April 3, 1928.

1,664,723

N. YOUNG

DEGASIFICATION OF COAL

Filed Oct. 30, 1919

Fig. 1.

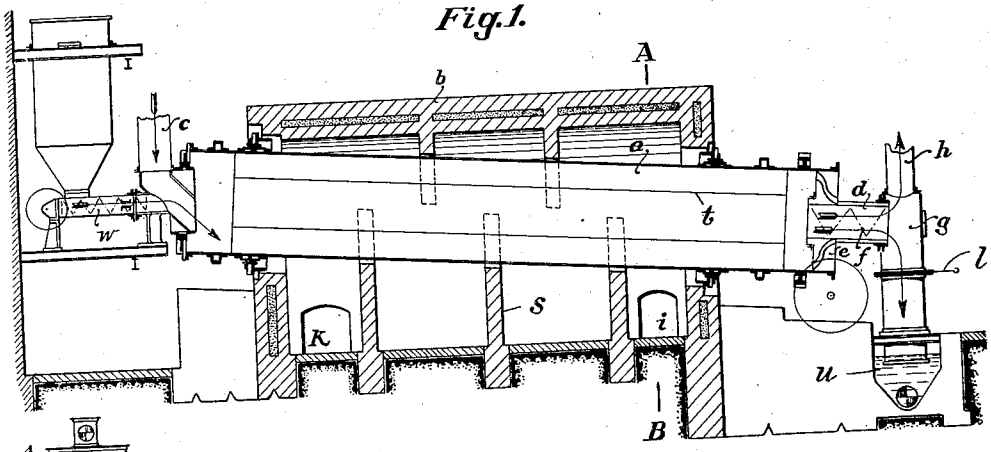


Fig. 3.

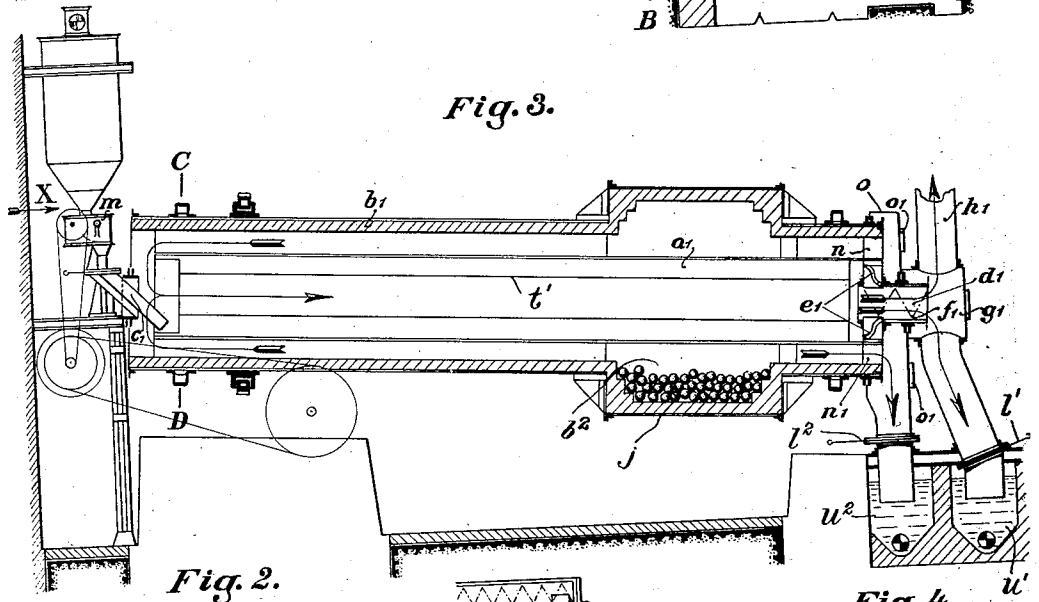


Fig. 2.

Section A-B.

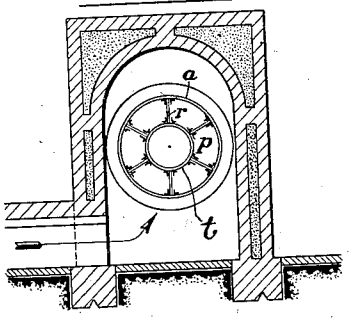


Fig. 5.

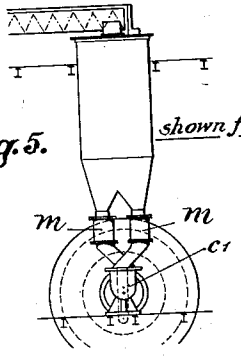
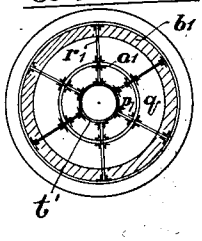


Fig. 4.

Section C-D.



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UNITED STATES PATENT OFFICE.

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DEGASIFICATION OF COAL.

Application filed October 30, 1919, Serial No. 334,628, and in Germany November 1, 1918.

The processes thus far suggested for the recovery of primary tar are chiefly based on the employment of apparatus of the producer type, but in such processes no sub-coke is obtained. In other suggested processes the coal is distilled in retorts and, provided the temperature is not raised above 550 deg. centigrade, yields a primary-tar and a cake of sub-coke. Other attempts have been made to carry out the distillation in externally heated, closed, rotary retorts, and these also have furnished primary tar and a sub-coke providing the temperature did not exceed 550 deg. centigrade, but said process is attended with the drawback that the work must be carried on intermittently and the rotary movement of the retort causes the degasified coal to cake together in lumps of a size and character as to hinder uniform degasification, greatly impede the discharge of the retorts, and, as the result of repeated working troubles render economical operation impossible.

For the sake of clearness, I desire to add that the term "degasified" coal is used to designate coal from which nearly all the volatile constituents have been driven out, while "gasification" of coal means its complete conversion into gas. The "sub-coke" referred to in this specification is a peculiar product of recent discovery, which was unknown prior to investigations made by Professor Fischer. This product is of loose, fluffy structure, of dark color, and much less coherent and resistant than ordinary silver-gray coke. "Sub-coke," in the sense just explained, can be formed only when external heating is employed to carry out a distillation process at temperatures of from 500° to 550° centigrade provided that normal pressure conditions are maintained, and there is produced, simultaneously with such "sub-coke," a fuel gas of great heating power and so-called "primary" tar. This latter term relates to tar produced at a relatively low temperature, that is to say, tar which has not undergone partial decomposition by being highly heated and therefore is free from naphthaline.

In contrast to these well known processes, the present invention of distilling coal is based on the employment of a continuous rotary tube furnace, which produces sub-coke, primary tar and fuel gas of high value, simultaneously, and obviates the defects of the well known rotary retorts. The present invention requires a rotary chamber or its equivalent which, as the rotary motion is established, feeds the coal toward the exit end of the chamber, openings at opposite ends of the chamber for the continuous introduction of coal and for discharge of sub-coke and volatile products respectively, the said openings being sealable against admission of air, and an indirect transmission of the dominant part of the heat needed to impart a temperature not in excess of approximately 550° C. to the coal through a wall of the rotary element or chamber.

The heating may be effected from outside, the drum being surrounded by a flue, and the gases required for heating—supplied by a fire—bathing the drum. These flue gases may also be replaced by the waste gases from other plants, for example the waste gases from coke-ovens, gasworks, or metallurgical works. This is, perhaps, the most economical plan.

By way of example, two forms of apparatus suitable for carrying out the process are illustrated in the accompanying drawings, Figure 1 is a longitudinal section and Figure 2 a cross section of the one form. Figure 3 shows the other form in longitudinal section, Figure 4 in cross section and Figure 5 an end elevation.

In Figures 1 and 2 a rotary tube furnace *a* of well-known type is employed, which is surrounded nearly all the way along by the brickwork *b*. The coal is introduced through the feed opening of the drum, by means of a device forming an airtight seal, which is important in connection with the invention. This can be effected by chutes, such as indicated at *c*, or by means of a worm *w* which also enables the drum to be charged without any admission of air. According to the invention, the discharging device must also be constructed in such a way as to prevent admission of air. A pipe *d* of smaller diameter than the drum is attached to the delivery end of the drum, and the material subcoked in the drum is lifted by vanes *e* rigidly secured to the inside of the drum into the pipe *d* and is conveyed by the worm *f* in said pipe to the discharge head *g* dipping into a water tank *u*. The entry of air through this discharging head is prevented by the provision of slides such as indicated at 1, by the column of material allowed to accumulate and by a water seal. The escaping mixture of high-grade fuel gas and of

tar vapours is drawn off by suction at the delivery end of the drum through the pipe d and exhaust pipe h for further treatment.

In the example shown, the coal is degasified on the counterflow system. The heating gases, supplied from a firegrate, an industrial plant or other source, enter the brickwork flue at i, and escape at k. Guide and baffle walls are arranged in the brick flue in such a way that the gases are utilized to the utmost. In this case, where the heating is effected from outside, the drum is not lined, but is provided with a partition tube t coaxial with the drum a and spaced from the inner wall thereof, and with longitudinal partitions r producing a plurality of compartments p in the same way as is known in connection with drying drums.

The external method of heating heretofore described may be used in combination with the passage of heated gases through the chamber, but the dominant heat (not in excess of approximately 500° to 550° C.) effective on the coal under treatment is, preferably, always, a heat of conduction which is transmitted through a wall in contact with the coal. For example, the waste gases escaping at high temperature from blast furnaces can be used for heating the drum externally, to impart to it the dominant heat while coke-oven gas may be used for auxiliary or supplemental internal heating. These gases may be passed respectively around and through the drum in the same direction or in counterflow.

Instead of using the waste gases from blast furnaces, the external heating may be effected by means of a furnace, and instead of the coke-oven gases, the gases from producers (both ordinary and hot-blast producers, and preferably tapped producers) may be passed through the drum. The drum a may also be heated by the fuel gas discharged at h. When both external and internal heating are to be employed, the external heating may be conducted as described above, while for internal heating gases of suitable character could be admitted through the connection c in which case the worm w would serve for feeding the coal to the furnace a. Part of the gases produced in said furnace and escaping at h might be used for external heating, by conveying a portion of such gases from the outlet h to the inlet i; generally, however, such use of the rich gas escaping at h will not be advisable.

The resulting sub-coke consists, as it leaves the rotary chamber, largely of ball-shaped lumps and is practically entirely free from dust in the sense of very fine light particles. This peculiar effect may be explained by the action of the rotary tumbling motion on the coal, the sticking particles of which tend to cake together in lumps as mentioned in the foregoing. As the mass formed by such sticky lumps rolls continuously down the rising side wall of the chamber, larger cakes are broken up into smaller ball-shaped lumps similar to the lumps which are formed if wet sticky snow glides down a hill. The product may be made into briquettes, after being crushed, the crushing being preferably effected in the drum itself by means of crushing bodies arranged therein, for instance balls such as used in ball mills. By this means increased heat transmission, and therefore improved utilization of the plant, is obtained. Crushing balls have been indicated at j in Fig. 3; these balls will tumble about and crush the material in the drum as the latter rotates.

In the construction according to Figs. 3–5, a rotary furnace is also used, but in this case of special construction, in order to obtain the best results in point of the production of gas and sub-coke, the degasification and recovery of the sub-coke are combined with the degasification of the coal. The rotary furnace consists of a lined external drum b', provided with a widened portion b^2, the construction of which will be clear from the drawing, and of an inner tube a', similar in construction to the drum a of Fig. 1. The charging device at c' is again arranged in such a way as to prevent the admission of air, and at the same time to allow both the drums a' and b' to be charged. Above the feed pipe is arranged a charging device m constructed in such a way as to prevent access of air. The charging devices used for producers or any other kind of furnace can also be used here. The inner tube a' is discharged into a water tank u' in the same way as with the example according to Fig. 1. The final product from the outer tube b' is discharged in the same way as usual in the case of rotary furnaces, and the material passes through a sheet-iron head o—also constructed so as to prevent admission of air—into a water tank u^2. At l', l^2 I have indicated on the heads g', o respectively, as means for preventing admission of air, slides or dampers similar to the slide l shown in Fig. 1.

With this second form of apparatus, the process is carried out in the following manner. Coal is charged into both drums at the same time for degasification and the recovery of sub-coke in the inner tube, and for gasification in the outer tube. The coal that has been heated and degasified in its progress through the preceding portion of the apparatus, collects in the chamber b^2, and in this way the necessary prolonged action to ensure complete gasification is obtained. The air required for combustion of the coal in the outer tube enters at n and can be accurately regulated by means of a damper o'. In this way, means are afforded for conducting the process in the drum in such a

way that the material is either merely degasified, or also gasified, just the same as in a gas producer. The hot ashes discharged into the water tank will convert a portion of the water into steam, such steam rising into the rotary furnace. The escaping gases are led through the second drum a' in the direction indicated by the arrows. The heat for degasifying the coal in the inner drum is generated by the process carried on in the outer drum. Both inner and outer drums are provided with longitudinal partitions r' which, in conjunction with said drums and with an internal tube t', form compartments p' and q, in a well known manner, to improve the utilization of the rotary tube. Instead of the gas produced in the outer tube (which gas is then drawn off), the further heating of the inner tube can be effected by the passage of gas from other sources—if desired, in conjunction with the gases generated in the outer tube.

In the practice of the process as described and as conducted within the limited temperature range set forth, it has been found that as the rotating element, i. e. the chamber or the drum or an equivalent rotary appliance, is caused to revolve the small particles of coal, of course, remain at the lower portion of the drum and are gradually tumbled over and over each other. As the particles of coal continually fall to the bottom of the drum, they are also progressively forced to move towards the exit end of the drum. The assembly and arrangement of the apparatus, as indicated in the drawings, is such that the coal as it passes through the drum is subjected to a gradually increasing temperature treatment. As the coal travels forward it softens under the influence of heat giving off some volatile materials and becoming plastic or sticky. The repeated lifting and dropping of the coal particles under these conditions tend to cause them to cement or stick together. As larger aggregates of such so-cemented particles are formed, they are carried up the side of the rotating drum and fall back, breaking up in this process. The continuous rotary and forward movement causes the product to assume bodies having rounded faces as distinguished from sharp edges, the smaller of said bodies appearing substantially as ball-like aggregates as heretofore described. When crushing balls, such as have been described in a previous part of the specification, are used for preparing the sub-coke for briquetting, their effect manifestly is chiefly to break up the larger aggregates and to reduce the entire material to bodies of relatively uniform size but inasmuch as the movement of the coal through the drum is the same whether the crushing balls are used or not the final product will still be in generally ball-like form though the individual balls will be smaller.

Now what I claim and desire to secure by Letters Patent is the following:

1. The process which consists in moving coal continuously into a treatment chamber at one portion thereof and out of such chamber at another portion thereof, heating the coal within said chamber, under agitation and under exclusion of air, to temperatures of approximately from 500° to 550° centigrade, thereby producing sub-coke together with primary tar and high grade fuel gas, and crushing such sub-coke within said chamber during the progress of said heating step.

2. The process of making sub-coke, primary tar, and a high grade fuel gas, which comprises feeding coal particles laterally in and also forwardly through a chamber so as to tumble the same therein, heating the thus-moving coal, while excluding air to a bitumen-expelling temperature approximately from 500 to 550° C., and by applying the dominant part of the said heat to said coal, indirectly, by conduction from the exterior of the body of coal, and coal particles at said temperatures and under said conditions adhering together and forming coherent masses or cakes, continuously subjecting all of said masses to the tumbling motion in said chamber and thereby breaking up said masses into lumps during said heating, continuously maintaining a flow of coal through said chamber, and separately and continuously removing from said chamber the lumps of sub-coke on one hand, and the primary tar and fuel gas on the other hand.

I claim the foregoing as my invention, I have signed my name this seventh day of October 1919.

NIELS YOUNG.