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GAS-PRODUCING FURNACE AND BURNER THEREFOR

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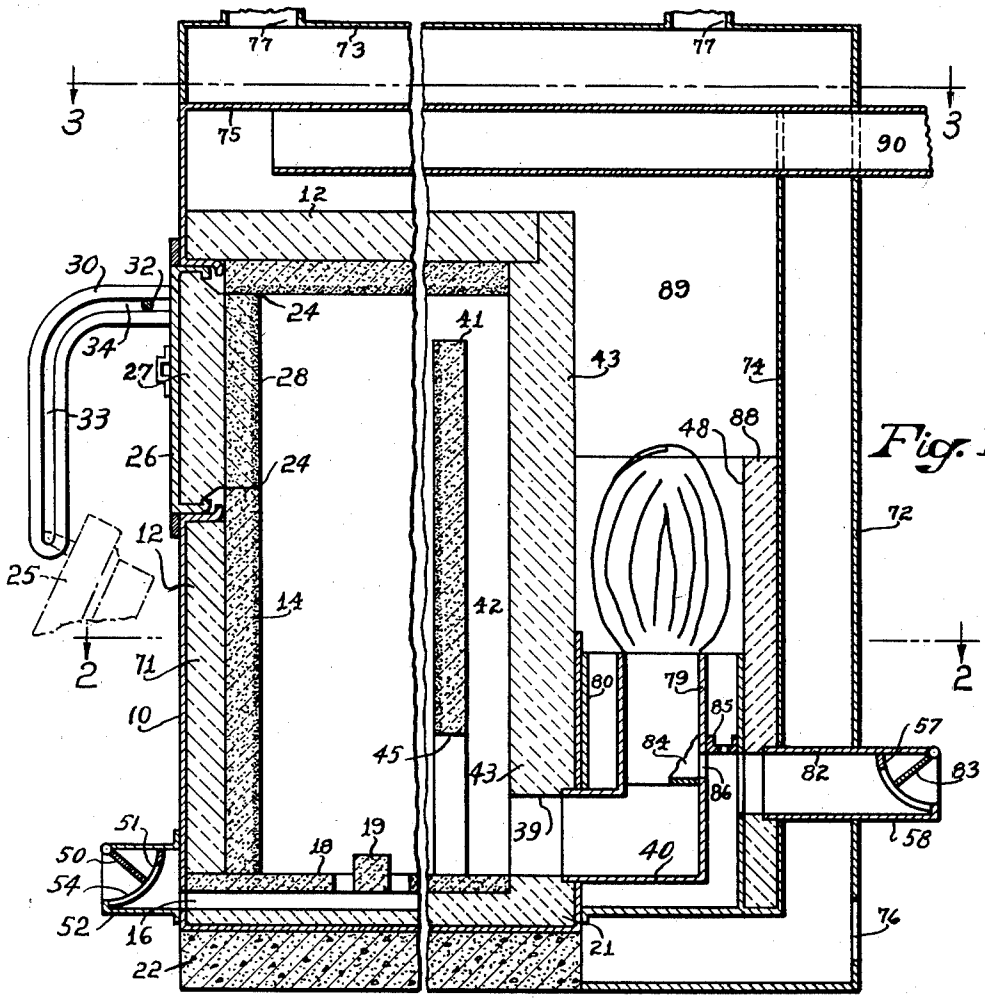


Fig. 1.

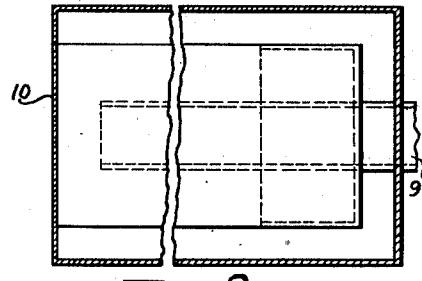


Fig. 2.

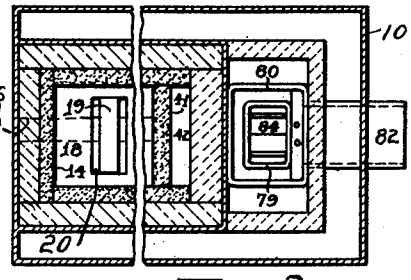


Fig. 3.

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GAS-PRODUCING FURNACE AND BURNER THEREFOR

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9 Claims. (Cl. 110—31)

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This invention relates to gas production and combustion and more particularly to a method of burning wood and apparatus for producing gas from wood and for deriving heat from the combustion thereof.

There are large wooded areas in the country where slash, imperfect growth and various types of trees should be removed to permit a better growth of the forest, and this wood is largely wasted. On the other hand, the standard fuels, coal and oil, are becoming increasingly expensive, and there is a demand for combustion apparatus which can make use of the inexpensive grades of wood for heating purposes. Wood has been commonly subjected to destructive distillation to obtain pyroligneous acid products, with an attendant production of tars and a combustible gas. This is accomplished by means of a regenerative checker work type of furnace or by an iron retort heated by an exterior combustion furnace. The low temperature distillates are furfural, acetic acid and other valuable substances, and the process is run primarily to obtain such end products. The non-condensible gases obtained from the wood are merely incidental to the process, although recovered and used. The resultant gases comprising CH_4 and CO are contaminated with a high percentage of CO_2. Although CO_2 combines with carbon at a high temperature to form CO, yet such distillation retorts have had to be run at low temperatures, such as from 320° F. to 700 or 800° F. so as to recover the pyroligneous acids efficiently. Hence, the gas production is not efficient, and the gas has to be purified from the condensible tars and other low boiling volatiles before it can be used. This process is handihapped by the deposition of tars and resins in the retorts and other parts of the system.

Wood is customarily burned in an ordinary stove or furnace for direct heating purposes, but the procedure is wasteful of the caloric value of the wood, and much of the heat goes up the chimney as unburned smoke and gases and in convection currents of excess air and CO_2. As heretofore burned, wood has not proven to be a satisfactory fuel. If wood is burned directly in a standard hot air or steam furnace whose firebox is adapted for coal, the quickly burning wood requires very frequent stoking and a great deal of the heat is lost up the chimney. However, it is desirable to employ wood for heating such types of furnace; but a mere enlargement of the firebox of the furnace to hold a greater capacity of wood would not satisfy the desired

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end, as will be explained, and particularly since the comparatively cold surfaces of the furnace do not provide for an efficient combustion. A combustible gas is the best type of fuel because of the ease with which it is transported and its combustion controlled; and it is therefore desirable, in accordance with my invention, that instead of being burned directly in the combustion furnace, the wood be transformed into a gas in a producer and the gas be burned in a combustion furnace where the heat may be directly applied for heating a building, or as needed for industrial purposes, such as the indirect heating or baking of various articles by means of a gas heated muffle.

The primary object of my invention is to overcome such problems and to provide apparatus for converting wood and other carbonaceous plant growth into combustible gaseous products and then burning the gas efficiently.

In accordance with my invention, I produce a combustible gas by an initial destructive distillation of various ingredients in wood and similar carbonaceous plant growth and provide a carbon residue, which, thereafter by chemical reaction with insufficient oxygen for complete combustion, is converted to carbon monoxide; and this procedure is carried on in an insulated refractory chamber where the exothermic reaction heat is stored and maintains a temperature well above the condensation points of the volatiles and insures that the carbon is present as incandescent charcoal and any CO_2 combustion product is immediately reconverted to carbon monoxide, so that substantially all of the gaseous products are combustible. This gas is thereafter burned for heating purposes while its superheated condition is maintained and before any condensate can be formed.

A further object of this invention is to provide apparatus which will produce such superheated conditions efficiently and economically and which may be very easily regulated to give a desired degree of heat in a combustion furnace.

A further object of the invention is to provide a fuel combustion furnace which has such insulation and constructional features that the carbonaceous material is held in an incandescent condition for a long period of time and the air feed thereto is so regulated that the desired volume of carbon monoxide is produced as may be required for heating purposes.

A still further object of the invention is to provide a simple type of combustion apparatus in which the carbon monoxide and other combus-

tible gaseous materials are first derived by destructive distillation and then supplied with a required amount of oxygen for an efficient combustion and burned before the stored heat is lost. Other objects will be apparent in the following disclosure.

Referring to the drawings which illustrate a preferred embodiment of the invention:

Fig. 1 is a vertical section of a gas producer, partly broken away, in association with a hot air combustion furnace;

Fig. 2 is a horizontal section on the line 2—2 of Fig. 1; and

Fig. 3 is a section on the line 3—3 of Fig. 1

According to this method, wood, and other plant growth, such as straw, refuse and fodder, which are herein termed wood, as distinguished from coal and other minerals, is burned in a two stage process. The first stage is based on the production of gas from the wood within an enclosed chamber having heat insulating, non-conducting, refractory walls capable of impounding the heat and maintaining a temperature well over 1500° F. and preferably 1800° F. and higher, or in the vicinity of 2240° F. which is the temperature of burning charcoal. The air inlet opening to the producer is small and accurately regulated, so that the oxygen admitted is not in excess of combustion requirements except when the fire is started, and thereafter it is supplied only in such a deficient amount as will maintain the production of carbon monoxide. The heat storing refractory walls build up a temperature condition which insures that the wood, or charcoal formed therefrom, is held in an incandescent condition and preferably above about 1800° F., or the temperature at which carbon dioxide reacts with carbon to form carbon monoxide and at which substantially all of the volatiles derived from the wood are heated gases. At this high temperature, the chemical reaction of carbon with the limited amount of oxygen admitted for combustion results in a very rapid reaction to produce carbon monoxide, and because of the incandescence of the charcoal and the superheated condition of the gases, the resultant product of this reaction is substantially wholly carbon monoxide, in addition to the volatile gases, such as methane and hydrogen, which are derived as distillation products from the green wood. For example, water in the wood forms steam which reacts with carbon at high temperatures to form hydrogen and carbon monoxide. Methane may be derived directly from the distillates.

When the producer is filled with green or dry sticks of wood and a fire is built, the initial reaction is one of ordinary combustion, wherein the heat is built up rapidly by the refractory walls of the producer until a temperature has been reached at which the exposed walls become incandescent and the reactions change to give a resultant formation largely of carbon monoxide. Thereafter, when the furnace, with its incandescent inner walls, is charged with logs of wood, the resins, tars and the more volatile ingredients of the wood burn with a rapidity of reaction determined by the amount of air introduced when the producer door was opened and according to the regulated supply of air thereafter admitted. Some of the gaseous distillation products pass to the exit and are burned in the combustion chamber. Within a few minutes, the entire process changes as the result of burning off the volatiles and the wood becomes incandescent charcoal throughout the major portion of its volume. As

air is admitted, the incandescent charcoal reacts with the oxygen to form carbon monoxide and the producer gas is made up almost wholly of that product. Since the mass is in an incandescent and highly reactable condition chemically, it is not ordinarily possible to admit enough air to defeat this process of forming carbon monoxide. That is, the incandescent charcoal or carbon grasps the oxygen and produces a volume of CO which is dependent on the quantity of oxygen introduced. Thus, the producer will give only carbon monoxide and not CO_2 as the primary product, if the temperature is maintained at 1800° F. or higher. Since the distillation products of wood come off at very low temperatures and usually well below 800° F., any distillation products that may be present, as well as the CO, are superheated to a very high degree by the heat reflecting and refracting qualities of the brick lining of the producer. Hence, all of the products are gaseous, except for the minute amount of mineral fly ash that may be formed and travel with the gases. Incidentally, there are substantially no ashes left in the producer, and such as remains may be cleaned out through the air inlet.

The second stage in this method involves transporting that gas in its superheated condition to a combustion zone where the gas is supplied with oxygen and preferably in excess, and in this zone the gas is burned entirely and the heat derived therefrom is absorbed by suitably located heat conductive walls. These walls may be a gas muffle which conducts the heat to articles arranged outside for heat treatment, or the walls may be the water walls or the air cooled walls of standard types of combustion furnaces.

The rate of gas production is regulated solely by regulating the amount of air introduced to the producer, and an efficient regulation of the system therefore need not involve regulating the quantity of air that is supplied to the burner, since it is merely necessary that there be air in excess for combustion in that second zone. However, more efficient operation is effected by regulating the air in the combustion zone, so as not to cause an excess of unconsumed air to be heated and pass up the chimney and so waste heat. Thus, there can be no smoke in the flame, provided an excess of air is present, since the superheated producer gas necessarily burns as soon as it reaches oxygen and the flame cannot be cooled to a temperature of producing smoke before the combustion has been fully completed. Hence a high combustion efficiency is obtained in one unit by burning the wood in a two-stage process involving storing the heat in the first stage to superheat the combustion products and compel the formation of only a combustible gas and then by using the stored heat as well as the heat of combustion in a secondary combustion zone.

Various structures may be employed to accomplish the above specified method. The producer comprises essentially a completely enclosing wall of insulating brick suitably held in place. As illustrated in the drawings, an exterior thin steel or other sheet metal wall or frame 10 may be constructed as a cylinder or preferably in a substantially hollow parallelepipedon shape which is long, narrow and high. This steel container, which is made as a unit so that the producer may be readily transported, is lined with an insulating material which will withstand the temperature of combustion of the gas and provide the required superheated condition. For this purpose, I prefer to employ two types of material.

Next to the steel shell 10 is a layer of light weight, refractory, insulating tile or brick 12 of low heat conductivity, which resists the passage of heat therethrough and which has such thickness relative to its conductivity that the metal shell is kept comparatively cool, such as below the boiling point of water. This may be mounted on the steel shell according to well known procedure. The innermost lining of the producer is a dense firebrick or other suitable highly refractory material 14 which is capable of withstanding the high temperature of the gas producing zone, as well as the shocks and abrasions incident to loading the produced chamber with large chunks of wood. This lining 14 may be the inner surface of a cast duplex brick, as hereinafter described. The floor or grate is likewise made of insulating and refractory bricks, and air is introduced in a carefully regulated amount through an inlet 16 which is preferably located near the bottom of the producer and beneath the grate structure or the wood supporting bottom. Strictly speaking, there is no grate, in the commonly accepted use of the term, and the wood is thrown directly onto the bottom brick lining of the producer.

Air may be admitted to the producer at various locations, either above or below the bottom, such as through the wood feed door or near it, and the air passage is so constructed as to insure a proper distribution of air to the under side of the wood supply. In the form illustrated, the air is admitted through the bottom. As shown, the floor may comprise a series of tiles or bricks 18 and another series of spaced tiles or bricks 19, the latter being higher and protecting the former from blows, as well as aiding in the air distribution. The bricks 18 and 19 are of different sizes, as shown, but they are preferably made of the same dense refractory material capable of resisting abrasion and blows as well as the high temperature. The air inlet 16 is a longitudinal central channel formed by spacing the courses of bricks 18, and lateral channels 20 communicate therewith at the opposite sides of the higher dense bricks 19, so that air may be fed to the major portion of the floor surface of the producer. The bricks 18 and 19 are mounted on a further layer of refractory, insulating fire bricks 21 of low heat conductivity. The steel shell 10 is shown in Fig. 1 as mounted on the concrete floor 22 of a building.

The wood to be converted to gas is introduced into the producer chamber through an opening 24 closed normally by a removable door 25 which is preferably located on the front wall and near the top of the producer chamber. This door may be formed of an outer steel plate 26 of suitable construction carrying a double course of light weight bricks 27 and dense bricks 28 similar to the brick layers 12 and 14. The door may be locked in position in a fitting opening in the producer wall by a suitable device, such as a pivoted lever carrying slide bars that engage eyes on the metal shell.

Since the inner side of the door becomes incandescent or very hot, it is preferably so mounted that when removed for the insertion of wood, the heated face will be held away from the operator. This may be accomplished by means of the two substantially L-shaped iron tracks 30 secured on the two opposite sides of the metal casing 10. These tracks may be each formed of a U-shaped channel iron, with the channels facing each other. The two ends of a rod 32 secured to the front steel face of the door ride within the channels and so carry the door and are guided in their movement by the track channels. The vertical channel portion 33 (Fig. 1) of the track is spaced far enough from the front steel wall of the shell so as to permit the door passing downwardly without contacting therewith. The upper portion 34 of the track channel is horizontal and so located that when the door is lifted manually or mechanically, the cross rod 32 will ride along the horizontal portion 34 of the track and the tapered door will fit snugly into the opening through the inner refractory and insulating lining of the producer.

The producer gas outlet pipe 40 communicates with a hole 39 through the rear vertical wall 43, which may be located near the bottom of the wall, or if desired, partway up that wall. In order to prevent the escape of the producer gas to any material extent through the door opening, when the door 25 is removed, a vertical baffle 41 may be located parallel with and spaced from the top and rear wall 43 sufficiently to form a gas passage 42 of such size that the producer gas in the upper portion of the producer chamber will be drawn by the burner suction downwardly through the channel 42 and thus be removed from the upper part of the producer even when the door is opened. The baffle wall 41 may be made of one or more insulating plates extending the full length of the producer gas chamber. It may be held in place within a groove within the brick structure of the two end walls, or by means of bricks projecting from the end wall faces to form supporting lugs.

The gas withdrawn from the producer is to be held at a high superheated temperature until it can be burned in the second stage of the process. Although various arrangements may be employed for maintaining the gas at the required superheated temperature, a satisfactory construction is that illustrated in the drawings, in which the combustion chamber is located close to the producer. A small short circuiting opening 45 is made in the baffle 41 at its lower end, so that some of the gas passes therethrough. This opening is directly opposite and in line with the center line of the exit pipe 40 through which the producer gas passes to the combustion chamber. This opening 45 is small enough so that part of the gas in the producer must pass out through the down passage 42, but it is large enough to provide considerable direct radiation to the burner pipe 40 from the extremely hot zone of the producer where the air first meets the carbonaceous material. Thus the gas coming down the passage 42 is further superheated as it leaves the producer.

The burner may be of a very simple construction. The producer gas, composed mainly of CO, is inert until mixed with air. This mixing may be accomplished in various ways. As shown, the exit pipe 40 communicates with a vertical burner pipe 79 which is surrounded by another pipe 80 carrying air, and each of the concentric pipes opens into the combustion chamber 48 where the two gases intermingle. This mixing takes place within the combustion chamber and there can be no flare-back of exploding gas into the producer, since there is no oxygen available. The outer concentric air supply pipe may be made large enough to provide sufficient air for any amount of producer gas that is supplied; or the air may be provided in a regulated amount. If the air is always in excess in the combustion chamber, the producer gas will burn completely.

Thus the heat that is to be derived in the combustion chamber may be regulated merely by regulating the inflow of air to the producer and so controlling the amount of carbon monoxide and other inflammable gases that are formed. The sizes of the pipes are suitably controlled to provide the required amount of air, which is that of about 1.25 cubic feet of air for each cubic foot of CO gas that is to be burned.

It is preferred to regulate the air supply to the producer, as well as to the combustion chamber, by a valve or damper which provides a precise control of small amounts of air. The valve at the entrance to the producer comprises a hinged plate **50** which makes a sliding and tight contact with an arcuate plate **51** fitted into the passage in the entrance pipe **52** that communicates with the air inlet passage **16**. This plate prevents all passage of air except what goes through a triangular opening **54** in the plate, which tapers from a wide base at its top to an apex at the bottom. By swinging the valve plate **50** to an uppermost position, the air opening is made maximum. As the valve is moved downwardly towards the apex the air is cut off gradually, and when the valve passes the apex, no air can enter. It is often desirable to permit a slight leakage of air to the producer chamber so as to provide enough combustion to maintain the required temperature conditions more easily; but the air may be shut off entirely for fairly long periods of time, such as several hours. The air supply to the burner **79** is regulated by a similar construction, as will be described.

The operation of the gas producer and combustion furnace requires that the gas remain highly superheated until it has reached the combustion chamber. Hence it is desirable that the combustion chamber be located quite close to the producer so that the two form a single unit, and the pipe **40** should be thoroughly insulated if there is any material distance of separation between the producer and combustion chamber. The air pipe surrounds the gas pipe only near the exit, so as to prevent cooling the producer gas too soon. The structure of the combustion furnace may be as desired, such as a water walled hot water or steam furnace of standard construction or a hot air furnace as illustrated.

The construction shown indicates how the producer may be employed with a hot air furnace. The producer is arranged to form a producer and combustion unit which is transportable as a single body. In this construction, the outer shell **10** extends down the front face wall of the producer, and the rear and side walls **72** and the top wall **73** are arranged to form an enclosing casing for the hot air furnace. Inner side walls **74** and top wall **75** together with associated parts form an outer air jacket surrounding the producer and combustion unit which receives its heat therefrom. Air is admitted through an opening **76** into the bottom of this air space, and the heat passes outwardly through hot air pipes **77** arranged at the top. Various provisions well known in the heating industry may be employed in connection with this hot air heater.

The combustion zone is arranged to burn the gas in a vertical column, although other arrangements may be employed. In this case the exit pipe **40**, which comes from the producer, has an elbow that provides an upwardly extending pipe **79** surrounded by an air pipe **80**. The outer annular space between the two pipes is supplied with air through the horizontal inlet pipe **82**

having a flap damper **83**, the same as the damper **50** with its associated parts. Likewise, the vertical burner pipe **79** is provided with the two plates **84** arranged to form a triangle with the apex at the bottom, so as to introduce air into the interial of the flame. The baffle plate **85** aids in forcing air through the opening **86** to the space between the plates **84**.

In this construction, the wall **43** of the producer does not require a steel plate at its rear since the combustion flame strikes the back of the wall. That central division wall is common to both the producer and the combustion zone, and the wall is kept at a very high temperature by the heat on both sides of it and thus aids in the producer operation. A brick wall **88** may extend partway up around the combustion flame. The products of combustion travel from the combustion chamber **89** through the horizontal exit pipe **90** which is open at both ends. Various other constructions may be employed to absorb the heat from the combustion flame, but in each instance it is desirable that the combustion take place at a point close to the producer so that the gases will remain highly superheated if a smokeless atmosphere is to be obtained.

A primary feature of this construction relates to the employment of that type of insulation which will maintain an incandescent condition within the furnace and preferably approaching 2240° F. at which charcoal burns. An ordinary wood stove may be safely made of iron; but if iron is introduced into the gas producer above described, it very quickly melts or forms a scale of iron carbide under the normal temperature conditions there maintained.

The operation of this producer requires that the temperature be held above that point at which an iron retort could be safely used. Hence, the producer walls are made of highly refractory materials, which are herein termed dense and light weight bricks.

A dense firebrick is one of relatively high heat conductivity in which its K factor is from 6 to 12, that factor being the thermal conductivity or the amount of heat in B. t. u.'s (British thermal units) per hour passing by conduction through a section of the material 1 inch in thickness and 1 square foot in area per 1° F. Such a firebrick made of dense burned fire clay and weighing 8 pounds or more per brick will withstand a temperature up to about 3200° F. This is preferably used for the producer chamber lining.

An insulating firebrick having a K factor of 0.6 to 3.0 is a light weight brick of considerable porosity weighing from 1 to 3 pounds for the same size as the dense brick above defined. This lighter type brick serves to minimize the heat loss. It will withstand temperatures ranging from 1600 to 3000° F.

Although the bricks may be made of other refractory materials, such as magnesia or kaolin, it is preferred to make use of standard firebricks. Another factor is that of shocks and abrasion incident to charging the producer. A dense silicon carbide plate or tile may be used as an abrasion resisting lining or inner face of the producer chamber, provided it is backed by insulating refractory material of low heat conductivity. The preferred inner face of the producer is preferably made of a duplex fire tile. That is, the inner layer **14** is made of two different materials cast in two layers. The inner face of a satisfactory duplex fire tile has a K factor of 8 to 12 and may be a General Refractories Com-

pany No. 24 castable refractory, or a mixture of crushed dense firebrick and a binder of "Lumnite" cement or calcium aluminate. The outer layer of the duplex tile as installed in the producer may have a K factor of 2 to 3 and may be formed of Babcock and Wilcox insulating mix formed of crushed insulating refractory B and W No. K28 with a binder of "Lumnite" cement. The two layers are cast together and cured by air drying to form a tile or brick. The lining **12** next to the steel shell **10** may be made of light weight firebricks, such as Babcock and Wilcox No. K23, which have a K factor of 0.6 to 2.0. The rear wall **43** and the bottom **21** may be made only of the light weight or insulating brick of a K factor below 3.

The ratio of the thicknesses of these two types of refractory is preferably that of 1 for the dense brick to 4 for the insulating brick. That is, the dense layer on the inner face of the duplex tile which is exposed to the direct radiant heat of the producer may be 0.5" to 1" thick on the vertical side walls and about 1.25" thick on the rear wall and floor or other surfaces which may be struck by the wood thrown into the producer chamber. The total refractory thickness averages about 5.5" thick; and the light weight layer formed of the refractories **12** and the rear layer of the duplex tile is in the neighborhood of 4.5" thick.

A unit which is 46" high, 41" deep or long and 21" wide externally with refractory insulation about 4.5 to 5" thick weighs only from 660 to 750 pounds when made of the insulating and dense refractories as above defined. Such a producer will run efficiently if stoked every 12 hours, and in actual performance, the charcoal fire has remained alive for 72 hours and ready for use.

This insulation insures that the producer walls may be kept at the required temperature of at least 1800 to 2000° F. with the consumption of only a very small amount of fuel, so that the producer may be held in a substantially quiescent condition throughout the night if it is used for heating a home and it will be ready for the production of a large volume of gas as soon as the air inlet is opened the next morning. Also, the volume of the producer is preferably that which will hold enough wood for a day's consumption or at least 12 hours. If the producer were lined with the same thickness of a dense refractory, it would not be possible to prevent a serious heat loss and the defeat of the process or an expensive consumption of wood. To get the same internal temperature and to maintain the outside steel wall at a safe and reasonable temperature, it would be necessary to use about 4 times the thickness of dense bricks for the same temperature here required. This would be a very heavy and unwieldy piece of apparatus weighing at least a ton which would not be serviceable in the average home and small buildings.

It will therefore be appreciated that certain primary conditions are met in this construction. One is to cut down the heat loss through the wall and which might make the device unsafe in an average home because of the danger of fire. Another is to maintain the producer at the required temperature at which a substantially instantaneous response may be had when the air inlet is opened to produce gas. The heat within the producer must be impounded and stored there for the CO reaction when needed, and this heat storage must be maintained for a comparatively long period of time without the consumption of a material amount of fuel. This method of producing gas from wood in a first stage and then burning it in a superheated condition in a second stage is far more efficient in caloric output than is an ordinary wood burning stove. The fact that a complete control is maintained over the primary source of air and the fact that efficient insulation is employed obviates the need for a retort, as one bed of fuel serves not only to provide the needed fuel for heating, but also for the production of gas to be burned elsewhere for other purposes. This fact greatly increases the efficiency and B. t. u.'s obtained from the fuel employed.

Although the supporting structure for the refractory has been defined as being made of metal plates, yet it will be understood that this supporting wall may comprise a metal frame carrying plates of refractory material. For example, the supporting and outside wall may be made of cast asbestos plates carried in a metal framework and within which is mounted the firebrick or refractory structure. Various other expedients may be adopted, and these are to be interpreted as embraced within the scope of the appended claims. Also, since nitrogen and other inert gases in air are inert, these are merely diluents and are not products of the gas producer, and their presence has been ignored in the above discussion.

Various modifications may be made in the structure as will now be apparent, and numerous applications of this method may be made; hence the above disclosure is to be interpreted as describing the principles and preferred aspects of this invention and not as imposing limitations on the appended claims.

I claim:

1. A household wood fuel combustion furnace comprising a single outer casing providing spaces for a gas combustion zone and a gas producing chamber, refractory walls within said casing forming a gas producing chamber having a fuel inlet opening an air inlet and a gas exit opening and which comprise an outer layer of refractory material of low heat conductivity for protecting the adjacent portions of the casing, an inner layer of shock resistant refractory material of high heat absorption capacity contiguous to the outer layer, a floor of shock resistant refractory material for supporting the fuel adjacent to the air inlet, and a removable closure for sealing the fuel inlet opening, the interior wall portions of the chamber being capable of withstanding and impounding the developed heat of combustion and thereby operatively maintain the gas and fuel superheated at a temperature in excess of 1800° F., regulatable means for supplying only a controlled amount of air to the air inlet and governing the fuel combustion and the production of producer gas in said chamber, a burner pipe leading from the producer chamber gas exit opening and having a burner at its outer end, means for admitting air in excess to the gas issuing from the burner, and means within said casing, including heat exchanging walls, which forms a zone for the combustion of the producer gas issuing from the burner.

2. A wood combustion furnace according to claim 1 wherein the inner layer is a dense refractory whose K factor is above 6, and the outer layer has several times the thickness of the inner layer and is made of light weight refractory of low heat conductivity having a K factor below 3, said layers having a total thickness related to the heat conductivity which insures impounding heat of combustion and maintaining a

low external surface temperature and an interior temperature above 1800° F.

3. A wood combustion furnace according to claim 1 comprising a baffle wall of refractory material in the high temperature chamber which forms a down draft passage opening at the top of the chamber, and wherein the burner pipe connects with the lower end of the passage.

4. A wood combustion furnace according to claim 1 comprising a vertical baffle wall of refractory material in the producer chamber in front of and spaced from the gas exit opening which forms a down draft passage from the top of the chamber to the exit opening, said baffle wall having a hole for the passage of a limited quantity of gas and a direct radiation of heat from the chamber to the exit opening.

5. A furnace according to claim 1 in which the floor of the chamber has vertical openings communicating with a horizontal air passage therebeneath which are arranged for leading air from the air inlet to the producer chamber, and comprising spaced refractory supports for holding the fuel above said vertical openings.

6. A wood combustion furnace according to claim 1 in which the means for admitting air to the gas issuing from the burner pipe comprises an air inlet pipe surrounding the burner pipe, a regulating valve controlling the flow of air thereto and means including baffles for introducing air into the interior of the burner flame and around the gas issuing from the burner pipe.

7. A furnace according to claim 1 comprising a refractory wall around the burner flame in the combustion zone which forms an open ended passage for the burning gas and prevents a direct contact of the gas flame, where it issues from the burner pipe, with the heat exchanging walls.

8. A furnace according to claim 1 in which the refractory walls of the producer chamber comprise a division wall separating and common to the producer chamber on one side and the combustion zone on the other side, so that heat transmitted through the division wall as well as that derived from the burner may be absorbed by the heat exchanging walls of the combustion zone.

9. A household wood fuel combustion furnace comprising a unitary hollow metal shell, refractory walls therein forming an enclosed gas producing chamber in a part of the shell space which has a fuel inlet, an air inlet and a gas outlet, said walls including a refractory top, an outer layer of refractory material of low heat conductivity mounted on the inner surface of the shell and protecting a side portion of the shell, a lining contiguous to said layer which is made of shock resistant refractory material of high heat absorption capacity, a shock resistant, heat retaining refractory floor for supporting fuel near the air inlet, a removable refractory lined closure for the fuel opening and a refractory division wall of high heat absorptive capacity which is spaced from the shell and forms a common wall dividing the shell into said chamber and an external combustion zone within the shell, means including heat exchange walls within said shell which cooperate with the division wall to complete said zone in which the producer gas is burned, a short burner pipe for leading the gas from said outlet into said zone, means for admitting air in excess to the burner pipe to burn the gas issuing therefrom, and regulatable means for admitting only a controlled amount of air through the air inlet of the producer chamber and thus regulating the rate of gas production, the refractory walls of the gas producing chamber being capable of impounding heat of combustion and maintaining an operative temperature of at least 1800° F. for a considerable period of quiescence within said chamber.

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