

Dec. 9, 1930.

W. RUNGE

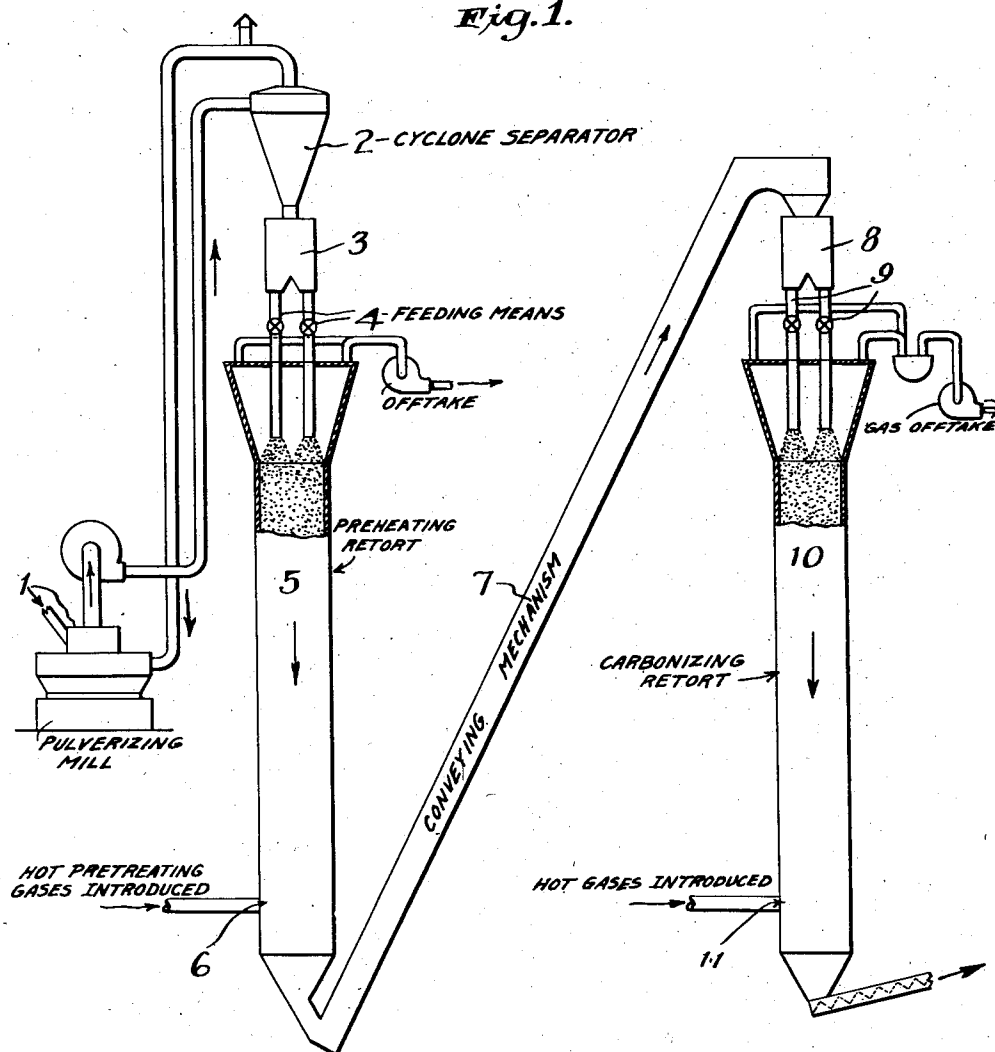
1,783,983

POWDERED COKE PRODUCT

Filed June 12, 1925

2 Sheets-Sheet 1

Fig. 1.



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2 Sheets-Sheet 2

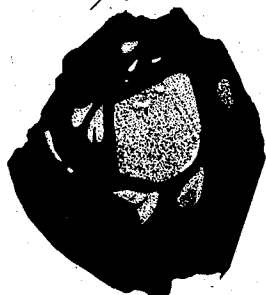
*Fig. 2.*



*Fig. 3.*



*Fig. 4.*



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## UNITED STATES PATENT OFFICE

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## POWDERED COKE PRODUCT

Application filed June 12, 1925. Serial No. 36,598.

The invention relates to the processing of coal for production of smokeless fuel thereby. It is particularly directed to a product obtained by the pulverizing and partial carbonizing of the coal under conditions to produce a product in relatively finely divided state and under conditions to eliminate a substantial portion—not all—of the hydrocarbon volatile content of the coal and so that many of the particles will each be in the form of relatively small hollow spheroids with one or more windows—visible under the microscope—in the surface thereof. The processing of the coal in the manner herein described slightly increases the area and volume of the individual particles.

The product which is the basis of this invention is particularly adapted for burning as fuel.

As illustrative of the manner in which the invention may be realized, reference is made to the accompanying drawings constituting a part of this specification. It will be manifest from what follows that the invention is not limited to the precise methods or apparatus specifically described but may be realized in various manners and ways without departing from the spirit and scope thereof.

In said drawings:—

Figure 1 diagrammatically illustrates an arrangement of coal processing apparatus.

Figure 2 is a reproduction of a micro-photo-graph of a particle of raw pulverized coal under a magnification of approximately 155 diameters and shows the angular nature of the particle or minute fragments of coal. In other words, it will be noted that the coal fragment is delineated in many respects by sharp lines and sharp edges.

Figure 3 is a reproduction of a micro-photo-graph showing the appearance of a minute fragment of coal after heat pretreatment in a gaseous medium at approximately 650 degrees F. This reproduction of the micro-photo-graph was made under a magnification of 155 diameters. Here it will be noted that the edges of the fragment have become rounded due presumably to fusion and the fragment is solid and opaque. The general shape is spherical. This is illustrative

of the appearance of the minute fragments of coal after a hot gas pretreatment at the approximate temperature just specified.

Figure 4 is a reproduction of a micro-photo-graph illustrative of a relatively hollow spheroid having a shell-like structure with windows in the shell-like structure. This is a particle of the finished product after the low temperature carbonization of the complete process, during which carbonization the average temperatures approximated 1000 degrees F. This figure is a reproduction of a micro-photo-graph taken under a magnification of 155 diameters.

The figures above referred to are sufficient to illustrate fundamental features described in connection with this invention. However there has been incorporated in the patent file as originally presented in the United States Patent Office, a set of micro-photo-graphs duly labeled and which illustrate in refined details actual structures realized from performing the invention prior to filing the application for patent in the United States Patent Office.

Referring now to the drawings in detail 1 indicates a pulverizing mill wherein the coal to be processed is initially pulverized to the desired degree of fineness for example to a fineness such that approximately 60% will pass through a 200 mesh screen (a screen defined by wires crossing at right angles to each other so as to form forty thousand openings per square inch) and so that substantially all of the pulverized coal will pass through a 40 mesh screen.

The pulverized coal is pneumatically conveyed to a cyclone separator 2 where it is collected and from which it is conveyed to a receiving hopper 3 from which it is fed by a suitable means 4 into the top of a pretreating retort 5. Within this pretreating retort the pulverized coal in cloud-like formation moves downwardly with delayed gravitation into and counter to slowly rising hot pretreating gases which are introduced in the lower regions of the retort as at 6. These pretreating gases are preferably, although not necessarily, heated air. When air is thus employed it constitutes a hot ox-

dizing medium by which the oxygen content of the coal undergoing pretreatment is slightly increased. The pretreated pulverized coal ultimately settles at the bottom of the pretreating retort and is collected and passed by any suitable conveying mechanism as 7 into a receiving hopper 8 from which it is fed by any suitable means as 9 into the top of a carbonizing retort 10. Herein the pretreated pulverized coal settles in cloud-like formation and with retarded gravitation into and counter to slowly rising hot carbonizing gases such as the gaseous products of combustion of a portion of the gas removed from the top of the carbonizing retort 10 which serve to reduce the coal into semi-coke. The hot gases for effecting the carbonization within the carbonizing retort 10 are supplied at the bottom thereof as at 11 and the temperatures of these rising hot gases is such that the coal temperature is approximately 1000 degrees F. The settling or gravitating of the coal undergoing the carbonizing operation is sufficiently delayed by the upwardly moving hot gases to effect the desired degree of carbonization or in other words, a sufficient length of time to substantially reduce the hydrocarbon volatile content of the coal and also a sufficient length of time to reduce the oxygen content of the coal below that which the original coal possessed.

It will be manifest that in the plant for realizing the invention suitable pipings and other instrumentalities should be employed for withdrawing and disposing of the pretreated gases and for collecting, purifying, storing or otherwise handling of the gases employed in or given off by the carbonization.

As to the effect of the different steps upon the coal undergoing treatment, this is illustrated by Figures 2 to 4 inclusive. All the coal undergoing treatment is in relative finely divided form being in the form of minute fragments or particles and a typifying illustration of a fragment of raw pulverized coal is seen in Figure 2. Here it will be noted that the prominent characteristics are the sharp lines and edges.

When the pulverized coal undergoes the hot pretreatment to wit under conditions such that the pretreating gases approximate 650° F. it loses these sharp edges and they are replaced by relatively smooth rounded surfaces. Where the pretreating gases are hot oxidizing gases such as a mixture of air and gaseous combustion products of a portion of the gas removed from the carbonizing retort 10 then the pretreated particles of pulverized coal take on, as determined by chemical analysis, another characteristic in that they have been oxidized by the hot pretreating air so that for example, pulverized coal having an initial oxygen content of

7½% may after the pretreatment, have an oxygen content of 8½%. The coal which has been thus pretreated and after having been subjected to the above mentioned low temperature carbonization, for example at coal temperatures of approximately 1000 degrees F., becomes further changed as to its physical and structural characteristics as is clearly illustrated in Figure 4.

A study of the product resulting from the low temperature carbonization of the pretreated coal shows that it is semi-coke composed mainly of spheroids, as shown in Figure 4, most of which are relatively hollow and many of which have what appears to be and what, for convenience I have termed, "windows" in the surface thereof, which windows are not apparent to the naked eye but with the aid of transmitted light are visible under the microscope.

It may not be desirable in all instances to subject the pulverized coal to a heat pretreatment prior to the carbonization but with the direct low temperature carbonization, the particles are, as a general rule, slightly larger than in the instance where the particles are produced by the pretreatment which is followed by the low temperature carbonization. This is best discernable by comparative screen analysis of the raw pulverized coal, the product realized by the direct carbonization, and the product derivable by the dual process to with the pretreating process which is followed by the low temperature carbonization.

According to the process of this application, one can take coal having a hydrocarbon volatile content of, for example 34%, and an oxygen content of approximately 7% to 10% and readily obtain therefrom the desired resulting semi-coke product. When a pretreatment is employed the steps of a specific aspect of the invention would include the following: pulverizing the raw coal to a fineness such that approximately 55% to 65% of the coal will pass through a 200 mesh screen and so that substantially all of the pulverized coal will pass through a 40 mesh screen, thereafter pretreating the pulverized coal by suspending the coal in the form of dust clouds in a current of slowly upwardly moving hot gases; preferably but not necessarily hot oxidizing gases, at temperatures of approximately 650° F. in the manner described, whereby the coal is dried, the hydrocarbon volatile content but slightly reduced, the density slightly lessened, the oxygen content slightly increased, the sharp edges of the coal fragments eliminated and the outer surfaces of the coal fragments rounded off. This pretreatment is followed by the separating of the treated particles from the treating gases and the showering of the pretreated coal in the form of dust clouds into and counter to a current of slowly

upwardly moving hot carbonizing gases at temperatures averaging approximately 1000 degrees F. so as to produce a semi-coke product with less oxygen than in the original coal.

5 The semi-coke thus produced by the direct action of hot carbonizing gases consists largely of particles in the form of relatively hollow spheroids of high porosity and low density relative to that of the original coal. 10 Many of the spheroids have a shell-like defining structure with windows in the surface thereof. The spheroids are of such size that 5% to 20% of the semi-coke will pass through a 200 mesh screen and such that practically 15 all will pass a 10 mesh screen. The semi-coke thus produced is in fact a low temperature coke and may have a hydrocarbon volatile content of approximately 8% to 12%.

20 I believe that I am the first to produce the product defined in the claims.

What is claimed is:

1. A powdered coke product obtained by pulverizing coal to convert it into finely divided form, by subjecting the pulverized coal 25 to the preheating action of hot gases having temperatures of approximately 650 degrees F. whereby the surface of the coal particles are rounded off, the volatile content slightly reduced and the density slightly lessened, and 30 by subjecting coal thus preheated and after it has been separated from its pretreating gases to low temperature carbonization in suspension in a gaseous carbonizing medium to produce a semi-coke having a hydrocarbon 35 volatile content of approximately 8% to 12% and in which most of the particles have been converted into substantially hollow spheroids with shell-like defining structures, the size of which spheroids is such that practically 40 all will pass through a 10 mesh screen.

2. A semi-coke according to claim 1 consisting of spheroids of such form and size that approximately 5% to 20% will pass through a 200 mesh screen.

45 3. A powdered coke product obtained by the method comprising subjecting pulverized coal to a preheating in a gaseous medium wherein the temperature of the coal is approximately 650 degrees F. whereby the surfaces of the coal particles are rounded off, 50 the hydrocarbon volatile content slightly reduced and the density lessened, separating the preheated coal from the said gaseous medium and subjecting the separated preheated coal to carbonization by showering it 55 in the form of a dust cloud into an upwardly moving current of hot carbonizing gases with the temperature of the coal at approximately 1000 degrees F., and separating the solid carbonized material from the carbonizing 60 gases, the said product being characterized by an 8% to 12% hydrocarbon volatile content and the particles of which are mainly in the form of relatively hollow spheroids 65 with a shell like defining structure the size

of which is such that substantially all of them will pass through a 10 mesh screen.

4. A powdered coke product obtained by the method comprising subjecting pulverized coal to preheating in a hot oxidizing atmosphere wherein the temperature of the coal is 70 approximately 650 degrees F. whereby the oxygen content of the coal is slightly increased, separating the oxidized products from the oxidizing atmosphere and subjecting 75 them to carbonization by showering them in the form of a dust cloud into a slowly upwardly moving current of hot carbonizing gases with the temperature of the coal at approximately 1000 degrees F. and separating 80 and collecting the carbonized residue whereby there is produced a residual product having slightly less oxygen than the original coal and having substantially less hydrocarbon 85 volatile content than the original coal, the said residual product consisting largely of particles in the form of relatively hollow spheroids with a shell like refining structure and of a size such that practically all of the 90 spheroids will pass a 10 mesh screen.

5. A powdered coke product obtained by the method comprising subjecting pulverized coal of a fineness such that approximately 55% to 65% will pass through a 200 mesh 95 screen and so that substantially all of it will pass through a 40 mesh screen, to preheating so that the temperature of the coal is approximately 650 degrees F. and subjecting the preheated coal to carbonization by showering it in the form of a dust cloud into 100 an upwardly moving current of hot carbonizing gases with the temperature of the coal at approximately 1000 degrees F. and separating the solid carbonized residue from the carbonizing gases, the said product consisting 105 largely of particles in the form of relatively hollow spheroids with a shell-like defining structure and being of such fineness that approximately 5% to 20% will pass through a 200 mesh screen and so that substantially all will pass through a 10 mesh 110 screen.

6. A powdered coke product obtained by the method comprising showering pulverized coal in the form of a dust cloud into an upwardly moving current of hot oxidizing gases 115 with the temperature of the coal at approximately 650 degrees F. whereby the surfaces of the coal particles are rounded off and the oxygen content slightly increased, separating 120 the oxidized products from the oxidizing atmosphere and subjecting them to carbonization by showering them in the form of a dust cloud into a slowly upwardly moving current of hot carbonizing gases with the 125 temperature of the coal at approximately 1000 degrees F. and separating and collecting the carbonized residue whereby there is produced a residual product having slightly less oxygen than the original coal and having 130

substantially less hydrocarbon volatile content than the original coal, the said residual product consisting largely of particles in the form of relatively hollow spheroids with a shell like defining structure and of a size such that practically all of the spheroids will pass a 10 mesh screen.

In testimony whereof I have hereunto signed my name.

WALTER RUNGE.

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