in FIG. 1, the device can be constructed as a first vertically positioned tube, the tube having a perimeter, an external wall **121** and a proximal end **124** and a distal end **123**. As shown in FIG 2., the device has an interior wall **122** and a first catalytic chamber **240**. As shown in FIG. 3, a second catalytic chamber **380** comprises a second vertically positioned tube, the second tube also having a perimeter, an external wall **381**, a proximal end **384** and a distal end **383**. As shown in FIG. 3, the second catalytic chamber **380** can also have an interior wall **385**.

[0019] As shown in FIG. 1, the first vertically positioned tube can be constructed with several shorter vertically positioned tubes of the same diameter bolted together. In one embodiment, each vertically positioned tube is between about 48 inches long and 60 inches long, for a total combined tube length of about 228 inches. In one embodiment, the first vertically positioned tube is made from A36 steel plates. In one embodiment, the diameter between opposing interior walls of the first vertically positioned tube is approximately 26 inches.

[0020] As shown in FIG. 2, in one embodiment, the device **100** is housed in a first vertically positioned tube having a perimeter, an interior wall, an exterior wall **121**, a proximal end **124** and a distal end **123**. In one embodiment, the housing contains a filter bed chamber **220** at the distal end **123**; an inlet **201** for carbon-based material and a spent carbon outlet **250**; a gas inlet **330** located between the spent carbon outlet **250** and the filter bed chamber **220**. The housing contains a microwave chamber **200** located above the filter bed chamber **220**. The microwave chamber **200** has a permeable top **202** comprising a microwave absorbing material, wave guides **150** located around the perimeter through which microwaves can be introduced into the device **100**, and a magnetron and an isolator attached to each wave guide **150**. The device **100** can have a first catalytic chamber **240** connected and distal to the microwave chamber **200**; a gas outlet **331** connected to the first catalytic chamber **240**; and, in one embodiment, a second catalytic chamber **380** connected to the gas outlet **331** of the first catalytic

chamber **240**. The second catalytic chamber **380** can be a second vertically positioned tube having a perimeter, an interior wall **385**, an exterior wall **381**, a proximal end **384** and a distal end **383**.

[0021] The method of cleaning gas involves using the device described in the previous paragraph by performing the following steps: filling the filter bed chamber **220** up to the top of the filter bed chamber **220** with carbon-based material; introducing microwaves into the microwave chamber **200** using the magnetrons and wave guides **150**; dissociating heavy carbons entrained within the gas by passing gas through the gas inlet **330**, the carbon-based material in the filter bed chamber **220**, the microwave chamber **200**, the first catalytic chamber **240** and the second catalytic chamber **380**; and then siphoning the purified gas.

[0022] II. Microwave Chamber Assembly

[0023] A. Feed Auger Assembly

[0024] In one embodiment, the biochar (also called activated carbon) can be the by-product of downdraft gasification, coal or any other carbon-based material suitable for filtration. As shown in FIG. 2, the activated carbon enters the device **100** through an auger chute **210**, the auger chute **210** has an inlet **214** and an outlet **215**. The device **100** has a filter bed chamber inlet **201** for activated carbon to enter a filter bed chamber **220**. In one embodiment, the auger chute **210** feeds carbon-based material, such as, for example, biochar into the top of the filter bed chamber **220**, adding to the bed of carbon-based material within the chamber. The feed auger assembly **110** can extend all or part of the way to the filter bed chamber inlet **201**. Microwaves can be prevented from back-flowing through the auger chute **210** by the carbon-based material itself, which interacts with the microwaves at the outlet of the auger chute **210** or by a guide if the guide extends into the microwave chamber **200**.

[0025] B. Filter Bed Chamber

[0026] In one embodiment, the biochar can fill the device **100** up to the microwave chamber **200**. In this embodiment, the biochar bed forms the bottom of the microwave chamber **200**. In operation, the leading edge of the biochar is an interface that acts as a catalyst during operation of the device for creation of a plasma field due to the interaction of the microwaves with the biochar.

controlled microwave guns (also called magnetrons) located around the perimeter of the outside microwave chamber **200**. The walls of the microwave chamber **200** are designed so that microwaves penetrate the walls at particular locations. The microwave chamber **200** can have holes or indentations to accommodate microwaves to pass through the walls. The design of the microwave chamber **200** allows the concentration of the microwaves to occur with discharges occurring between particles of biochar. The concentrated effect of these discharges will form a plasma region causing temperatures within the plasma regions to reach just under a theoretical temperature of 5,000 degrees F. In one embodiment, the top **202** of the microwave chamber **200** is made up of a specially designed lining such as silica carbide and aluminum oxide a carbon and aluminum oxide mixture. The microwave chamber **200** may comprise a lining on its interior walls made of silica carbide and aluminum oxide or carbon and aluminum oxide. In one embodiment, the interior of the entire device **100** is lined with silica carbide, silica oxide, aluminum oxide, refractory alloys, other ceramics or another material having similar properties that is stable at high temperatures. In one embodiment, certain areas of the microwave chamber **200** are lined with a microwave absorbing material **260** that will produce high temperature zones to further enhance the thermal cracking process. The combination of materials used throughout the microwave chamber **200** also prevents microwaves from escaping the device **100**. The microwave absorbing material can be any material that effectively converts microwave energy into heat energy. These materials can be, for example, without limitation, silica carbide mixes (concentrations of between 2.5 % and as high as 12% suspended in any standard high temperature ceramic slurry).

[0031] The cellular wall structures of biochar or lignite have the geometries that are necessary for a discharge. The device **100** creates and sustains a plasmoid in a confined environment, the “e-field” density at the top of the bed of biochar promotes a plasma discharge. The top of the bed of biochar is at or near the top **223** of the filter bed chamber **220**. The plasma discharge is a manifestation of the densified e-field interacting with the biochar. The continued supply of the microwaves and replacement of the biochar sustains the discharge within the environment. The biochar has sharp points along its surface, which promote the creation of a discharge. The interaction between the electromagnetic wave and these points causes the plasma discharge. Unlike other materials, the geometry of biochar promotes

CLAIMS

1. A gas cleaning device comprising:

a first vertically positioned tube having a perimeter, an interior wall, an exterior wall, a proximal end and a distal end;

a filter bed chamber at the proximal end; the filter bed chamber having an inlet for carbon-based material and a spent carbon outlet;

a gas inlet located between the spent carbon outlet and the filter bed chamber;

a microwave chamber located above the filter bed chamber, the microwave chamber comprising:

a permeable top comprising a microwave absorbing material,

wave guides located around the perimeter through which microwaves can be introduced into the device, and

a magnetron and an isolator attached to each wave guide;

a first catalytic chamber connected and distal to the microwave chamber;

a gas outlet connected to the first catalytic chamber; and

a second catalytic chamber connected to the first chamber, the second catalytic chamber comprising a second vertically positioned tube having a perimeter, an interior wall, an exterior wall, a proximal end and a distal end.

2. A device according to Claim 1, further comprising a residue extraction auger assembly attached to the spent carbon outlet.

3. A device according to Claim 2, further comprising a feed auger assembly connected to the filter bed chamber.

4. A device according to Claim 1, in which the microwave absorbing material comprises ceramic tiles impregnated with a material that catalyzes conversion of microwave energy into heat energy.

5. A device according to Claim 1, in which the microwave chamber comprises a lining on the interior wall in which the lining is silica carbide and aluminum oxide or carbon and aluminum oxide.

6. A device according to Claim 1, in which the carbon-based material is activated carbon.

7. A device according to Claim 1, in which the first catalytic chamber further comprises aluminum oxide.

8. A device according to Claim 7, in which the second catalytic chamber further comprises injected steam or purified oxygen.

9. A device according to Claim 1, in which the first vertically positioned tube is a non-cylindrical tube.

10. A device according to Claim 1, in which there are 7 wave guides and the wave guides are standard 1.7 inch x 3.4 inch wave guides each with a WR340 flange.

11. A device according to Claim 1, in which the magnetrons are fired by programmable logic controlled power supplies.

12. A device according to Claim 1, in which the magnetrons are standard class D emitters and fire at 2.45GHz.

13. A device according to Claim 1, further comprising thermocouples embedded inside the interior wall of the device.

14. A device according to Claim 1, in which the wave guides further comprise tuners to reduce back-scatter of the microwaves.

15. A device according to Claim 1, the microwave chamber further comprising the isolator between the magnetron and wave guide to protect the magnetron and prevent overheating.

16. A device according to Claim 1, in which each wave guide is on a different vertical plane.

17. A device according to Claim 1, further comprising a water jacket around the device.

18. A method of cleaning gas comprising:

using a gas cleaning device the device comprising:

a first vertically positioned tube having a perimeter, an interior wall, an exterior wall, a proximal end and a distal end;

a filter bed chamber at the proximal end; the filter bed chamber having a top and a bottom, an inlet for carbon-based material and a spent carbon outlet;

a gas inlet located between the spent carbon outlet and the filter bed chamber;

a microwave chamber located above the filter bed chamber, the microwave chamber comprising:

a permeable top comprising a microwave absorbing material,

wave guides located around the perimeter through which microwaves can be introduced into the device, and

a magnetron and an isolator attached to each wave guide;

a first catalytic chamber connected and distal to the microwave chamber;

a gas outlet connected to the first catalytic chamber; and

a second catalytic chamber connected to the first chamber, the second catalytic chamber comprising a second vertically positioned tube having a perimeter, an interior wall, an exterior wall, a proximal end and a distal end;

filling the filter bed chamber up to the top of the filter bed chamber with carbon-based material; introducing microwaves into the microwave chamber using the magnetrons and wave guides; dissociating heavy carbons entrained within the gas by passing gas through the gas inlet, the carbon-based material in the filter bed chamber, the microwave chamber, the first catalytic chamber and the second catalytic chamber; and

siphoning the purified gas.

19. A method according to Claim 18, further comprising filling the filter bed chamber using a feed auger assembly connected to the filter bed chamber.

20. A method according to Claim 19, further comprising removing spent carbon using a residue extraction auger assembly attached to the spent carbon outlet.

21. A method according to Claim 18 further comprising concentrating a microwave field within the device using microwaves supplied by magnetrons.

22. A method according to Claim 20 further comprising maintaining levels of carbon-based material using the residue extraction auger assembly attached to the spent carbon outlet.

23. A method according to Claim 19 further comprising refilling and maintaining levels of carbon-based material using the feed auger assembly connected to the filter bed chamber.

24. A method according to Claim 23 further comprising monitoring and adjusting levels of carbon-based materials using a control system and sensors.

25. A method according to Claim 18, in which the microwave absorbing material comprises ceramic tiles impregnated with a material that catalyzes conversion of microwave energy into heat energy.

26. A method according to Claim 18, in which the microwave chamber comprises a lining on the interior wall in which the lining is silica carbide and aluminum oxide or carbon and aluminum oxide.

27. A method according to Claim 18, further comprising injecting steam or purified oxygen into the second catalytic chamber.

28. A method according to Claim 18, in which each wave guide of the device is on a different vertical plane.

29. A method according to Claim 18, the device further comprising a water jacket around the device.

30. A method according to Claim 18, in which the carbon-based material is activated carbon.