

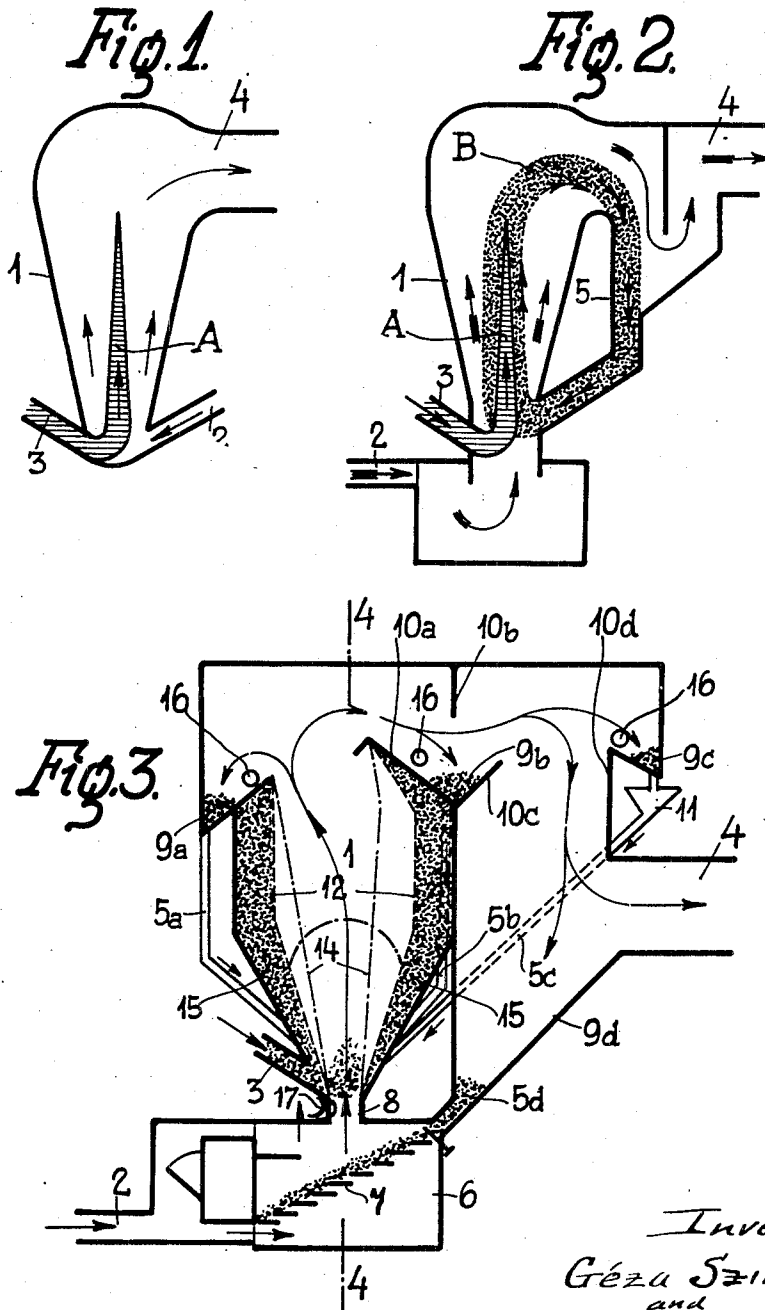
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PROCESS FOR GASIFYING AND DISTILLING COAL DUST

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A PROCESS FOR GASIFYING AND DISTILLING COAL DUST

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This invention relates to the gasification of fuel and it relates more particularly to the gasification and distillation of coal dust.

The process of producing gas from coal dust suspended in a current of air is not unknown in the art, but previous proposals for the attainment of this end have not been entirely successful, since the endothermic reaction in the reduction of carbon dioxide to carbon monoxide is comparatively slow, so that the period of time, during which the coal dust is traveling through the combustion chamber is insufficient to allow the substantially complete reduction to carbon monoxide which is desirable in a commercially operable plant.

The theoretical desideratum is an apparatus in which coal dust introduced into the combustion chamber is completely gasified so that the products of combustion will be producer gas with a high content of carbon monoxide and completely spent ashes.

The lack of a reaction period of sufficient length cannot be balanced by increasing the surface available for combustion by reducing the size of the particles of coal, since such a decrease would result in an increase of the velocity at which the coal dust travels through the combustion chamber, up to the velocity of the gas. In addition to this the conditions of the reaction would be impaired, since the velocity of the gas flow with respect to the velocity of the coal dust would be decreased.

Nor could the reaction period be increased in point of time by increasing the dimensions of the combustion chamber without having such chamber of such size as to be commercially impracticable.

The object of this invention is to provide an improved method of gasifying and distilling coal dust in a partial combustion chamber of relatively small dimensions without decreasing the size of the particles of coal or the time of reaction available. A further object of this invention is to provide means for gasifying coarse, unsieved coal dust such, for example, as a mixture of coal dust less than 5 mm. in size, that is, a mixture of fine coal dust, slack coal, and pea coal.

Reference has been hereinbefore and will be

hereinafter made to coal dust as the substance under treatment, but it is to be understood that this is merely by way of example and that the invention contemplates the use of any finely divided fuel.

The above objects and others which will become apparent upon perusal of this disclosure and the appended claims are attained by forming a flame of fresh coal dust held in suspension by a current of air, with a reduction in the supply of oxygen available for combustion, and maintaining about such flame a circulating curtain of incandescent coal or coke dust consisting of a substantially constant quantity of such material.

The invention will be more clearly understood by reference to the annexed drawing in which:

Fig. 1 is a schematic showing of the operation with the showing of the apparatus in vertical section;

Fig. 2 is a schematic showing of the operation of suitable apparatus in performing the method or process of the invention, with the showing of the apparatus in vertical section;

Fig. 3 is a diagrammatic sectional elevation of a complete apparatus in operation to perform the method or process of the invention.

With reference to Fig. 1, showing the operation of the heretofore known coal-dust gas producer, 1 is an upwardly flaring shaft, having bottom openings 2 and 3 for the introduction of air and coal dust respectively, the coal dust being driven upwardly. The inner hatched cone A signifies the quantity of coal dust at different levels in the shaft 1, the arrow in the outline of the cone indicating the upward direction of travel of the coal dust and the arrows on opposite sides indicating the upward direction of flow of the air from its point of introduction through the bottom opening 2. As indicated by the cone A, the quantity of coal dust diminishes progressively during its rise, owing to combustion, so that only gases leave the shaft at 4 in the direction indicated by uppermost arrow in Fig. 1. In the short period, during which the coal dust travels upwardly through the shaft, in addition to the combustion to carbon dioxide, the reduction of the evolved carbon

dioxide to carbon monoxide should but does not take place to a degree meeting the practical requirements, due to the fact that for this latter reaction only a small fraction of the height of the shaft is available in which the necessary absence of free oxygen and the temperature required for reduction prevail.

A novel feature of the invention resides in the maintenance, and means therefor, of a curtain of incandescent coke dust, indicated in Fig. 2 by the dotted stream B, which circulates in a closed circuit through the gasifying chamber 1 and the return channel 5, a portion of such curtain or stream B at all times surrounding the region of active combustion indicated by the cone A. This circulation is brought about by the inertia of the particles of coke dust, and their greater specific gravity than the gases in which they are suspended, which cause such particles to continue to flow downwardly when such gases turn upwardly around the baffle into the passage 4.

The reactions are thought to be as follows:

A portion of the freshly introduced coal dust A is burned to carbon dioxide as it enters the shaft 1. The carbon dioxide is reduced to carbon monoxide by coming in contact with the great surface presented by the particles of incandescent coke circulating in the stream B, with a consumption of the excess heat generated by the combustion of the quantity of coal burned to carbon dioxide. The particles of the stream B consumed by the gasification will be replaced by particles of the coal dust current A, heated to incandescence, so that a state of equilibrium is maintained in the plant and the quantity of incandescent coke dust circulating in the closed circuit B is kept substantially constant.

In order that the quantity of coke dust circulating in the stream B may be observed, a window (not shown) may be provided in the return channel 5 or in a branch thereof or by an observation funnel as 11 in Fig. 3, or by burning a fraction of the return stream B with the fresh air to be introduced into the gasifying chamber and measuring the temperature of combustion developed.

With reference to Fig. 3, 1 is an upright shaft flaring upwardly from its bottom opening 8. The shaft is provided with a draft chamber 6, having the step grate 7 therein disposed. Air or oxygen is introduced at 2 into draft chamber 6. Baffle plates 10a, 10b, 10c and 10d are placed in the interior of the apparatus to compel frequent change in direction of the gas flow leaving the shaft. A plurality of dust collecting chambers 9a, 9b and 9c are arranged in the interior of the apparatus to receive the dust carried off by the gas and return channels 5a, 5b and 5c are associated with the dust collecting chambers to return dust therefrom into shaft 1. Fresh

coal is fed at 3 into the rising gas current.

The air introduced at 2 may be preheated by means of regenerators, or economizers (not shown) or it may be preheated by burning a certain quantity of fuel on grate 7. Coal dust fed at 3 into the rising gas current is ignited and will be carried upward by the gas current. The velocity of the gas current through the bottom opening 8 is such that even the coarsest particles of coal admitted into the shaft cannot break through the air flow rising through the bottom opening 8, such coarse particles being kept in suspension, while the finer particles are carried upward by the gas current. As the cross sectional area of the gas current increases upward, its velocity decreases correspondingly so that even the finer dust particles do not pass through the shaft too rapidly, and the downwardly decreasing area prevents the falling of even the coarsest particles. Thus, as previously pointed out, coarse coal dust, consisting of a mixture of different sizes, can be utilized.

In starting the plant a fire is kindled on the grate 7 and at 3 is introduced coal dust, considerably in excess of that which could be burned with the air introduced at 2 in accordance with the quantity of gas to be produced. The excess of coal dust is converted to coke by distillation and is carried off by the gas flow in an incandescent state in the direction of the arrows and is deposited in the dust collecting chambers 9a, 9b and 9c whence it is returned in an incandescent state by the return channels 5a, 5b and 5c, to the shaft 1 in which it meets the rising gas current and is again carried upward. This stream of incandescent coke dust which constantly circulates through the shaft and the return channels 5a, 5b and 5c, corresponds to the stream or curtain B of Fig. 2.

In the operation of the plant thereafter the quantity of coal dust introduced at 3, is so regulated that only the burned or fully gasified part of the stream is restored and the quantity of incandescent coke flowing back through the return channels is kept constant. It is thought to be preferable, thought not essential, not to return to the shaft 1, the finest and most completely burned dust, which is collected in the last collecting chamber 9d, but to deliver it through channel 5d to the grate 7 on which it will be burned with fresh air introduced at 2.

In the continuous operation of the plant, the quantity of coke dust returning to the shaft 1, in proportion to the amount of fresh coal introduced, may be kept constant, by temporarily storing any excess of the returning incandescent coke dust in a bunker located in one of the return channels, such, for example, as 11 in channel 5c which funnel may serve as a bunker, from which the

quantity returning to shaft 1 may be increased in the event that the quantity there present becomes less than the desirable average constant quantity.

5 The quantity of fresh coal introduced at 3 is preferably increased to such extent as is compatible with the maintenance of a return flow of incandescent coke dust which is constant. If any excess of coal is introduced
10 at 3, the quantity of incandescent coke dust, corresponding to the excess over the return quantity to be kept constant, must be extracted from the circuit and may be utilized in any desired manner.

15 The mixture of gases consisting substantially of hydrocarbons resulting from the distillation of the quantity of coal dust corresponding to the quantity of coke dust extracted from the circuit, causes an enrichment of the producer gas produced. The enrichment of the producer gas with hydrocarbons and the quantity of coke dust produced therewith result in the production of a combustible gas of very high value, so that the
20 plant works substantially as a distillation plant rather than as a gasifying plant.

Where the plant is to operate as a distillation plant it is preferable to introduce the quantity of coal dust corresponding to the
30 quantity of coke dust to be extracted from the circuit, and, if desired, even the entire quantity of fresh coal need not be introduced at 3, or in the vicinity of the bottom of the shaft, but rather may be introduced, by any
35 appropriate means (not shown in Fig. 3), into the higher levels of the shaft where reduction rather than combustion takes place, so that the quantity of hydrocarbons produced is not decreased by combustion.

40 As previously stated, it is essential to keep the quantity of returning incandescent coke dust constant. It is not necessary to observe the entire return flow, since in continuous operation of the plant, the quantity of dust
45 returning from any one of the dust collecting chambers will be substantially indicative of the whole quantity which is returning. Hence it is necessary to examine only the return from the next to the last collecting
50 chamber 9c or the last collecting chamber 9d. Such observation may be made directly as, for example through a window (not shown) inserted in the return channel or by an observation of the funnel or bunker 11, or indirectly by measuring the temperature of
55 the burnt gases produced by the combustion of the dust conducted from chamber 9d to grate 7. If such return quantity or the temperature of combustion decreases or increases, the quantity of coal dust feed at 3
60 is correspondingly increased or decreased in order to maintain the necessary average constant quantity of dust in the return flow.

The entire quantity of the incandescent
65 coke dust from the last dust collecting cham-

ber 9d need not be fed to the grate 7 but may be burned with the air to be introduced for the production of producer gas. If desired this dust can be burned in economizers or regenerative (not shown) for the preheating
70 of air to be admitted into the shaft at 2.

In order to protect the walls of the shaft against the high temperatures developed in the combustion zone, and at the same time to promote the endothermic reaction of the
75 reduction of the evolved carbon dioxide to carbon monoxide, provision is made by this invention, for a comparatively stagnant or whirling gas cushion or curtain between the walls of the shaft and the rising gas current, such gas cushion or curtain being saturated
80 with incandescent coke dust thereby protecting the walls of the shaft from radiated heat and preventing the hotter gases from coming in contact with such walls. In carrying out
85 this feature of the invention, the shape of a defined gas jet is imparted to the rising gas current by suitably shaping the bottom opening of the shaft, such gas jet being indicated by the dotted lines 12, flaring upward in the
90 lower section of the shaft, while the upper section of the gas jet will, owing to the cooling caused by the endothermic reaction, assume a substantially cylindrical shape. According to the invention the walls of the shaft
95 recede with respect to the cone-shaped region indicated by chain lines 14 connecting the bottom opening 8 of the shaft with its upper opening, so that between the rising gas jet and the walls of the shaft, a gas mantle or
100 curtain 15, indicated in Fig. 3 by the dotted surface, is created. In this gas mantle or curtain the gas stagnates or whirls and the incandescent coke dust particles suspended in
105 such mantle or curtain, protect the walls of the shaft against the higher temperature of the hotter parts of the inner gas jet. The coke particles afford such protection both by their screening effect and by reason of the
110 fact that they reduce the carbon dioxide of the inner gas jet to carbon monoxide with a consumption of heat. Hence protective cooling of the shaft is not achieved by the introduction of an excess of cold air in order to form an "air curtain", but on the contrary
115 the air supply is reduced while coal dust is fed in excess and, in consequence, no free oxygen is present. An inner core of higher temperature and complete combustion is thus formed within the shaft, such core being surrounded by a reduction zone of lower temperature in the nature of a mantle or curtain.

The incandescent coke dust collected in the several dust collecting chambers need not
125 necessarily be returned through the return channels 5a, 5b and 5c to the bottom of the shaft, but might be returned directly by means not shown in Fig. 3 to the upper part of the gas mantle or curtain 15, so that the
130 return stream of dust or a part thereof drops

progressively through the mantle or curtain 15 and passes therefrom into the rising gas current.

In using coal which produces readily fusible ashes, tubes 16 cooled with air or water are desirably arranged within the dust collecting chambers 9a, 9b and 9c to protect the settled incandescent dust against extreme temperatures and against caking. The heat removed by tubes 16 can be used in preheating the air introduced at 2 or in preheating boiler feed water.

If the quantity of gas to be produced is to be altered by an increase or decrease of the air admitted at 2 or the coal fed at 3, it is desirable to correspondingly increase or decrease the cross-sectional area of the narrowest part of the bottom opening 8. For this purpose a movable wall or walls of any suitable character may be used, such for example as the adjustable damper 17 arranged in the bottom opening.

What is claimed is:

1. In a process for gasifying and distilling coal dust, wherein the coal in the form of dust or fine granules is driven through a heated gasifying chamber in an ascending current of gas and is thereby distilled and partially gasified, a quantity of oxygen insufficient for complete combustion being employed; the improvement which comprises so regulating the gasification that an ungasified portion of incandescent coal dust is carried along with the current of gas, withdrawing combustible gas and a portion at least of the incandescent fuel from the upper portion of the gasifying chamber, separating the incandescent fuel from the gas, and continuously introducing a portion at least of said fuel dust, after separation from the current of gas, together with fresh coal dust into the lower portion of the gasifying chamber.

2. A continuous process for gasifying and distilling coal, which comprises continuously introducing coal dust into the lower portion of a heated gasification and distillation chamber, driving the coal dust upwardly through the chamber by the force of a limited supply of air likewise introduced into the lower portion of the combustion chamber, and effecting an incomplete gasification of the coal dust within the chamber, a portion of the coal dust being converted into combustible gas, and the remainder being rendered incandescent, continuously removing combustible gas and incandescent solid material from the upper portion of the gasification chamber, separating the solid material from the gas and returning a portion at least of such material to the lower portion of the chamber and introducing it into the reaction zone together with the fresh supply of coal dust and air.

3. A process for gasifying and distilling coal dust, wherein coal in the form of dust or fine granules is driven through a gasifying

shaft in an ascending current of gas and thereby is gasified and distilled, employing a quantity of oxygen insufficient for complete combustion; characterized by the fact that an ungasified incandescent portion of fuel dust is carried along by the gas in addition to the supply of fresh coal dust and is introduced in part at least into the gasifying chamber, said dust after separation from the current of gas being returned in continuous circulation to the gasifying shaft.

4. Process in accordance with claim 3, characterized by the fact that the supply of fuel to the gasifying chamber is maintained uniform in that the supply of fresh coal is decreased upon increase of the returned material, and is increased upon decrease of the returned material.

5. Process in accordance with claim 3, characterized by the fact that with a uniform supplying of fresh coal, the excess of the separated fuel over that necessary to maintain the return material constant is temporarily stored up in order to again be fed into the return flow upon decrease of said return flow.

6. Process in accordance with claim 3, characterized by the fact that more fresh coal is introduced than is necessary for maintaining the return flow uniform, and that the excess of the separated fuel not necessary for the return flow is discharged in the form of coke dust.

7. A process in accordance with claim 3, characterized by the fact that the ascending gas current which carries along the solid fuel is blown through a mass of reducing gas, which reducing gas does not take part in the flow of the gas current, and is essentially at rest or in eddying flow within the gasifying chamber, the reducing gas separating the core of relatively high temperature in the gasifying chamber constituting the complete combustion zone, from the walls of the shaft.

In testimony whereof we affix our signatures.

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