METHOD AND APPARATUS FOR COMBUSTION

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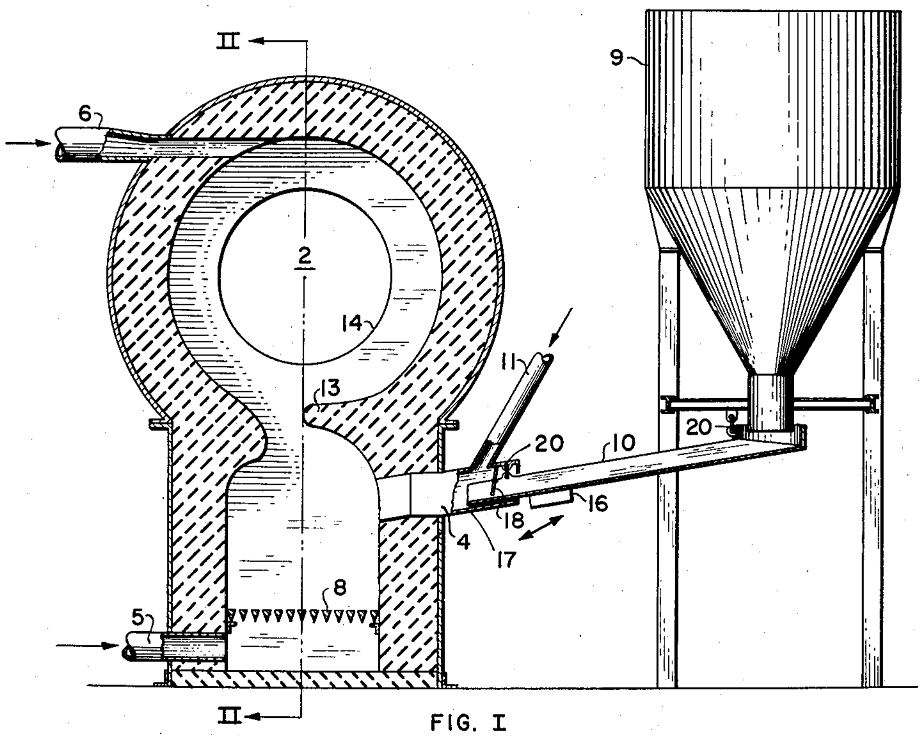

FIG. I

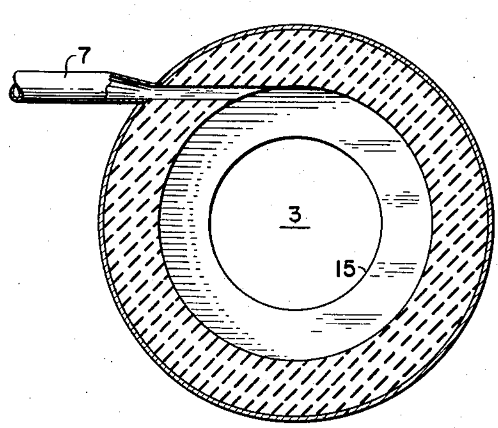

FIG. III

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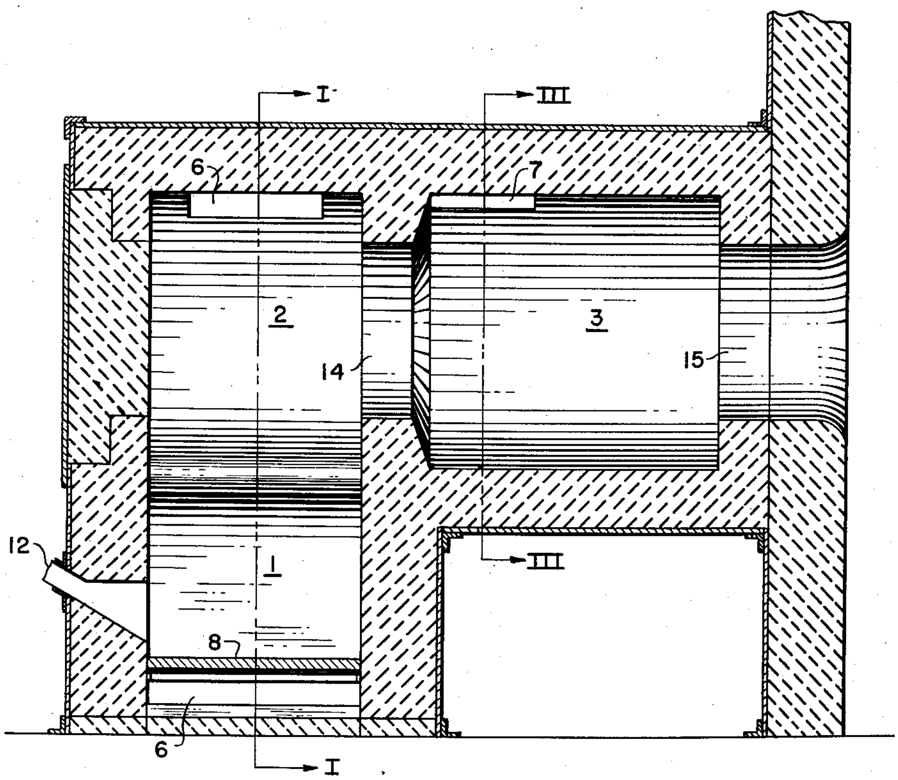

FIG. II

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METHOD AND APPARATUS FOR COMBUSTION

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The invention relates to a method and an apparatus suitable for burning solid fuel substantially comprising a mixture of soot and oil and shaped into soft pellets or globules. A fuel of this kind generally comprises a mixture of soot and gas oil and optionally a little water and is obtained by intimately mixing soot liberated from chemical processes with amounts of gas oil, diesel oil or other similar hydrocarbon oil.

As an example of a fuel so formed, reference is made to the solid aggregates of soot and oil formed using as starting material the soot in water obtained in removing soot produced in the partial combustion of hydrocarbon with oxygen to form gas mixtures containing hydrogen and carbon monoxide.

The pellets or globules produced in the above manner generally have an average diameter in the range of from approximately 3 to 15 mm.

A fuel of this type may comprise, for example, 35–80% of gas oil, 10–60% of soot (carbon), 0–2% of ash and a few percent of water. It is practically impossible to burn this product in a normal furnace hearth.

It is, therefore, an object of this invention to provide a method and apparatus by which combustion of a fuel of the above type may be effected.

The instant invention now provides a method by which the above-mentioned fuel is completely burnt, as well as an apparatus suitable for performing this method, which apparatus is of a compact construction and suitable for connecting, for example, to the front of a normal boiler, furnace or the like.

According to the invention the method of burning this fuel is characterized in that the fuel and primary combustion air are continuously brought together in a primary chamber in which the oil is gasified and at least partially burnt, while at the same time the pellets or globules disintegrate into smaller particles, and that the resultant mixture which contains substantially all the soot in the fuel, is led by the gas stream to a second chamber to which secondary combustion air is also supplied, in which second chamber the remainder of the fuel is completely burnt.

The apparatus suitable for carrying out this method is characterized according to the invention by a gasification chamber provided with a fuel supply device and a supply for primary combustion air, which gasification chamber is in communication with an axially symmetrical combustion chamber which is provided with a tangential supply for secondary combustion air, which combustion chamber has a narrowed discharge opening for the combustion gases.

The combustion takes place in two stages requiring completely different conditions in order to obtain a good result. In the first stage the gas oil vaporizes and gasifies with partial combustion; the carbon remaining behind is substantially unburnt. As a result of the gas oil leaving the pellets they become porous and during this stage of the process readily distintegrate into smaller

parts; the still unburnt oil vapors then have to burn together with the carbon in the second stage.

In the apparatus according to the invention the narrowed discharge opening for the flue gases prevents particles, e.g. of the size of a few millimeters, from being entrained after the second stage with the flue gases in an unburnt or only partially burnt state; the particles remain in the combustion chamber until they are completely burnt.

The gasification chamber is preferably provided, for example, near the bottom, with a grate situated above the primary combustion air inlet, so that this air can only enter the gasification chamber via this grate, which is arranged below the fuel supply device.

The gasification chamber is preferably box-shaped and the combustion chamber is of a cylindrical design with a substantially horizontal center line, both chambers being in communication through an opening in the peripheral wall of the combustion chamber, which opening is narrowed and provided with a lip or tongue which hinders the flow of secondary combustion air to the gasification chamber.

According to the invention the combustion chamber may be provided with a circular narrowing which separates the part situated above the gasification chamber from the remainder of the combustion chamber.

The invention will now be described in greater detail with reference to the drawing showing an embodiment of the combustion apparatus according to the invention. Fig. I is a vertical sectional view of the burner taken on line I—I in Fig. II, and Fig. II is a vertical sectional view taken on line II—II in Fig. I. Fig. III is a vertical sectional view taken on line III—III of Fig. II.

Referring to the figures, **1** is a box-shaped gasification chamber, while cylindrical co-axial parts **2** and **3** together constitute the horizontal combustion chamber. The gasification chamber **1** is provided with a fuel supply device **4** and an air inlet **5** for primary combustion air. The secondary combustion air is supplied to the part **2** of the combustion chamber via a tangential air linlet **6**; if necessary, further combustion air may also be supplied to the part **3** of the combustion chamber via an air inlet **7**. The gasification chamber is provided with a grate **8**, disposed horizontally and situated between the fuel supply device **4** and the air inlet **5**. A feed reservoir **9** is kept constantly filled with pellet-shaped fuel; this reservoir is funnel-shaped and has steep walls in order to promote the admission of the fuel to an open vibrating chute **10**, this being desirable in view of the great adhesive power between the particles or globules. Near the gasification chamber **1** the vibrating chute **10** discharges into a tube **17** communicating with the gasification chamber **1**, a shut-off element **18** being arranged between the tube **17** and the part of the vibrating chute **10** which is outside this tube, which element has the form of a valve resting on the fuel. The chute **10** is mounted on hangers **20** so that it is possible for the chute to be brought into vibration relative to the fixed tube **17** by means of the vibrating device **16**. Alternatively, the wall of the chute **10** may have a flexible section. Downstream of the valve **18** a supply **11** for compressed air issues into the tube **17**. This compressed air can create an equilibrium in the tube **17** with the gas pressure in the gasification chamber, so that gas is prevented from leaking from this chamber via the fuel supply device.

It is also possible to use a single or double screw conveyor instead of a vibrating chute as supply device for the fuel, or a supply chute provided with guide elements. The correct selection of the type of supply device which it is desired to use of course depends on the type of the fuel; the greater the percentage of gas oil in the fuel pellets, the greater will be the tendency to use a supply device with moving parts. If the pellets are not too compact, a vibrating chute is greatly to be preferred.

The passage between gasification chamber **1** and the part **2** of the combustion chamber is provided with a lip or tongue **13** which is so shaped and directed that the secondary combustion air which rotates along the peripheral wall of the combustion chamber while passing the passage is unable to enter the gasification chamber. The combustion chamber which is divided by means of a constricted opening in the two parts **2** and **3** communicating through a circular opening **14**, is also provided with a likewise narrowed opening **15** for the discharge of the combustion gases.

Finally, the gasification chamber **1** is also provided with an inspection and ignition opening **12**.

The combustion apparatus operates as follows:

The fuel globules are led from the feed reservoir **9** via the vibrating chute **10** and the tube **17** into the gasification chamber **1** where they find their way on to the grate **8**. Primary air is led to the gasification chamber via the air inlet **5**; this air passes through the grate and the velocity and pressure of this air are such that the fuel pellets, or at least a part thereof, are entrained by the air, in the sense that the pellets dance, as it were, on the grid. The following takes place in the gasification chamber:

(1) Drying and pre-heating of the pellets.

(2) Evaporation, gasification and partial combustion of the gas oil.

(3) Pulverization and disintegration of the pellets as a result of the violent movement of the fuel bed caused by the rapid flow of combustion air through the grate.

Combustion gases enter the combustion chamber via the narrowed opening between gasification chamber **1** and part **2** of the combustion chamber, as well as still unburnt gas oil vapors, which gases and vapors entrain the particles formed in the gasification chamber during the pulverization and disintegration of the pellets. The secondary combustion air which is tangentially supplied via the inlet **6** is mixed with the other media and causes a rotation of the contents of the combustion chamber in the manner known in cyclone burners, so that the solid particles move towards the wall and by colliding therewith disintegrate into still smaller particles. In this part of the combustion chamber the gas oil is further burnt, the carbon is also partly gasified and the particles split up into smaller particles as mentioned above, and in conclusion the combustion of the solid particles is initiated.

Complete combustion is finally effected in the last part of the combustion chamber of any remaining gas oil vapors and carbon monoxide formed, and finally of the fine particles of solid carbon which enter this part of the combustion chamber under favorable combustion conditions as regards fineness and temperature. On their helical course through the combustion chamber these particles have sufficient time to come into contact with air and burn completely. The outlet of the combustion chamber is narrowed to prevent carbon particles near the wall from leaving the chamber unburnt. The sharp-edged construction **15** promotes the retention of the still unburnt carbon particles.

It is unnecessary to add air to the combustion chamber through opening **7**, if, for example, fuel and combustion air have already been mixed to a sufficient degree in the two preceding stages. Furthermore, the apparatus can be controlled more readily when the combustion air is supplied in two stages only instead of in three.

Nor is it always necessary to divide the combustion chamber into two parts by means of a constriction, for the combustion will proceed satisfactorily even without such a constriction. Whether or not a constriction of this kind is used depends, among other things, on the composition of the fuel, since if it contains a relatively small percentage of volatile components, the presence of a constriction is an advantage.

In this case the intensity of combustion of the part **2** of the combustion chamber is very high, as both fuel and air are retained for some time and a good mixing takes place. This is accompanied by a high temperature and therefore with much radiation energy which is partially passed to the gasification chamber **1**, promoting the ignition of the fuel; ignition difficulties in the gasification chamber when the fuel contains a small percentage of volatile components are thus avoided.

If the fuel contains ash with a relatively low melting point, the omission of the constriction will be an advantage, however, because molten ash is thus prevented from finding its way onto the grate **8** through the opening between the part **2** of the combustion chamber and the gasification chamber **1**, and the combustion process is not disturbed. Without the presence of a constriction this ash finds its way on to the bottom of the part **3** of the combustion chamber, where a draw-off device may or may not be arranged.

In conclusion it should be noted that the capacity of an apparatus as described above is very great, compared to known apparatuses for solid fuel, since the grate load in this apparatus is approximately 1,200 kg. of fuel per square meter of grate surface per hour.

I claim as my invention:

1. A method of burning carbon particles comprising: mixing carbon particles with hydrocarbon oil and water to form solid pellets having an average diameter of 3–15 mm., feeding said pellets continuously into a gasification and partial combustion chamber, introducing air into said chamber, partially burning the pellets with said air in said chamber so that the pellets disintegrate in said chamber, passing the resulting stream of gases and disintegrated pellets upwardly into a second chamber of cylindrical shape, introducing a tangential air stream into said secondary chamber whereby further burning of the gases and disintegrated pellets takes place in a horizontally axially rotating flame pattern, thereafter discharging the gases through a narrow axial outlet from said secondary chamber.

2. An apparatus for burning solid fuel pellets containing finely divided carbon and oil comprising: a gasification chamber, a fuel pellet supply means leading into said chamber, a grate in said chamber for supporting fuel pellets in said chamber, a primary air supply means situated below said grate, a first cylindrical combustion chamber having its longitudinal axis horizontal directly connected to said gasification chamber and mounted thereon, said two chambers being in communication through an opening in the peripheral wall of said first combustion chamber which opening is narrowed and provided with a tongue element to hinder the flow of gases to the gasification chamber from first combustion chamber, a tangentially directly secondary air inlet to said first combustion chamber, a restricted axial outlet piece connecting said first combustion chamber to a second co-axially mounted cylindrical combustion chamber having a tangentially directed air inlet and a restricted axial outlet piece.

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