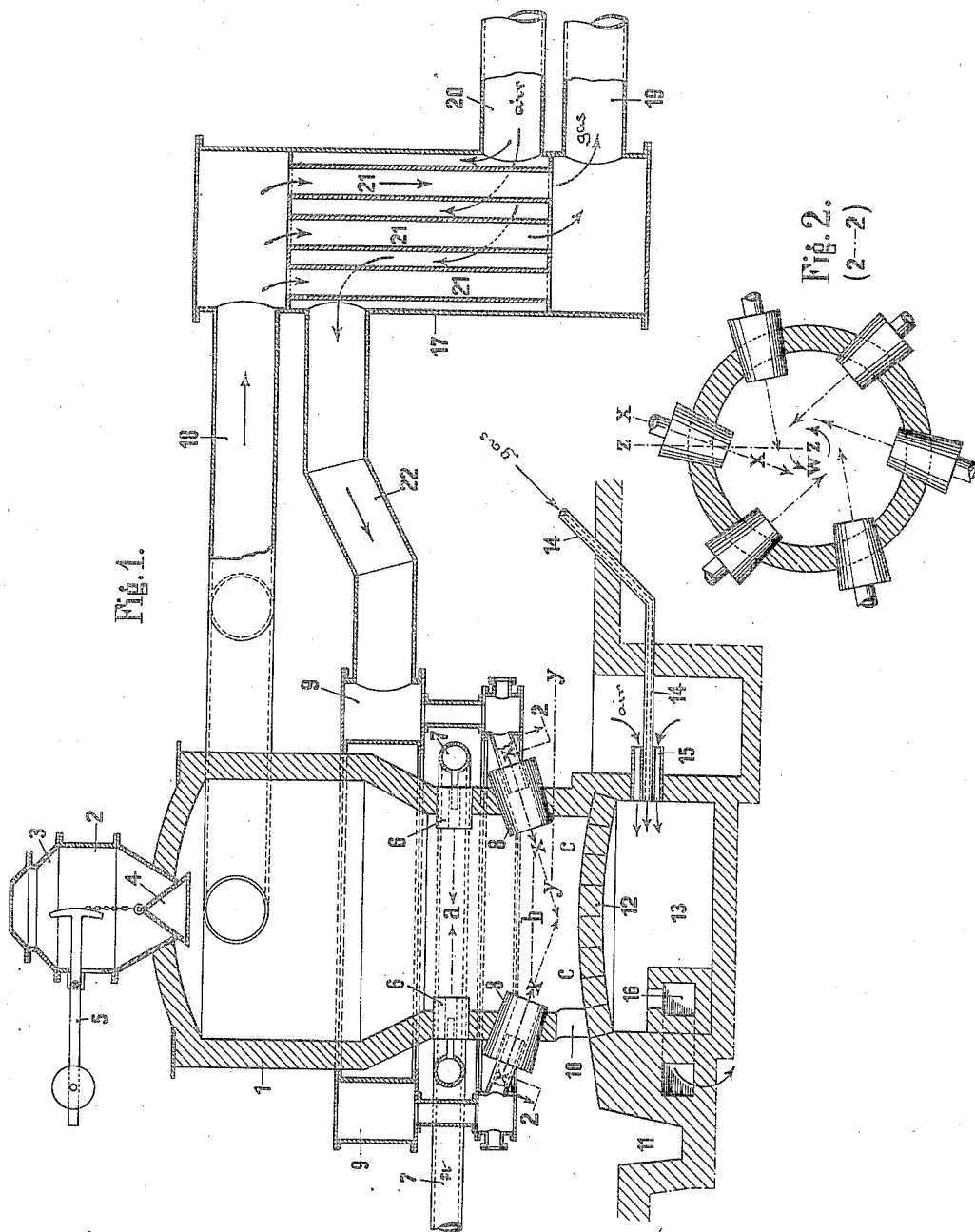


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METHOD OF AND APPARATUS FOR GENERATING PRODUCER GAS.
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UNITED STATES PATENT OFFICE.

EMMANUEL SERVAIS, OF LUXEMBURG, LUXEMBURG.

METHOD OF AND APPARATUS FOR GENERATING PRODUCER-GAS.

1,098,534.

Specification of Letters Patent.

Patented June 2, 1914.

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To all whom it may concern:

Be it known that I, EMMANUEL SERVAIS, a citizen of the Grand Duchy of Luxemburg, residing at Luxemburg, in the Grand Duchy of Luxemburg, have invented certain new and useful Improvements in the Method of and Apparatus for Generating Producer-Gas for Power and Heating Purposes, of which the following is a specification.

This invention relates to the manufacture of producer-gas for power and heating purposes, performed with discharge of the slag in a liquid state and the object of the invention is to provide means whereby the production of gas from fuel, more particularly from inferior fuel such as coal-waste, coke-waste, brown coal or lignite, can be performed without premature formation of slag in the charge, liable to cause obstruction; and with security of maintaining the slag in a liquid state in the slag pan, from which it can be drawn off freely at intervals.

In connection with gas-producers discharging liquid slag, that is to say producers working with blast, it is found that obstructions by slag are particularly liable to occur above the twyers admitting the blast. Arches are formed in the charge, which prevent access of fresh fuel to the twyers. The blast sweeps through the upper layers and causes combustion, whereby liquid is formed, which flows downward toward the colder blast and solidifies, causing obstruction. According to the present invention this is prevented by restricting the melting of the ash to the twyer zone, the charge above this zone being cooled to a temperature below that at which slag is formed, the cooling being effected by introduction of gases or vapor, for example, steam or carbon dioxide, the decomposition of which absorbs heat.

The proper temperature for the fuel is ascertained by taking the temperature of the gases issuing from the generator, and this latter temperature depends on the nature of the fuel used. In the case of fuel containing volatile constituents or much water, the temperature of the gas is low, sometimes even under 100° C., whereas in the case of coke and fuel with a low percentage of vola-

tile constituents, such as anthracite, the gas is usually at a temperature between 450 and 500° C.

The cooling of the charge, as indicated is not in itself sufficient to allow of continuous working of the generator. In order to allow of such working it must be possible to draw off the slag at intervals in a thin liquid state. Slag is a bad heat-conductor, and the slag hearth is cooled by radiation and conduction, so that a solid crust of slag is liable to be formed on the bottom and walls thereof, whereby the opening of the gate is rendered difficult. As the thickness of the crust on the bottom increases, the outlet hole must be made at a higher level, and ultimately there is risk of slag entering the twyers and stopping the work. To prevent this incrustation I heat the hearth externally. Though this does not increase the temperature of the slag, which is not necessary, it prevents such difference of temperature between the contents of the hearth and its surroundings as is liable to cause solidification of slag.

From the fact that slag is liable to solidify on the bottom and walls it is clear that the temperature of the slag bath is not uniform throughout the bath. The action of the external heating in preventing incrustation, can accordingly be assisted by providing for uniform distribution of heat in the bath, and this can be done by continuously agitating the bath. For this purpose I use the blast, arranging twyers downwardly and laterally inclined so that they deliver the blast in a manner which causes circulation of the bath.

It has been observed that solidification of the slag becomes more rapid as the slag approaches the blast, from which it appears that the blast favors solidification. I attribute this solely to the coldness of the air blown into the generator. Hot blast, directed as described on to the bath, produces jets of flame which impinge on the bath and further reduce the tendency to solidification of the slag. Inferior fuels, such as coke dust, in a divided state, and lignite which breaks up when gas is evolved therefrom, have heretofore been made into briquets prior to use in a generator discharging liquid slag, as otherwise the blast makes channels

through the charge, and causes carbon dioxide to be produced instead of carbon monoxide, or even leaves free oxygen in the gas. With my invention the cost of briquetting can be saved, because the steam vapor or gas introduced above the tuyers, for cooling the charge, maintains the more or less divided fuel in a loose state, owing to absence of formation of slag, and channels formed by the blast are quickly broken down by the steam or gas entering under pressure. The maintenance of the charge in a loose state by the gas or steam, as described, also obviates the necessity for poking or raking the charge. It is found that the tendency to formation of channels by the blast is greatest at the sides of the generator. Accordingly it is found advantageous to give the steam inlet ports a lateral inclination, so that the steam sweeps in a more or less tangential or chordal direction. This arrangement also increases the uniformity of the mechanical effect of the steam, over the cross-section of the charge, and prevents "dead corners," more especially at the sides, where the formation of slag is most dangerous, as adhesion of slag to the walls obstructs the descent of the charge.

In producing gas from fuel of low specific weight, for example coke dust, it is found that some fuel is carried upward by the stream of gas and is withdrawn from the zone of combustion. This is more particularly the case when working with abundant blast at comparatively high pressure. I overcome this difficulty by more or less saturating the fuel with milk of lime, whereby the fuel is rendered sufficiently heavy to prevent it from being carried upward by the blast. The milk of lime also has a favorable effect on the composition of the slag. The hydrate of lime does not give off its water until a high temperature is obtained, but then the water is in part decomposed and enriches the gas. Though I primarily intend the addition of milk of lime for use with light fuel which is in a divided state or is liable to crumble, I may use the same with any other kind of fuel which is porous or capable of absorbing the liquid.

An important factor in regard to free withdrawal of liquid slag at intervals is the uniformity of the composition of the slag, as the melting point depends on the composition. Difficulty has heretofore been encountered in this respect and this I attribute to the fact that some flux, such as limestone, has been used to make the ash melt, and the melting only takes place where the flux is brought into contact with ash at the requisite temperature. Clearly it is essential to have a proper mechanical mixture of flux and ash, in order that no solid limestone may pass down into the hearth, and thus be withdrawn from action on the ash

and cause variations in the chemical composition of the slag, rendering the latter at times viscous and at times thin. Moreover, the proportion of ash varies at times, so that the mere addition of a flux such as limestone cannot result in a uniform product, because the requisite quantity of flux cannot at all times be known. In practice it is impossible to insure uniformity by taking samples of the slag and analyzing the same. I meet this difficulty by using finished slag as a flux, the composition of which comprises lime, alumina, silica, etc., like the slag discharged from the generator, the lime being in such proportion as to enable the slag to perform the function of the limestone heretofore used. A slag suitable for this purpose is blast-furnace slag. The silica in the ash combines with part of the lime in this slag, and the remainder of the lime, together with the silica, alumina, etc., in the blast-furnace slag, is drawn off with the generator slag. This addition forms a kind of regulating factor in regard to the composition of the slag, so that the variations in quality are slighter than if limestone or the like is used as flux. The slag-flux melts at a temperature below that at which slag is formed, and its melting is not dependent on contact with another ingredient of the charge. Whereas, in case of some irregularity in the charging or the like, some limestone would pass unmelted into the slag-hearth, the slag-flux under the same conditions melts and carries with it some ash into the hearth, melting the said ash, and the remainder of the ash, falling unmelted into the hearth, encounters there sufficient lime to cause it to melt.

Another advantage of using blast-furnace slag as a flux lies in the fact that the slag entering the hearth is always at the same temperature, and the amount of slag obtained per unit of time is considerably greater than if limestone is used as flux. The temperature of the bath is much more uniform.

Apparatus for working according to my improved process is shown in the accompanying drawings, in which—

Figure 1 is a vertical section thereof, and Fig. 2 a cross section on the line 2—2 of Fig. 1.

In the drawing 1 designates the generator, at the top of which is a charging hopper 2, with lid 3 and bell valve 4 controlled by a lever 5. In the lower part of the generator there is a cooling zone *a*, into which steam is admitted by means of nozzles 6 connected to a steam pipe 7. Instead of steam, I may use other vapor or gas the decomposition of which absorbs heat, that is to say causes part of the heat to become latent. As already mentioned the nozzles 6 are preferably laterally inclined, *i. e.* tangential to an

imaginary horizontal circle in the generator, in the same manner as shown in Fig. 2 for the blast twyers 8. Below the zone *a* is the combustion zone *b*, into which extends the
 5 twyers 8 connected to the blast pipe 9. Below the combustion zone is the hearth *c* for the slag, the slag being discharged through a gate 10 into a trough 11.

As shown in Fig. 1 the axes *x, x* of the
 10 twyers 8 are downwardly inclined to the horizontal plane *y—y* below the twyers, so that the blast impinges on the slag bath. As shown in Fig. 2, in which *z z* is a radial
 15 line from the center of the generator, the axes *x* are also laterally inclined, or tangential to a circle within the generator, so that the blast produces a kind of eddy, as indicated by the arrow *w*, and the slag bath
 20 is maintained in constant circulation, where- by solid constituents thereof, if accidentally present, are quickly reduced to a liquid state, and the bath is rendered uniform throughout in its composition. Below the
 25 convex floor 12 of the slag-pan there is a heating chamber 13, to which combustible gas is supplied by a pipe 14, and air by pipes 15, the products of combustion being carried to a chimney by a flue 16. The noz-
 30 zles 6 and twyers 8 may be cooled by water, but means for this purpose are not shown in the drawing. The air supplied to the blast pipe 9 passes through a heater 17, through which the gas produced in the generator passes on its way from the eduction pipe 18
 35 to the gas pipe 19. The cold air for blast- ing the generator flows from a pipe 20 into the heater 17, and passes in the latter around the vertical passages 21 through which the
 40 producer gas flows, the heated air then pass- ing through a pipe 22 to the pipe 9, and twyers 8.

In operation, the producer is kept con-
 45 tinuously charged with a suitable quantity of carbonaceous fuel mixed with a suitable flux, if desired, the lower portion of the charge being maintained at a gasifying tem-
 50 perature by blasts of heated air injected through the twyers 8. The intense heat causes combustion of the fuel, the heat pro-
 55 duced being sufficient to completely gasify the carbonaceous portion of the charge and to melt the mineral ingredients, the molten material collecting in the hearth *C*. In order to prevent fusion above the zone of the
 twyers, a sufficient quantity of steam or other endothermically decomposable gas or vapor is introduced through the twyers 6. As by my invention, ample provision is made for taking care of the slag produced, the
 10 high temperature, above 1000° C., required for the complete formation of carbon mon-
 oxid, may be continuously maintained. As the charge is kept below the slag fusion tem-
 15 perature until the zone incandescence at the twyers is reached, there is no danger of

clinkering, and the free carbon is completely gasified. When the charge reaches the neighborhood of the twyers, the slag-form-
 ing ingredients are completely melted, and, by my method of heating the slag-hearth, are maintained in fluid condition until
 70 tapped from the producer.

What I claim is:

1. An improvement in the manufacture of gas in a gas producer, which consists in
 75 maintaining a gasifying temperature at the lower portion of the fuel charge by a blast of air introduced through twyers, cooling the charge above the twyers to a tempera-
 80 ture below that of slag fusion by introduc- ing thereinto a gas or vapor which decom-
 85 poses with absorption of heat, permitting molten slag to accumulate on a hearth be-
 low the twyers, and supplying additional heat to the slag to prevent solidification
 thereof.

2. An improvement in the manufacture of gas in a gas producer, which consists in
 90 maintaining a gasifying temperature at the lower portion of the fuel charge by a blast of air introduced through twyers, cooling the charge above the twyers to a tempera-
 95 ture below that of slag fusion by introduc- ing thereinto a gas or vapor which decom-
 100 poses with absorption of heat, permitting molten slag to accumulate on a hearth be-
 105 low the twyers, and maintaining the slag in molten condition by heating the hearth.

3. An improvement in the manufacture of gas in a gas producer, which consists in
 100 maintaining a gasifying temperature at the lower portion of the fuel charge by a blast of air introduced through twyers, cooling the charge above the twyers to a tempera-
 105 ture below that of slag fusion by introduc- ing thereinto a gas or vapor which decom-
 110 poses with absorption of heat, permitting molten slag to accumulate on a hearth be-
 low the twyers, maintaining the slag in molten condition by heating the hearth, and
 115 agitating the slag bath by causing the heat- ed blast to impinge thereon.

4. In a method of manufacturing gas in a gas producer by maintaining a gasifying
 115 temperature at the lower portion of the charge by a blast of air introduced through twyers, the step which consists in injecting a gas or vapor, which decomposes with ab-
 120 sorption of heat, chordally into the charge above the blast twyers, thereby maintain-
 ing the charge below the temperature of slag fusion and preventing the formation of channels therein.

5. The method of manufacturing gas in a gas producer, which consists in adding to
 125 the fuel a preformed slag flux having a melting-point below the temperature of fu-
 sion of the fuel-ash, maintaining a gasify- ing temperature by a blast of air introduced
 130 through twyers at the lower portion of the

charge, cooling the charge above the twyers to a temperature below that of slag-fusion by introducing thereinto a gas or vapor which decomposes with absorption of heat, and permitting molten slag to accumulate on a hearth below the twyers.

6. The method of manufacturing gas in a gas producer, which consists in adding to the fuel a slag flux having a melting-point below the temperature of fusion of the fuel-ash, maintaining a gasifying temperature by a blast of air introduced through twyers at the lower portion of the charge, cooling the charge above the twyers to a temperature below that of slag-fusion by introducing thereinto a gas or vapor which decomposes with absorption of heat, permitting molten slag to accumulate on a hearth below the twyers, and supplying additional heat to the slag to prevent solidification thereof.

7. In a gas-producer operating with discharge of liquid slag, the combination of blast twyers, means for injecting gas or vapor into the charge above said twyers, and means for supplying heat to the slag below said twyers.

8. In a gas-producer operating with discharge of liquid slag, the combination of blast twyers, with nozzles located above said twyers for introducing gas or vapor into

the charge, the axes of said nozzles being tangential to a circle within the producer.

9. In a gas producer, a shaft, twyers for injecting air located in the lower portion of the shaft, a slag hearth beneath the twyers, and means for continuously supplying heat to the exterior of the slag hearth to maintain the fluidity of the slag therein.

10. In a gas producer, a shaft, twyers for injecting air located in the lower portion of the shaft, a slag hearth beneath the twyers, and means for externally heating the slag hearth.

11. In a gas producer, a shaft, twyers for injecting air located in the lower portion of the shaft, and a slag hearth beneath the twyers, said twyers having their axes downwardly and laterally inclined.

12. In a gas producer, a shaft, twyers for injecting air located in the lower portion of the shaft, a slag hearth beneath the twyers, said twyers having their axes downwardly and laterally inclined, and means for heating the exterior of the slag hearth.

In testimony whereof I affix my signature in presence of two witnesses.

EMMANUEL SERVAIS. [L. s.]

Witnesses:

HELEN NUFER,
ALBERT NUFER.