(No Model.) 2 Sheets—Sheet 1.

M. M. ARMSTRONG.

SMOKELESS COMBUSTION OF FUEL.

No. 522,187. Patented July 3, 1894.

Fig. 1.

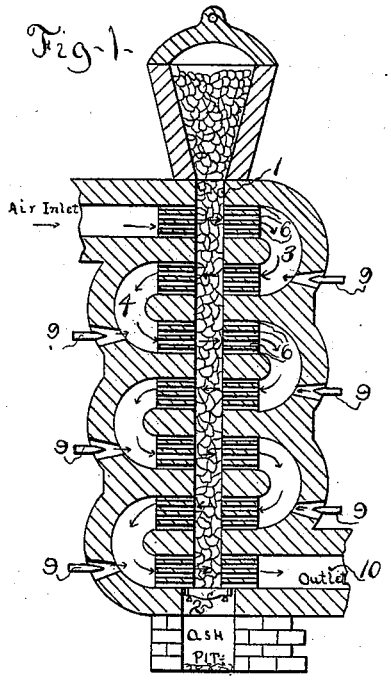


Fig. 2.

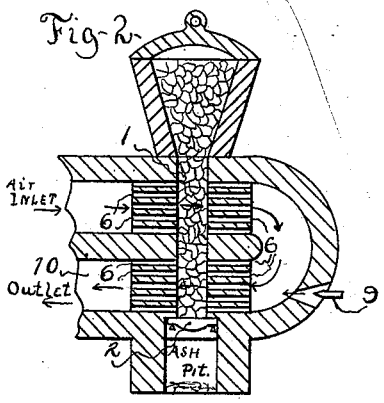


Fig. 3.

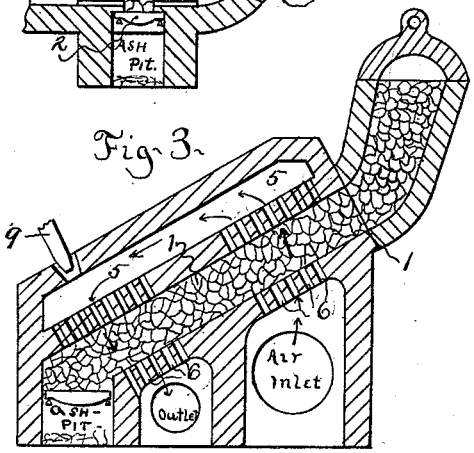


Fig. 4.

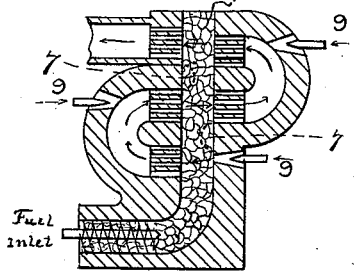


Fig. 6.

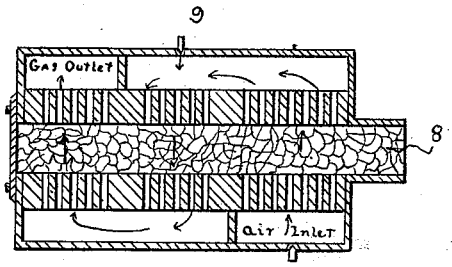
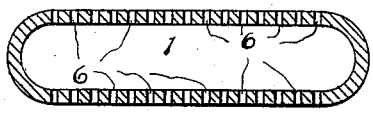


Fig. 5.



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(No Model.) 2 Sheets—Sheet 2.

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SMOKELESS COMBUSTION OF FUEL.

No. 522,187. Patented July 3, 1894.

Fig. 7.

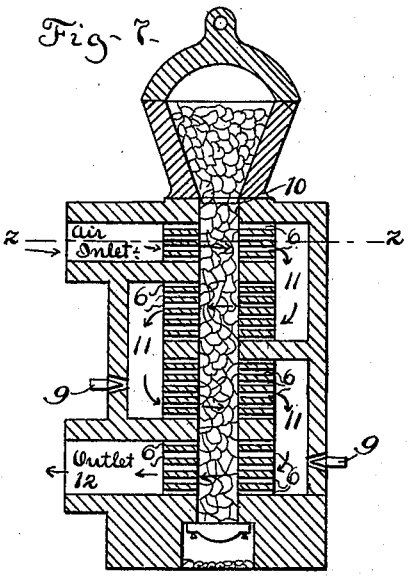


Fig. 8.

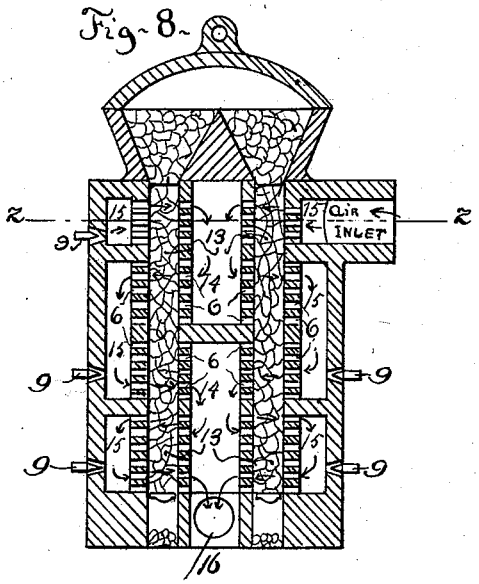


Fig. 9.

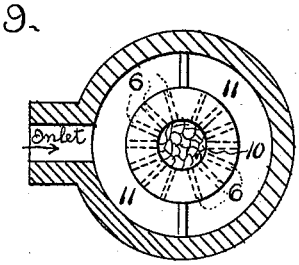
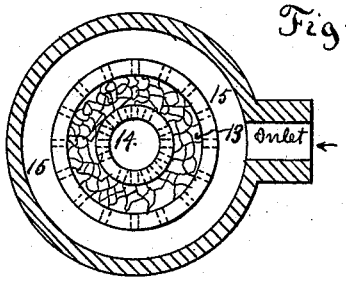


Fig. 10.



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UNITED STATES PATENT OFFICE.

MEYLERT M. ARMSTRONG, OF PHILADELPHIA, PENNSYLVANIA.

SMOKELESS COMBUSTION OF FUEL.

SPECIFICATION forming part of Letters Patent No. 522,187, dated July 3, 1894.

Application filed February 12, 1894. Serial No. 499,984. (No specimens.)

To all whom it may concern:

Be it known that I, MEYLERT M. ARMSTRONG, a citizen of the United States, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented certain new and useful Improvements in Smokeless Combustion of Fuel; and I do hereby declare the following to be a sufficiently full, clear, and exact description thereof as to enable others skilled in the art to make and use the said invention.

This invention relates to the combustion of fuel for the more complete development of caloric by converting the fuel into combustible gases by the aid of air or air and steam, and has for its object the thorough conversion of the fuel into combustible gases, whereby hydrocarbons or other volatilizable portions of the fuel are prevented from becoming afterward condensed in the form of smoke or soot, but assume a gaseous character susceptible of clean combustion, and are completely utilized with the other combustible portions of the fuel.

Briefly stated the process or method may be said to consist in first igniting a charge of fuel in a furnace chamber or retort of considerable length and permitting it to burn by natural draft until the combustion of the entire fuel column has commenced, the products of combustion during this stage of the operation being permitted to escape after which the vessel is closed, and currents of air more or less heated are passed transversely through perforations in the retort or furnace, and the fuel column as it is consumed and progresses through the furnace or retort, and further on in the length of the retort returning the gaseous products with additional air or air and steam transversely through the portion of the fuel in the retort or vessel through the portion which has previously been treated and partly consumed, and repeating this operation or process of returning the products of combustion with air, or air and steam any desired number of times, so that the hydrocarbons and other combustible portions of the fuel become converted into combustible gas which does not precipitate carbon, and is thus consumed with complete exhaustion and good economy of the combustible. As the fuel column in the retort is consumed and subsides additional fuel is added from time to time which ignites from that already in the retort and also from the heat of the retort, so that the operation is continuously maintained, and a continuous supply of fuel gas susceptible of smokeless combustion is discharged.

The accompanying drawings represent an apparatus in several forms adapted to conduct this process.

Figure 1 is a vertical section of one form in which the air and products of fuel combustion repass six times through the fuel; Fig. 2 a vertical section in which they return once and pass twice across and through the fuel, in both these instances being in a vertical chamber or retort. Fig. 3 shows an inclined retort in which a like process is conducted. Fig. 4 shows a vertical retort in which the fuel is fed in at the bottom and forced upwardly, and the gas and products of combustion return twice through the fuel. Fig. 5 shows a cross section of a preferable form of retort for this purpose. Fig. 6 shows a horizontal section of a furnace in which fuel is fed horizontally in the direction of the length of the furnace and air, or air and steam, transversely through it; Fig. 7 a cylindric vertical retort or furnace with annular air supplying and gas conducting chambers surrounding it. Fig. 8 shows an annular retort with both a central and an annular series of air supplying and gas conducting chambers. Fig. 9 shows a horizontal section of the furnace depicted in Fig. 7, made in the plane indicated by the dotted line z, z, in Fig. 7. Fig. 10 shows a horizontal section made in the plane indicated in the dotted line x, x, in Fig. 8.

Referring to Figs. 1 and 2, the fuel is supplied in the retort 1, and the fire kindled in the ordinary method as in a stove upon a grate 2, and supplies the fuel until about two thirds full more or less, the combustion being by natural draft, and the products of combustion during this kindling operation being allowed to waste, and when the fuel is fully ignited, and the retort filled with fuel and closed so as to stop the further waste of the products of combustion the normal operation commences as follows:—A current of air is passed transversely across the upper part of the retort through the perforated walls 6 thereof, and entering a chamber 3, returns from said cham-

ber through the fuel and retort to the chamber 4, and thence to another chamber, passing and repassing across and through the fuel in the meantime fuel is continuously supplied at the top of the retort, and as it is exhausted it sinks, and becomes heated to incandescence and comes in contact with the products of combustion of the former combustions, and air preferably in heated condition, which is admitted in the several chambers 3 and 4, either alone or together with steam, so as to augment the amount of oxygen supplied and increase the liberation or generation of gas. The gas, after finally passing through the fuel as the fuel becomes exhausted at the grate, may be immediately ignited for use, or may be collected, washed, purified and stored for the purpose of distribution and later consumption.

The distance between the points of discharge of gas and products of combustion from the retort 1 to the point of re-entering the retort from the channel or chamber 3, should be such relatively to the diameter of the retort that the gases and air or air and steam shall find an easier exit to the next chamber 3 on the opposite side of the retort from the point of re-entrance than by flowing lengthwise through the column of fuel in the retort 1.

Referring to Fig. 3 the retort 1, is placed in an inclined or oblique position, and the fuel fed downwardly through it. In this retort the fuel is ignited in the same manner as in that described in the previous figures and is similarly fed, the fuel becoming heated to incandescence in its descent as it is exhausted or consumed. Air entering transversely near the upper end, passes through the perforations in the walls 6, and passes across the retort; thence to the chamber 5, where the further supply of air is mingled with it and again passes transversely through the retort, and through a part of the charge which has already been subjected to the first air supply with which it combines and is withdrawn below the retort as combustible gas, whence it is used by being withdrawn for calorific purposes under boilers, and furnaces or other apparatus requiring heat.

In the form shown in Fig. 4 the retort 1 is vertical; fuel, however, is fed at the base and forced upwardly, and the primary air current enters the retort near the base, and rises in the retort and passes transversely across the retort, returning again with an increased supply of air, and so on, passing and repassing, until the top of the retort is reached. Obstructions 7, 7, as indicated in dotted lines, may be placed in the retort so as to compel the products of combustion to traverse transversely rather than vertically in the retort; but by judicious proportioning of the form of the retort this may become unnecessary. In this retort the fuel is ignited by kindling from the bottom, and the top is left open until the fuel is fully ignited to incandescence after which it is closed and the normal operation of feeding from below proceeds.

A preferred form of retort is shown in cross section in Fig. 5.

Fig. 6 shows yet another form of retort marked 8 in which the fuel is ignited as in an ordinary furnace and then filled and thereafter is forcibly fed lengthwise, say from the right to the left and as it is consumed heats to incandescence in its progress and the air current passes transversely through it in a horizontal direction, receiving an augmentation of air, or air and steam from the returning channels or chambers 3 at each time when it returns into the retort, so that the air and the free gases resulting from the combination of air and decomposed steam are thoroughly charged with carbon and rendered combustible in the highest practicable degree. The gas thus generated passes through a final contact of the incandescent fuel and has a high heating value. If burned immediately it utilizes the heat developed in its generation, and when stored is adapted to the purposes of gas engine propulsion, metalurgical furnaces, steam generation, and in short to any of the uses to which gaseous fuel may be applied, and with proper burners may be used for culinary and illuminating purposes.

Referring to Figs. 7 and 9 the fuel is ignited as in the case of the retort shown in Fig. 1, and is continuously fed in the top of the cylindric retort 10, and as it is consumed heats to incandescence and air is introduced through perforations 6, in the retort 10, and gas passed from the retort 10, into the annular chamber 11, where it mingles with additional supplies of air or air and steam, and re-enters repeatedly and passes transversely through fuel in the retort for further combination therewith at points further from the inlet and the resultant gases are discharged through the flue 12.

Referring to Figs 8 and 10 fuel is ignited and fed as in Figs. 1, 7, and 9, in the top of a perforated retort 13 but the retort differs in being of annular form and the products of combustion and additional air or air and steam pass and repass through it to and from central chambers 14, and annular surrounding chambers 15, and is finally discharged for use at the flue 16, and in the same manner and with like effect as in preceding figures.

The several forms of apparatus hereinbefore described and shown are not herein claimed as part of this invention but are the subject of another application for Letters Patent.

Having described this invention, what I claim is—

A new and improved method and process of utilizing solid fuel consisting in progressively passing such fuels through a retort, chamber, or vessel and repeatedly passing across and through such fuel currents of aeriform fluid with products of previous com-

bustion, so that the fuel which had been previously but partially consumed with the first passage of air through it, is further consumed by a second and further passage of the products of previous combustion, and so on, until exhausted and the entire combustible portion converted into gas susceptible of smokeless combustion, substantially as set forth.

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