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METHOD FOR OBTAINING A COMPLETE, SMOKELESS COMBUSTION OF SOLID FUELS, AND A FIREPLACE FOR THIS PURPOSE

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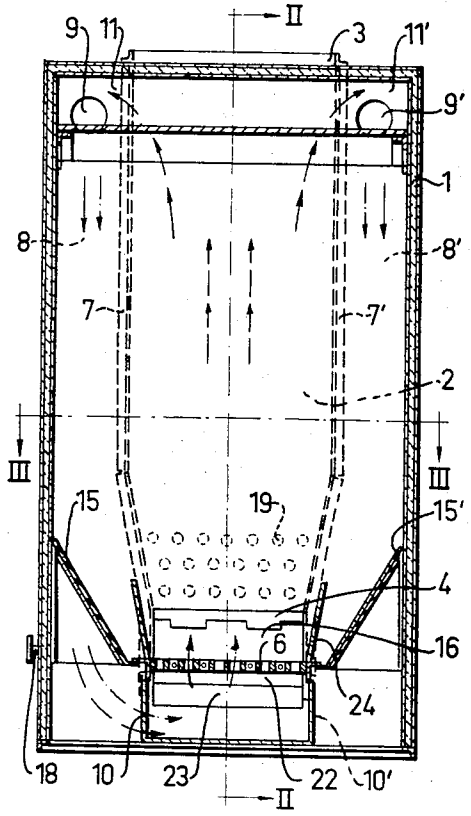


Fig. 1

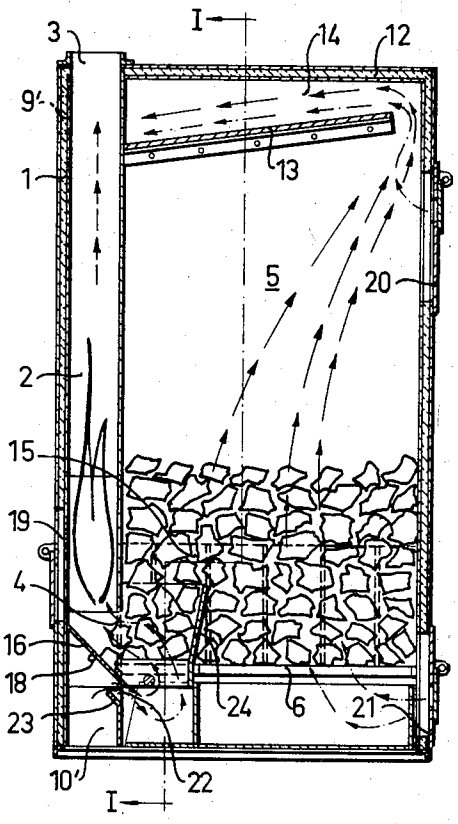


Fig. 2

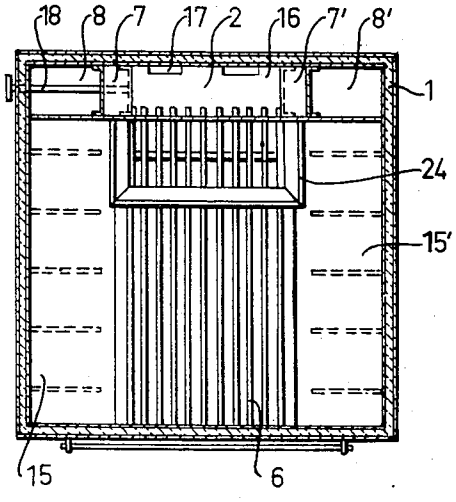


Fig. 3

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METHOD FOR OBTAINING A COMPLETE, SMOKELESS COMBUSTION OF SOLID FUELS, AND A FIREPLACE FOR THIS PURPOSE

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9 Claims. (Cl. 110—31)

This invention relates to a method for obtaining a complete, smokeless combustion of solid fuels, such as coal, coke, peat, wood or the like, and to a fireplace for this purpose.

Prior methods for combusting solid fuels have not resulted in a complete combustion of the combustible substances present in the solid fuels. Consequently, a great part of these substances has converted into fluegases, which, of course, involves both losses and inconvenience. This is due to the fact that certain substances evaporate without reaching the flashing point, while other substances consist of chemical compounds, whereof the single constituents are combustible or adapted to promote a combustion but as a compound are noncombustible. Thus, a prerequisite for a complete combustion of solid fuels is that all combustible substances reach their flashing point at the proper time, and that at least certain of the compounds of the fuel, are reduced by cracking, which can take place only at a temperature of 700–1000° C., so that the constituents thus decomposed and evaporated may partake in the combustion.

An important object of this invention is the provision of an improved method for obtaining a complete, smokeless combustion of solid fuels, such as coal, coke, peat, wood or the like, in that all combustible substances of the solid fuel are brought to their flashing point at the proper time.

A further object of this invention is the provision of an improved method according to the first object wherein at least certain of the compounds of the fuel are reduced by cracking.

A further object of this invention is the provision of an improved fireplace with means for effecting a recirculation and preheating of at least the major portion of the gases generated in a manner that at least the major portion of the combustible substances reach their flashing point at the proper time.

A further object of this invention is the provision of an improved fireplace according to the last mentioned object with means for effecting a recirculation and preheating of the gases generated in a manner to bring about a cracking of at least certain of the compounds of said gases.

The above and other desirable objects inherent in and encompassed by the invention are elucidated in the ensuing specification, the appended claims, and the annexed drawing, in which:

Fig. 1 is a front elevation of the fireplace in vertical section along the line I—I in Fig. 2;

Fig. 2 is a side elevation in vertical section through the fireplace centre along the line II—II in Fig. 1; and

Fig. 3 is a cross-section along the line III—III in Fig. 1.

The full-line arrows indicate the flow directions of the generated gases, and the dash-dot arrows indicate the flow directions of the primary and secondary air streams, whereas the dash-line arrows indicate the flow directions of the exhaust gases.

Referring now to the drawing, the numeral 1 designates the fireplace jacket, which may be open on the front side. The numeral 2 designates the gas combustion channel arranged at the rear side of the fireplace against the jacket 1. The upper end of the gas combustion channel 2 communicates with the evacuating channel 3 and its lower portion communicates with the combustion chamber 5 through an opening 4 provided in it on a level with the upper side of the grate 6. Extending along the opposite sides 7 and 7' of the combustion chamber 2 and parallel thereto are two air ducts 8 and 8' having at their top ends openings 9, 9' through the jacket 1 for sucking in primary and secondary air intended for the combustion. Also, the bottom portions of the air ducts 8, 8' are provided with openings 10, 10' in communication with the gas combustion channel 2 and lying on a level below the grate 6. The upper ends of the air ducts 8, 8' have rectangular openings 11, 11' towards the combustion chamber 5. The walls of the air ducts 8, 8' and the combustion channel 2 facing the combustion chamber 5 may be arranged in one and the same plane. The combustion chamber 5 is confined at the top by a plate 12 which also confines the air ducts 8, 8', and preferably is a part of the jacket 1. Below the plate 12 there is provided a shield 13 that separates the openings 11 from the combustion chamber 5. Thus, a channel 14 leading from the front portion of the combustion chamber to the openings 11, 11' is formed between the plate 12 and shield 13. Said channel 14 is open at the front portion of the fireplace. The grate 6 is flat and supported on two inclined walls 15, 15' secured to the walls of the jacket 1. Thus, the grate 6 forms with the walls 15, 15' a pan having inclined side walls. Said grate 6 proper is formed as a grid whereas the walls 15, 15' are imperforate. The walls 15, 15' which are inclined with respect to the grate 6 have their one ends engaging the front wall of the jacket 1 and their other ends engaging the wall separating the gas combustion channel 2 and ducts 8, 8' from the combustion chamber. Thus, the opening 4 in the gas combustion channel 2 lies right in front of the grate 6. The swingable lid 16 rakes obliquely upwards from the under surface of the grate 6 and can be set to shut off the combustion channel 2. The lid 16 serves to complete the grate and to control the flow of air and gases. The lid 16 may be fixedly arranged in an oblique position and the longitudinal edge thereof adjacent the jacket 1 is provided with recesses 17 to prevent complete shut-off of gases and air flowing from below. The lid may be provided with a number of apertures instead of the recesses 17. The lid 16 may be positioned at will from the outside by means of a control member 18, and may even be thermostat controlled. The rear wall of the gas combustion channel 2 is provided with apertures 19 above the lid 16 for controlled admission of secondary air to the gas combustion. The front wall of the fireplace is provided with a door 20 for supply of fuel and primary air and another door 21 for supply of primary air and for the removal of ashes, which are collected in a box slidable beneath the grate 6. Beneath the lid 16 and on a level below the grate 6 the gas combustion channel 2 is provided with a horizontally disposed, elongated opening or slot 22 which at the lower edge thereof is provided with a baffle 23 which rakes obliquely upwards. On the grate 6 and in front of the opening 4 into the gas combustion channel 2 there is disposed a U-shaped baffle 24, which confines a small area or zone of the grate 6 in front of the opening 4. This opening 4 is of less area than the largest opening area of the gas combustion channel 2 and/or the evacuating channel 3. The U-shaped baffle 24 extends below the grate 6 and constitutes at this place a frame, against the forward

edge of which the innermost end wall of the ash box abuts, whereas the side walls of the ash box extend past said end wall in a manner such that these portions of the side walls may engage with the frame edges perpendicular to the forward edge. Thereby a certain area is confined in front of the elongated slot 22 when the ash box is pushed in.

The fireplace according to the invention may also function as an open fireplace. In this case the major portion of the front wall of the jacket 1 is omitted, e.g. down to the upper edge of the inclined walls 15.

The fireplace according to the invention functions as follows:

After being ignited the fuel mass burns incomplete between the baffle 24 and the front wall of the fireplace. Thereby flue-gases are generated in the combustion chamber 5 from the fuel mass supported on the grate 6 within this zone. These flue-gases consist of small coal particles and gases such as carbon monoxide, steam, and carbon dioxide. During combustion a negative pressure is created in the combustion chamber 5 due to the concentrated combustion under high temperature in the zone in front of the opening 4, and in the gas combustion channel 2. Due to this, air is sucked in through the opening 9, 9' and/or the lid 20 and flows through the air ducts 8, 8', the openings 10, 10' and the opening 22 under the grate 6 to the burning fuel mass, through which the air passes to the combustion channel 2 within the space confined by the baffle 24. However, part of the air also flows through the lid 21 into the ash pit and is passed through the grate 6 to the fuel mass in order to maintain the incomplete combustion. As the channel 14 communicates with the air ducts 8, 8', through openings 11, 11', a high negative pressure will be created also in the channel 14, and due to this flue-gases and air, which are contained in the combustion chamber 5, are sucked through the channel 14 to the air ducts 8, 8', which are heated by the combustion in the gas combustion channel. All this gas-mingled, preheated air flows out through the opening 22 and through the glowing, concentrated fuel mass in front of the opening 4 to the gas combustion channel 2. If required secondary air may be admitted through the openings 19 in the rear wall of the gas combustion channel 2. The combustion intensity depends on the relation of the area of the opening 4 to that of the evacuating channel 3 in a manner such that if the area of the opening 4 is less than that of the evacuating channel 3 the draught will increase and therewith the admission of air and gases. By means of the baffle 23 in combination with the U-shaped baffle 24 the mixture of air and gases is passed to a zone in front of the opening 4 where a complete cracking may be best obtained. The air admitted through the lid 21 is enough for maintaining the incomplete combustion so that the gas generation may take place in the combustion chamber 5.

The principles of the invention, in other words, is the arrangement of three successive combustion zones of successively increased temperature as set forth below. The first zone comprises an extended fuel mass on a grate with admission of primary air in order to obtain a flue-gas generation. The second zone comprises a smaller, glowing fuel mass with increased draught and admission of primary air in mixture with all the flue-gases from the first zone, whereby the constituents of the mixture of flue gases and primary air which are noncombustible per se are cracked by catalysis in this second zone. The third zone comprises a gas combustion channel with separate admission of secondary air for a complete combustion of the products obtained in the second zone.

Essential is, in other words, the combination of at least four features, viz: (A) a preparatory combustion in an extended fuel mass, the first zone; (B) recirculation of all flue-gases from the first zone to the second zone; (C) a forced combustion in a smaller, glowing fuel mass—the second zone—in order to obtain a decomposition or cracking; (D) final combustion of the decomposed constituents in the gas combustion channel—the third zone—with admission of secondary air.

The chemical process causing the complete combustion of solid fuels is as follows:

The flue-gases formed in the combustion chamber 5 consist of combustible particles, such as carbon, C, and gas, such as carbon monoxide, CO, and of incombustible gases, such as carbon dioxide, CO_2, and steam H_2O, and air, the oxygen, O_2, of which is capable of sustaining the combustion.

The flue-gases, mixed with ingoing fresh-air, which stream through opening 20 (primary air) are undergoing the following process when passing through the gas free, glowing fuel mass which acts as a catalyst (activator): CO_2 is reduced into CO. The reduction causes a temperature drop in the glowing fuel mass, and this will prevent incrustation in the form of sintered ashes. H_2O is reduced into H_2. Thus the noncombustible gases are converted into combustible substances C, and gases H_2+CO, and O_2, which have combustion sustaining properties. The carbon particles, C, reach the flashing point when passing through the glowing mass. Obviously, the process brings about a combustion of all combustible flue-gases, rendering the exhaust gases through the evacuating channel 3 smokeless, that is free from visible constituents.

The flue-gases and air ejected through the opening 19 (secondary air), are used to increase the combustion temperature in the flame above the fuel mass, and thus, if required, to bring about an increased admission of secondary air in order to promote the complete combustion in the gas combustion channel 2.

Coke and anthracite, which are normally fuels poor in gas, are made rich in gas through the addition of steam and carbon dioxide at the prevailing cracking temperature, and this will greatly facilitate the complete combustion.

The invention sets forth a completely new principle in combustion technique, which is much more economical than the principles hitherto known as far as solid fuels are concerned.

The invention can be used to advantage in both closed and open fireplaces of any size and capacity. The shape of the fireplace is of no importance.

Thus, it should be understood that the invention is not confined to the embodiments described above and illustrated in the drawings but may be modified in several ways without abandonment of the inventional spirit.

I claim:

1. A fireplace for effecting a complete, smokeless combustion, comprising in combination, a combustion chamber, a jacket enclosing said combustion chamber and forming the front, side and rear walls of the fireplace, a grate provided in the lower portion of the fireplace to carry the fuel mass, an ash pit below said grate, the fireplace being provided with an evacuating channel, a vertically disposed gas combustion channel at the rear portion of the fireplace and adjacent to the rear wall thereof, said gas combustion channel being in communication with the evacuating channel and being also in communication with the combustion chamber, a wall between the gas combustion channel and the combustion chamber, said wall having an opening adjacent to the grate and on a level above the grate and through which opening the communication between the gas combustion channel and the combustion chamber is effected, said gas combustion channel extending down to the lower portion of the fireplace, air ducts located at opposite sides of the gas combustion channel, said air ducts being provided at their upper ends with inlet openings for the admission of air and flue gases generated from the fuel mass, said air ducts having their lower ends disposed on a level below the grate and having thereat inlet openings communi-

cating with the lowermost portion of the gas combustion channel, said gas combustion channel having an inclined lid engaging the walls of the gas combustion channel and located near the opening that is situated near the grate and also located above the last-mentioned inlet openings, a portion of the fuel mass being adapted to rest against said lid, an elongated, horizontally disposed slot provided in the front wall of the gas combustion channel on a level below the grate and below the lid, said lid being adjustable to let flue gases and air from the air ducts to pass from below said lid through a confined small portion of the grate in front of the opening that is located near the grate and the fuel mass resting on the grate portion, and on to the gas combustion channel, and a baffle within the combustion chamber having a portion disposed above the grate and forwardly of the opening to thereby provide said confined small portion of the grate and to direct the flue gases through said opening and into the gas combustion channel.

2. A fireplace as provided for in claim 1, wherein the baffle which defines the confined small portion of the grate is vertically disposed and has a portion located below the grate and has legs provided with ends abutting the wall of the combustion chamber in which the opening is provided, thus dividing the combustion chamber into a special zone in front of said opening.

3. A fireplace as provided for in claim 2 wherein the baffle is substantially U-shaped and wherein that part of the baffle which is located below the grate is in the form of a frame shaped to confine a part of the ash pit forwardly of the gas combustion channel so that flue gases and air from the slot are positively directed upwardly through the grate and in front of the opening above the grate and into the gas combustion channel.

4. A fireplace for effecting a complete, smokeless combustion, comprising in combination, a combustion chamber, a jacket enclosing said combustion chamber to form the side, rear and front walls of the fireplace, a grate provided in the lower portion of the fireplace to carry the fuel mass, an ash pit below the grate, the fireplace being provided with an evacuating channel, a vertically disposed gas combustion channel behind the combustion chamber and adjacent to the rear wall of the fireplace, a wall at the rear of the evacuating channel provided with an opening at the back of the grate and on a level above the grate, said opening establishing communication between the gas combustion channel and the evacuating chanel said gas combustion channel extending down to the lower portion of the fire place, air ducts at opposite sides of the gas combustion channel, said air ducts being provided at their upper ends with inlet openings for fresh air and for flue gases generated from the fuel mass, and said air ducts having at their lower ends on a level below the grate inlet openings communicating with the lowermost portion of the gas combustion channel, said gas combustion channel having adjacent to the opening at the back of the grate and at the upper side of the grate, an inclined lid against which a part of the fuel mass rests, said lid engaging the walls of the gas combustion channel, the front wall of the gas combustion channel having an elongated, horizontally disposed slot on a level below the grate and below the lid, an inclined baffle disposed at the lower edge of the elongated slot and adapted to positively direct the flue gases and air discharging from said slot to the grate from below said grate, said lid being adapted to pass flue gases and air from the air ducts through a confined small portion of the grate in front of the opening situated at the back of the grate and the fuel mass residing on said grate portion and further on to the opening of the gas combustion channel, and baffle means located forwardly of said opening for defining said confined portion of the grate.

5. A fireplace for effecting a complete, smokeless combustion, comprising in combination, a combustion chamber, a jacket enclosing said chamber to form the rear, side and front walls of the fireplace, a grate provided in the lower portion of the fireplace to carry the fuel mass, an ash pit below said grate, the fireplace being provided with an evacuating channel, a vertically disposed gas combustion channel at the rear portion of the fireplace adjacent to the rear wall thereof, a wall between the combustion chamber and the gas combustion channel, said wall having an opening establishing communication between said combustion chamber and the gas combustion channel, said opening being on a level above the grate, said gas combustion channel extending down to that portion of the fireplace that is located below the grate, air ducts at opposite sides of the gas combustion channel, said air ducts being provided at the upper ends with inlet openings for air and for flue gases generated from the fuel mass, said air ducts having at their lower ends inlet openings located below the grate and communicating with the lowermost portion of the gas combustion channel, said gas combustion channel having adjacent to the opening at the rear of the grate and at the uppermost side of the grate, an inclined lid against which a portion of the fuel mass rests, said lid engaging the walls of the gas combustion channel, an elongated horizontally disposed slot provided in the front wall of the gas combustion channel on a level below the grate and below the lid, said lid being located above said slot and being adapted to allow flue gases and air from the air ducts to pass through a confined small portion of the grate in front of the opening and the fuel mass resting on said grate portion and further on into the opening of the gas combustion channel, the opening of the gas combustion channel into the combustion chamber being of less area than the total opening area of the evacuating channel, thereby providing a strongly concentrated draught through said opening in order to obtain the required cracking temperature, and baffle means in the combustion chamber operating to define said small confined area of the grate.

6. A fireplace for effecting a complete, smokeless combustion, comprising in comprising in combination, a combustion chamber, a jacket enclosing the combustion chamber to form the rear, side and front walls of the fireplace, a grate provided in the bottom portion of the fireplace to carry the fuel mass, an ash pit below said grate, the fireplace being provided with an evacuating channel, a vertically disposed gas combustion channel behind the combustion chamber, a wall between the combustion chamber and the gas combustion channel, said wall having an opening establishing communication between the combustion chamber and the gas combustion channel, said opening being located adjacent to the grate and on a level above the grate, said gas combustion channel extending down below the grate to the bottom portion of the fireplace, air ducts at opposite sides of the gas combustion channel, said air ducts being provided at the upper ends with inlet openings for air and for flue gases generated from the fuel mass, and said air ducts having their lower ends disposed on a level below the grate and provided with inlet openings communicating with the lowermost portion of the gas combustion channel, said gas combustion channel having adjacent the opening near the grate and at the uppermost side of the grate, an inclined lid against which a part of the fuel mass rests, said lid engaging the walls of the gas combustion channel, an elongated, horizontally disposed slot provided in the front wall of the gas combustion channel on a level below the grate and below the lid, said lid being adapted to pass flue gases and air from the air ducts through a confined small portion of the grate in front of the opening and the fuel mass resting on said grate portion, a baffle defining said small portion of the grate, the combustion chamber having a flat, substantially horizontally disposed shield spaced from an upper wall of the fire-

place, said shield being positioned to provide a channel to the uppermost openings of the air ducts.

7. A fireplace for effecting a complete, smokeless combustion, comprising in combination, a combustion chamber, a jacket enclosing the combustion chamber to form the rear side and front walls of the fireplace, a grate provided in the lower portion of the fireplace to carry the fuel mass, an ash pit below the grate, the fireplace being provided with an evacuating channel, a vertically disposed gas combustion channel at the rear of the fireplace and adjacent to the rear wall thereof, said gas combustion channel being in communication with said evacuating channel and also in communication with the combustion chamber, a wall at the rear of the combustion chamber provided with an opening adjacent to the rear of the grate and establishing said communication, the gas combustion channel extending down to the bottom portion of the fireplace, air ducts at the opposite sides of the gas combustion channel, said air ducts being located at the upper ends thereof and being provided with inlet openings for air and for flue gases generated from the fuel mass, said air ducts having their lower ends disposed on a level below the grate and provided with inlet openings communicating with the lowermost portion of the gas combustion channel, said gas combustion channel having adjacent to the opening at the rear of the grate and at the upper side of the grate, an inclined lid against which a part of the fuel mass rests, said lid engaging the walls of the gas combustion channel, an elongated, horizontally disposed slot provided in the front wall of the gas combustion channel on a level below the grate and below the lid, said lid being adapted to pass gases and air from the air ducts through a confined small portion of the grate in front of the opening at the rear of the grate, and further on to the gas combustion channel, baffle means for defining said confined small portion of the grate, and the gas combustion channel being provided in its rear wall with inlet openings for the admission of secondary air to the gas combustion channel adjacent the opening at the back of the grate, into the combustion chamber.

8. A fireplace for effecting a complete, smokeless combustion, comprising in combination, a combustion chamber, a jacket enclosing the combustion chamber to form the side, front and rear walls of the fireplace, a grate provided in the lower portion of the fireplace to carry the fuel mass, an ash pit below the grate, the fireplace being provided with an evacuating channel, a vertically disposed gas combustion channel adjacent to the rear wall of the fireplace, said gas combustion channel having a front wall, said gas combustion channel being in communication with said evacuating channel, and being also in communication with said combustion chamber, a wall between the combustion chamber and the gas combustion channel, said wall having an opening by means of which the communication between the gas combustion channel and the combustion chamber is established, said opening being adjacent to the rear end of the grate and on a level above the grate, said gas combustion channel extending down to the lower portion of the fireplace, air ducts at the opposite sides of the gas combustion channel, said air ducts being provided at their upper ends with inlet openings for air and also for flue gases generated from the fuel mass, and said air ducts having their lower ends disposed on a level below the grate and provided with inlet openings communicating with the lower portion of the gas combustion channel, said gas combustion channel having an inclined lid adjacent the opening at the rear of the grate and at the upper side of the grate, a part of the fuel mass resting against said lid, said lid engaging the walls of the gas combustion channel, an elongated, horizontally disposed slot provided in the front wall of the gas combustion channel on a level below the grate and below the lid, an inclined baffle disposed at the lower edge of the elongated slot and adapted to positively direct the flue gases and air discharging from said slot to the grate from below the grate, said lid being adapted to pass flue gases and air from the air ducts through a confined small portion of the grate in front of the opening and through the fuel mass resting on said grate portion and further on to the opening leading to the gas combustion channel, baffle means defining said confined small portion of the grate, the opening at the rear of the grate between the gas combustion channel and the combustion chamber being of less area than the total opening area of the evacuating channel to thereby provide for a strongly concentrated draught through said opening in order to obtain a required cracking temperature.

9. A fireplace for effecting a complete, smokeless combustion, comprising in combination, a combustion chamber, a grate provided in the bottom portion of the fireplace to carry the fuel mass, an ash pit below the grate, the fireplace being provided with an evacuating channel, a vertically disposed gas combustion channel at the rear portion of the fireplace, said gas combustion channel being in communication with said evacuating channel and being also in communication with said combustion chamber, a wall between the gas combustion channel and the combustion chamber, said wall having an opening adjacent to the grate and at the rear of the same and on a level above the grate, said gas combustion channel extending down to the bottom portion of the fireplace, air ducts at opposite sides of the gas combustion channel, said air ducts being provided at the upper ends thereof with inlet openings for air and for flue gases generated from the fuel mass, said air ducts having their lower ends disposed on a level below the grate and provided with inlet openings communicating with the lower portion of the gas combustion channel, said gas combustion channel having an inclined lid located adjacent to the opening at the rear of the grate and above the grate and against which lid a part of the fuel mass rests, said lid engaging the walls of the gas combustion channel, an elongated, horizontally disposed slot provided in the wall between the gas combustion channel and the gas combustion chamber and on a level below the grate and below the lid, an inclined baffle disposed at the lower edge of the elongated slot and adapted to positively direct the flue gases and air discharging from said slot to the grate from below the grate, said lid being adapted to pass flue gases and air from the air ducts through a confined small portion of the grate in front of the opening and the fuel mass resting on said confined grate portion and further on to the opening leading into the gas combustion channel, baffle means defining said small confined portion of the grate, the opening from the gas combustion channel to the combustion chamber being of less area than the total opening area of the evacuating channel to provide for a strongly concentrated draught through said opening in order to obtain the required cracking temperature, the combustion chamber having a flat, horizontal shield spaced from the top of the fireplace in a manner to provide a channel leading to the uppermost openings of the air ducts.

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