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PROCESS FOR AGGLOMERATING CARBONACEOUS MATERIALS

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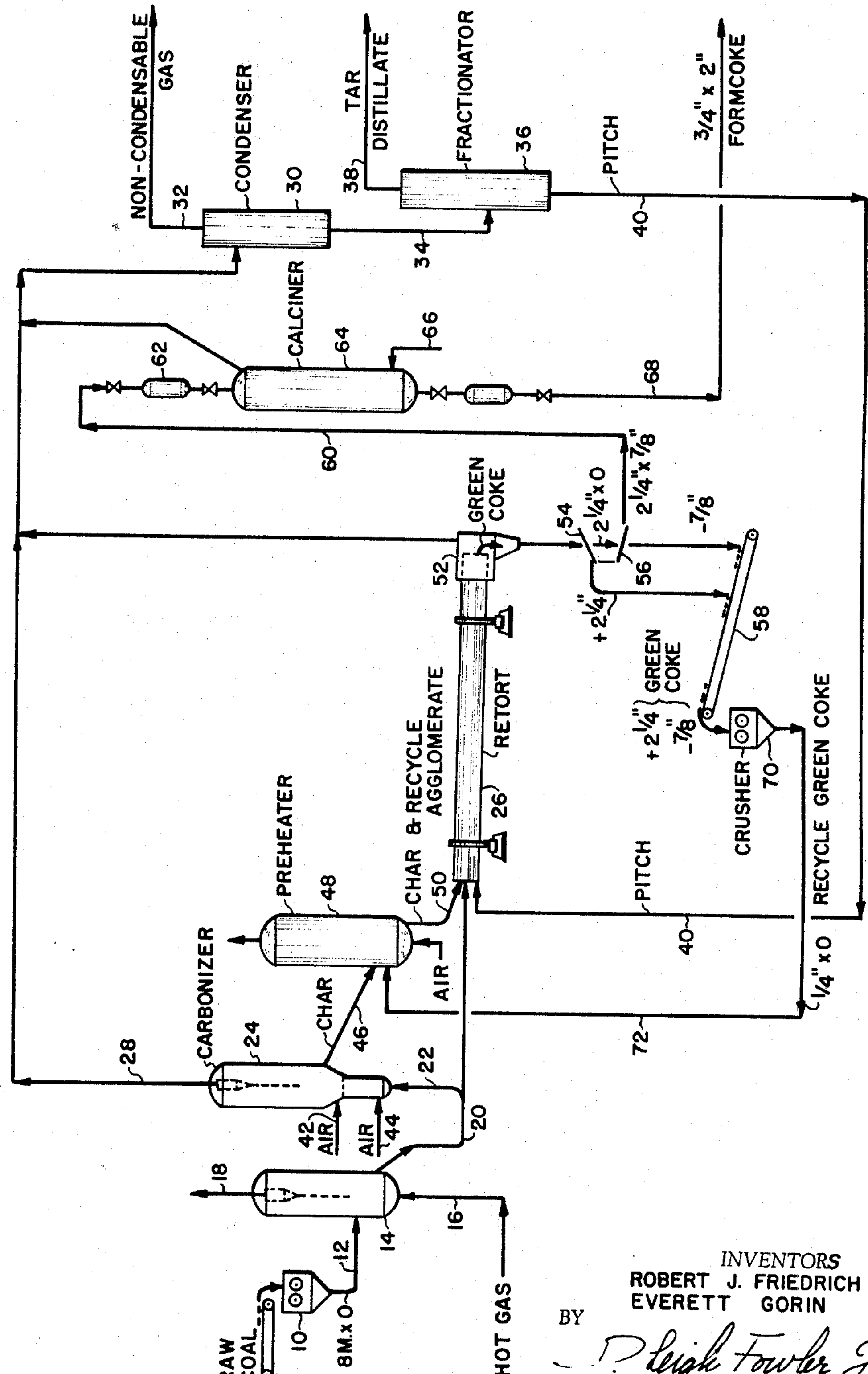

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PROCESS FOR AGGLOMERATING CARBONACEOUS MATERIALS

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This invention relates to a process for agglomerating discrete carbonaceous particles in a tumbling zone of a rotating retort and more particularly to a process for recycling a portion of the agglomerate product to the tumbling zone of the retort for agglomeration with other discrete carbonaceous particles.

United States Patent 3,073,751, entitled, "A Method of Making Formcoke," and assigned to the assignee of this invention, discloses a process for making formcoke from a caking coal. In this process, particulate bituminous coal and finely divided char (the solid carbonaceous residue of coal which has been distilled between 800° and 1400° F.) are introduced into a tumbling zone of a rotating retort. Pitch may also be added to the tumbling zone of the rotating retort with the coal and char to serve as an additonal binder and to increase the yield of the formcoke. Suitable relative proportions of the constituents introduced into the retort are: 30–60 parts by weight caking coal, 40–65 parts by weight char, and 0–20 parts by weight pitch. The temperature within the retort is maintained in the range of between 750° and 825° F. The desired temperature of the mixture in the retort is maintained under essentially adiabatic conditons, that is, the raw materials are preheated before they are introduced into the tumbling zone of the rotating retort to supply as sensible heat substantially all the heat required to achieve the desired temperature in the tumbling zone. The retort is rotated to effect tumbling and intimate mixing of the solids. As the mixture is tumbled in the retort, discrete agglomerates are formed while concurrently partial distillation of the coal occurs, thereby evolving tar, the pitch portion of which, when recycled, serves as an additonal binder for the agglomerates when pitch is included in the formulation. The residence time of the carbonaceous solids in the retort is generally about 15–40 minutes. The hot green agglomerates are recovered from the retort and thereafter calcined at an elevated temperature, e.g. between 1400–1900° F. with a preferred range of between 1550–1800° F. The calcined agglomerate is the product formcoke that has the density, strength and abrasion resistance of conventional blast furnace coke and, in fact, the strength is generally superior to that of conventional coke.

For use as a metallurgical coke in conventional blast furnaces, it is desirable that the formcoke have a size no greater than 3″ and preferably between ¾″ and 2″. The narrowest possible range of sizes is preferred but a size range between ¾″ and 2″ is satisfactory. The raw or green agglomeates recovered from the retort have a spectrum of sizes and the agglomerates of desirable size are separated from the undersize and oversize agglomerates and calcined at an elevated temperature to provide a product formcoke having the desired size range. Economically, it is highly desirable to recycle the undersize and oversize green agglomerates to the tumbling zone of the retort as a portion of the feed material. It was discovered, when the undersize green agglomerates were recycled to the retort without prior processing, that a substantial portion of the recycled green agglomerates remained as discrete particles in the tumbling zone and did not participate with the other discrete feed material to form homogeneous agglomerates. It was further discovered that a substantial portion of the recycled agglomerate product remained the same size throughout the entire tumbling process and was therefore unsuitable as a portion of the feed material. The inability to assimilate all of the offsize green agglomerate product in the formcoke by recycle to the tumbling zone reduced the economic incentives of the process and substantially increased the overall cost of the product formcoke having the desired size spectrum.

It is believed agglomerates are formed in the tumbling zone of a rotary retort in the following manner. The particulate constituents are intimately mixed in the tumbling zone by the rotation of the rotary retort during the initial stage of agglomerate formation and form a loosely coherent plastic mass that breaks up into relatively fine plastic particles. The plastic particles during continued tumbling unite to form larger particles or seed particles by a snowballing type of mechanism. As the seed particles roll down the inclined top surface of the bed formed in the retort, the fine plastic particles adhere to the seed particles and cause a continued growth of the seed particles. The growth process continues until the coal carbonizes sufficiently to eliminate adhesion and the binder loses its plasticity as a result of temperature and residence time. The agglomerates then rigidify and no further agglomerate growth takes place. The agglomerate product recovered from the retort is a homogeneous carbonized admixture of the constituents fed to the retort. The coal and pitch portion of the feed material is subjected to carbonizing temperatures during the tumbling process so that the agglomerate product is similar in many respects to the discrete particulate char formed by low temperture carbonization.

Where a portion of the agglomerate product was recycled to the tumbling zone of the rotary retort it was discovered that the recycled agglomerate product having a size larger than a predetermined size would not adhere to the fine plastic particles formed in the tumbling zone to form larger sized agglomerates, and the recycled larger sized agglomerates would not participate in the agglomeration process. It was discovered if the agglomerate product recycled to the tumbling zone of the rotary retort was comminuted to substantially the same size as the other constituents fed to the rotary retort as for example to a size capable of passing through a screen having ¼″ openings, the recycled agglomerate product would participate in the agglomeration process and the recycled agglomerate product would assimilate with the other constituents and grow or agglomerate to form the desired homogeneous agglomerate.

It was further discovered that the product agglomerates after comminution to a size capable of passing through a screen having ¼″ openings could be subjected to elevated temperatures to supply a portion of the heat required for the adiabatic process without adversely affecting the properties of the product formcoke.

Accordingly, the principal object of this invention is to provide a process for treating the offsize agglomerate product so that it will participate with other discrete carbonaceous particles in the tumbling zone of a rotating retort to form homogeneous agglomerates suitable for calcining into formcoke of desired strength and density.

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Another object of this invention is to provide a process for agglomerating discrete carbonaceous particles that also includes as a constituent particles of the agglomerate product previously formed in the tumbling zone of a rotating retort.

Another object of this invention is to provide a method for making agglomerates from discrete carbonaceous particles which includes comminuting the offsize agglomerate product to substantially the same size as the other particulate carbonaceous constituents, and introducing the comminuted agglomerate product into the tumbling zone of the rotating retort for assimilation with the other particulate carbonaceous constituents.

Other objects of this invention will become apparent upon reference to the following description and to the accompanying drawings in which a preferred embodiment of the invention is shown schematically.

Referring now to the drawing for a description of the preferred embodiment of the invention, finely divided caking bituminous coal is introduced into a comminuting device **10** where it is reduced to a size consisting of, for example, 14 mesh x 0 Tyler standard screen. The comminuted coal particles are fed through a conduit **12** to a coal drier or preheater **14** where the coal particles are subjected to a temperature of about 600° F. by means of a hot gas supplied through conduit **16**. The vapors are withdrawn from the coal drier **14** through outlet **18**. A stream of preheated coal is withdrawn from the coal drier or preheater **14** through the conduit **20**. A portion of the preheated coal is conveyed through branch conduit **22** to a low temperature carbonizer **24**. The remaining preheated coal is supplied through conduit **20** to the tumbling zone of a rotating retort **26**.

If desired, the raw coal can be comminuted to a size capable of passing through a screen having ¼" openings, hereinafter defined as a ¼" x 0 size, and conveyed to the coal drier **14**. When withdrawn from the coal drier **14** the coal particles can be separated into two different sized fractions; the larger sized fraction is retained on a 14 mesh Tyler standard screen and has a spectrum of sizes between ¼" and 14 mesh, and the smaller sized fraction, i.e. the fraction passing through the 14 mesh Tyler standard screen (14 mesh x 0) is conveyed through conduit **22** to the carbonizer **24**.

The coal particles in carbonizer **24** are heated to a temperature of about 900° F., preferably in a dense phase fluidized bed. The operation of such carbonization zone is well known and does not form an essential part of this invention except to the extent that the char so produced in a fluidized bed has particularly desirable properties as a constituent of formcoke. The tar vapors evolved in the carbonizer **24** are conducted through a conduit **28** to a condenser **30**. Other tar vapors evolved in other portions of the process may also be conducted through conduit **28** to condenser **30** where the noncondensable gases are recovered through conduit **32** and the tar condensate is recovered through conduit **34**. The tar is fractioned in a fractionator **36** and a distillate fraction is recovered through conduit **38** and a pitch fraction is recovered through conduit **40**. The pitch fraction is conveyed through conduit **40** to the rotating retort **26**, as later described.

Air is supplied to the carbonizer **24** through conduits **42** and **44** and the hot char is withdrawn from the carbonizer **24** through conduit **46** and introduced into a preheater **48** where the char is heated to a temperature of about 1100° F. by any suitable means. Heat may be supplied by partial combustion of the char within the preheater vessel **48**. The particulate carbonaceous material, heated to about 1100° F. is then conveyed through conduit **50** to the rotating retort **26** and admixed in the tumbling zone of the rotating retort **26** with the preheated coal particles supplied through conduit **20** and the pitch supplied through conduit **40**. Means may also be provided to preheat the pitch to a temperature of about 700° F. The preheat temperatures for the coal, char and pitch are suitably adjusted in accordance with the relative proportions of the three ingredients to yield the desired average temperature of the admixture which may be between about 725° F. and 825° F. depending on the characteristics of the feed material. The atmosphere in the retort should be nonoxidizing and any air employed in the preheater should be completely consumed.

The retort **26** has an enclosure **52** surrounding the discharge end thereof so that the agglomeration within the retort **26** is accomplished under substantially nonoxidative conditions. The agglomerate product withdrawn from the retort **26** is classified or screened into three fractions, namely an oversize fraction wherein all agglomerates have a size larger than 2¼", an undersize fraction wherein all agglomerates have a size smaller than ⅞", and an intermediate desired size fraction wherein all agglomerates have a size smaller than 2¼" and larger than ⅞". The agglomerates are classified into the three fractions by discharging the agglomerate product from the retort **26** onto a first screen **54** which has 2¼" openings. The oversized fraction, i.e. +2¼", remains on screen **54**. The desired fraction, i.e. 2¼" x ⅞" and the undersized fraction, i.e. −⅞", pass through the 2¼" openings in screen **54** onto screen **56**. The screen **56** has ⅞" openings and the desired fraction, i.e. 2¼" x ⅞", remains on screen **56** and the undersized fraction, i.e. −⅞", passes through the openings in screen **56**.

The desired fraction (2¼" x ⅞") is conveyed from screen **56** by a suitable conveying device schematically illustrated at **60** to a lock hopper **62**. The agglomerates are conveyed from the lock hopper **62** to a calciner **64** that is adapted to operate under a pressure of between 0 and 300 p.s.i. and at a temperature of between 1400 and 1900° F. A hot gas, preferably a reducing gas, is introduced into the calciner **64** through a conduit **66** and passes upwardly therethrough in countercurrent heat exchange relation to the downwardly moving stream of agglomerates. In calciner **64** the rate of heating is regulated to produce strong formcoke. The operation of the calciner is well known in the art and does not form an essential part of this invention. The agglomerates experience about a 12½% linear shrinkage in the calciner **64** and the calcined formcoke i.e. the product formcoke, withdrawn from calciner **64** through conduit **68** has a spectrum of sizes between 2" and ¾".

The oversized agglomerate fraction (+2¼") remaining on screen **54** and the undersized agglomerate fraction (−⅞") passing through screen **56** are both discharged onto the conveyor belt **58** and conveyed to a crusher or comminuting device **70** where both fractions are comminuted to a size capable of passing through a screen having ¼" openings. The comminuted offsized agglomerates have a size spectrum consisting of particles having a size smaller than ¼" (¼" x 0). The comminuted agglomerate product having a size of ¼" x 0 is conveyed from the crusher **70** through conduit **72** to the char preheater **48** where the comminuted agglomerate product is admixed with the char from the carbonizer **24** and heated to a temperature of about 1100° F. Where a fluosolids preheater is employed, the offsized agglomerates are ground to a size spectrum consisting of particles having a size smaller than 8 mesh (8 m. x 0) so that the offsized agglomerates and the char from carbonizer **24** will both fluidize in the preheater **48**. The admixture of char and comminuted agglomerate product is conveyed through conduit **50** to the retort **26**.

Depending on the operating conditions, the oversized and undersized agglomerate product comprised between 20–40% of the product recovered from the retort **26**. Table I illustrates the product size of three typical runs where a caking bituminous coal from the Pittsburgh seam and a char obtained by the distillation of a caking bituminous coal, likewise from the Pittsburgh seam, were used.

The coal had a size of 14 mesh x 0 and the char had a size of 8 mesh x 0. The product size is set forth in Table I.

TABLE I

Run No.	1	2	3
Product Size, wt. percent:			
+4"	0.0	0.0	0.0
3 x 4"	1.6	0.3	0.0
2 x 3"	14.4	15.0	3.0
1½ x 2"	21.2	26.3	16.0
1 x 1½"	27.8	34.6	41.2
¾ x 1"	12.2	13.2	21.0
½ x ¾"	10.7	7.9	13.9
−½"	12.1	2.7	4.9
Total +¾"	77.2	89.4	81.2
¾ x 4"	77.2	89.4	81.2
¾ x 3"	75.6	89.1	81.2
¾ x 2"	61.2	74.1	78.2
Median Size (inches)	1.27	1.39	1.11
Bulk Density +¾" agglm.	31.7	32.7	32.5

The total weight percent of the desired size (¾" x 2") in Run #1 was 61.2 weight percent of the total formcoke product. In Run #3 78.2 weight percent of the formcoke product had the desired size spectrum. The oversize fraction of Run #1 consisted of 16 weight percent and 22.8 weight percent of the formcoke product was the undersized fraction. Similarly, in Run #3 the oxersize fraction consisted of 3 weight percent of the total formcoke prod-

of the rotary retort. It is further apparent, from Table II, as illustrated in Run #5, that a substantial portion of the agglomerates having a size between ¼" and ½" does not participate in the agglomeration. Fifty-four percent of the original agglomerates having a size between ¼" and ½" did not participate in the agglomeration process. Where the agglomerates have a size between ⅛" and ¼", the agglomerates participate in the agglomeration process and are evenly distributed throughout the agglomerate product. The distribution of the agglomerates fed to the tumbling zone of the rotating retort were detected by radiological counting and the percentage of the irradiated agglomerates in each size fraction were thereafter determined.

Table III illustrates the product formcoke size of three typical runs where bituminous coal, char obtained by the distillation of a caking bituminous coal and recycled agglomerate product were agglomerated in the tumbling zone of a rotary retort under substantially the same conditions as Runs #4, #5 and #6 of Table II and thereafter calcined.

It is apparent from Table III that a formcoke product may be produced having the desired size consist from constituents including recycled agglomerate product.

TABLE III

Run No.	Wt. percent coal	Wt. percent aggl. prod.	Aggl. prod. size	Wt. percent LTC char	Product size (inches), wt. percent on						
					+3	3 x 2	2 x 1	1 x ¾	¾ x 0	Total +¾	Total ¾ x 2
7	48	20	¼ x 0	32	11.4	14.8	61.2	8.7	2.8	96.1	69.9
8	46	20	¼ x 0	34	—	6.5	64.8	17.2	6.9	88.5	82.0
9	46	20	¼ x 0	34	—	24.9	65.3	6.8	2.0	97.0	72.1

uct, and 18.8 weight percent of the total product consisted of undersized formcoke product.

To determine whether the recycled agglomerates would assimilate with the other carbonaceous materials in the agglomeration process, three runs were made where 5 weight percent of the carbonaceous material fed to the rotating retort was a radioactive agglomerate product.

A bituminous coal was neutron irradiated at the Brookhaven laboratories and had a radioactivity of .2 millicurie/gram. A char having a radioactivity of .2 millicurie/gram was formed from the irradiated coal particles and admixed with other bituminous coal in a tumbling zone of a rotary retort to form an agglomerate product. The undersized fraction of the irradiated agglomerates was further separated into three fractions, ¼" x ⅛", ½" x ¼", and ¾" x ½". Three runs, indicated as Runs #4, #5 and #6 in Table II, were made in a manner substantially the same as the process described.

TABLE II

Run No.	4	5	6
Size of radioactive agglomerates fed to retort (in.)	¼ x ⅛	½ x ¼	¾ x ½
Percent of radioactive agglomerates in different sized agglomerate product obtained from retort (aggl. prod. size):			
4 x 3	16	—	—
3 x 2	18	12	0
2 x 1	18	24	0
1 x ¾	16	6	8
¾ x ½	16	4	90
½ x ¼	16	54	Trace
Total	100	100	98

Based on the radioactivity of the stream of recycle agglomerates it was possible to trace specific feed fractions and to determine whether different sized recycled agglomerates participate in the agglomeration process. Table II illustrates that agglomerates having a size between ½" x ¾" do not participate in the agglomeration process, and are withdrawn from the rotary retort at substantially the same size as it is fed to the tumbling zone

The desirable size fraction of Run #7 consisted of 69.9 weight percent of the formcoke product. The oversize fraction was 25.2 weight percent and the undersize fraction was 2.8 weight percent. In Runs #8 and #9 the desired fraction consisted of 82 weight percent and 72.1 weight percent respectively. Runs #7, #8 and #9 illustrate that suitable percentages of the formcoke product having the desired size fraction may be obtained if the size of the recycled agglomerate product is controlled.

The herein described process may also be used in making a formcoke product from a noncaking or weakly caking coal. When coals of this type are used, a sufficient amount of binder such as tar or the like must be used so that the discrete carbonaceous particles will agglomerate in the retort.

The agglomerate product produced in the rotary retort is similar in many respects to the char product obtained by the low temperature carbonization of coal. Where it is desirable to obtain a formcoke product that has a narrow size spectrum, the char formed by the low temperature carbonization of coal can be eliminated as a constituent. The agglomerate product, comminuted as described in the above process can be substituted for the low temperature char. In this process the agglomerate product is screened to relatively narrow size fractions so that about 60% of the agglomerate product is considered offsize product and comminuted to substantially the same size spectrum as the coal particles and then recycled to the rotary retort.

According to the provisions of the patent statutes, the principle, preferred construction, and mode of operation of the invention have been explained and what is considered to represent its best embodiment has been illustrated. However, it should be understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

What is claimed is:

1. The method of agglomerating discrete carbonaceous particles in a tumbling zone of a rotating retort including

carbonaceous particles previously subjected to agglomeration in said tumbling zone comprising,

introducing finely divided coal particles and finely divided carbonaceous particles previously subjected to agglomeration into said tumbling zone, said carbonaceous particles having substantially the same size spectrum as said coal particles,

maintaining said tumbling zone under agglomerative conditions,

tumbling said finely divided coal particles and said finely divided carbonaceous particles in the presence of a pitch binder under nonoxidative conditions until agglomerates are formed,

withdrawing said agglomerates from said tumbling zone,

separating said agglomerates into preselected sized fractions including a desirable size fraction and an offsize fraction,

comminuting said offsize fraction so that said comminuted product forms finely divided carbonaceous particles having a size spectrum substantially the same as said finely divided coal particles,

recycling said comminuted product of agglomerates having a size spectrum substantially the same as said finely divided coal particles to said tumbling zone for agglomeration with said finely divided coal particles,

separating and calcining in a calciner said desirable size fraction,

recovering formcoke from said calciner, and

recovering a vaporous product from said calciner, a portion of which is condensed to serve as a part of said pitch binder.

2. The method of agglomerating discrete carbonaceous particles in a tumbling zone of a rotating retort including carbonaceous particles previously subjected to agglomeration in said tumbling zone comprising,

introducing finely divided caking bituminous coal, a pitch binder, and finely divided solid distillation residue of coal into said tumbling zone,

maintaining said tumbling zone under agglomerating conditions,

tumbling said finely divided caking bituminous coal, said pitch binder and said finely divided solid distillation residue of coal under nonoxidative conditions until agglomerates are formed,

withdrawing said agglomerates from said tumbling zone,

separating said agglomerates into preselected sized fractions including a desirable size fraction and an offsize fraction,

comminuting said offsize fraction so that said offsize fraction is capable of further agglomeration with other finely divided caking bituminous coal and other finely divided solid distillation residue of coal,

recycling said comminuted offsize fraction to said tumbling zone,

tumbling said (treated recycled agglomerates) recycled comminuted offsize fraction of agglomerates, other finely divided caking bituminous coal, pitch binder and other finely divided solid distillation residue of coal under nonoxidative conditions until agglomerates are formed containing said recycled comminuted offsize fraction of agglomerates,

separating and calcining in a calciner said desirable size fraction,

recovering formcoke from said calciner, and

recovering a vaporous product from said calciner, a portion of which is condensed to serve as a part of said pitch binder.

3. The method of agglomerating discrete carbonaceous particles in a tumbling zone of a rotating retort including carbonaceous particles previously subjected to agglomeration in said tumbling zone comprising,

introducing finely divided caking bituminous coal, a pitch binder and finely divided solid distillation residue of coal into said tumbling zone, said caking bituminous coal and said solid distillation residue of coal having a size capable of passing through a screen having 1/4" openings,

maintaining the temperature of said tumbling zone between 750 and 825° F.,

tumbling said finely divided caking bituminous coal, said pitch binder and said finely divided solid residue of coal under nonoxidative conditions until agglomerates are formed,

withdrawing said agglomerates from said tumbling zone,

recycling an undersize fraction of said agglomerates having a size capable of passing through a screen having 1/4" openings to said tumbling zone,

tumbling said recycled undersize fraction of said agglomerates, other finely divided caking bituminous coal, other pitch binder and other finely divided solid distillation residue of coal under nonoxidative conditions until a desirable size fraction of agglomerates is formed having a size capable of being retained on a screen having 1/4" openings and containing said recycled undersize fraction of agglomerates,

separating and calcining in a calciner a desirable size fraction of said agglomerates,

recovering formcoke from said calciner, and

recovering a vaporous product from said calciner, a portion of which is condensed to serve as a part of said pitch binder.

4. The method of agglomerating discrete carbonaceous particles in a tumbling zone of a rotating retort including carbonaceous particles previously subjected to agglomeration in said tumbling zone comprising,

introducing finely divided caking bituminous coal, a pitch binder, finely divided solid distillation residue of coal not previously subjected to agglomeration in said tumbling zone and finely divided carbonaceous particles previously subjected to agglomeration into said tumbling zone,

maintaining the temperature of said tumbling zone between 750 and 825° F.,

tumbling said finely divided caking bituminous coal, said pitch binder, said finely divided solid residue of coal and said finely divided carbonaceous particles under nonoxidative conditions until agglomerates are formed,

withdrawing said agglomerates from said tumbling zone,

separating said agglomerates into two size fractions, a small size fraction capable of passing through a screen having 7/8" openings and a large size fraction capable of being retained on a screen having 7/8" openings,

comminuting said small size fraction so that all of said agglomerates in said small size fraction are capable of passing through a screen having 1/4" openings to form finely divided carbonaceous particles previously subjected to agglomeration,

recycling said finely divided carbonaceous particles to said tumbling zone for agglomeration with said finely divided coal particles and said finely divided distillation residue of coal,

calcining at least a portion of said large size fraction of agglomerates in a calciner,

recovering formcoke from said calciner, and

recovering a vaporous product from said calciner, a portion of which is condensed to serve as a part of said pitch binder.

5. The method of agglomerating discrete carbonaceous particles in a tumbling zone of a rotating retort including carbonaceous particles previously subjected to agglomeration in said tumbling zone comprising,

introducing finely divided caking bituminous coal particles, a pitch binder, finely divided particles of the solid distillation residue of coal not previously subjected to agglomeration in said tumbling zone and finely divided carbonaceous particles previously subjected to agglomeration into said tumbling zone, said coal particles, distillation residue particles and carbonaceous particles having a size capable of passing through a screen having openings of a preselected size,

maintaining the temperature of said tumbling zone between 750 and 825° F.,

tumbling said finely divided caking bituminous coal particles, said pitch binder, said finely divided particles of the solid distillation residue of coal and said finely divided carbonaceous particles previously subjected to agglomeration under nonoxidative conditions until agglomerates are formed,

withdrawing said agglomerates from said tumbling zone,

separating said agglomerates into three preselected size fractions, a small size fraction capable of passing through a screen having ⅞" openings, an intermediate size fraction capable of passing through a screen having 2¼" openings, and a large size fraction capable of being retained on a screen having 2¼" openings,

combining said small size fraction and said large size fraction,

comminuting said small size fraction and said large size fraction so that all of said agglomerates in said combined fractions have a size capable of passing through a screen having openings of said preselected size and form finely divided carbonaceous particles previously subjected to agglomeration,

recycling said finely divided carbonaceous particles previously subjected to agglomeration to said tumbling zone for agglomeration with said finely divided coal particles and said finely divided distillation residue of coal,

calcining said intermediate size fraction in a calciner,

recovering formcoke from said calciner, and

recovering a vaporous product from said calciner, a portion of which is condensed to serve as a part of said pitch binder.

6. The method of agglomerating discrete carbonaceous particles in a tumbling zone of a rotating retort including carbonaceous particles previously subjected to agglomeration in said tumbling zone comprising,

introducing finely divided caking bituminous coal, pitch binder and finely divided solid distillation residue of coal into said tumbling zone,

maintaining the temperature of said tumbling zone between 750 and 825° F.,

tumbling said finely divided caking bituminous coal, said pitch binder and said finely divided solid residue of coal under nonoxidative conditions until agglomerates are formed,

withdrawing said agglomerates from said tumbling zone,

separating said agglomerates into two size fractions, a small size fraction capable of passing through a screen having ⅞" openings and a large size fraction capable of being retained on a screen having ⅞" openings,

comminuting said small size fraction so that all of said agglomerates in said small size fraction are capable of passing through a screen having ¼" openings,

heating said comminuted agglomerates having a size capable of passing through a screen having ¼" openings to a temperature of about 1100° F.,

recycling said heated comminuted agglomerates to said tumbling zone,

tumbling said heated recycled agglomerates, other pitch binder, other finely divided caking bituminous coal and other finely divided solid distillation residue of coal under nonoxidative conditions until agglomerates are formed having a size capable of being retained on a screen having ¼" openings and containing said heated recycled agglomerates,

calcining at least a portion of said large size fraction in a calciner,

recovering formcoke from said calciner, and

recovering a vaporous product from said calciner, a portion of which is condensed to serve as a part of said pitch binder.

7. The method of agglomerating discrete carbonaceous particles in a tumbling zone of a rotating retort including carbonaceous particles previously subjected to agglomeration in said tumbling zone comprising,

introducing caking bituminous coal, a pitch binder and solid distillation residue of coal having a size capable of passing through a screen having ¼" openings into said tumbling zone,

maintaining the temperature of said tumbling zone between 750 and 825° F.,

tumbling said finely divided caking bituminous coal, said pitch binder and said finely divided solid residue of coal under nonoxidative conditions until agglomerates are formed,

withdrawing said agglomerates from said tumbling zone,

separating said agglomerates into three preselected size fractions, a small size fraction capable of passing through a screen having ⅞" openings, an intermediate size fraction capable of passing through a screen having 2 ¼" openings and being retained on a screen having ⅞" openings, and a large size fraction capable of being retained on a screen having 2¼" openings,

combining said small size fraction and said large size fraction,

comminuting said small size fraction and said large size fraction so that all of said agglomerates in said combined fractions have a size capable of passing through a screen having ¼" openings.

recycling said comminuted agglomerates having a size capable of passing through a screen having ¼" openings to said tumbling zone,

tumbling said recycled agglomerates, other pitch binder, other finely divided caking bituminous coal and other finely divided solid distillation residue of coal under nonoxidative conditions until agglomerates are formed having a size capable of being retained on a screen having ⅞" openings and containing said recycled agglomerates,

calcining said intermediate size fraction in a calciner,

recovering formcoke from said calciner, and

recovering a vaporous product from said calciner, a portion of which is condensed to serve as a part of said pitch binder.

8. The method of agglomerating discrete carbonaceous particles in a tumbling zone of a rotating retort including carbonaceous particles previously subjected to agglomeration in said tumbling zone comprising,

heating caking bituminous coal particles having a size capable of passing through an 8 mesh Tyler Standard Screen to a temperature of about 600° F.,

heating solid distillation residue of coal particles having a size capable of passing through a 14 mesh Tyler Standard Screen to a temperature of about 1100° F. in a heater,

introducing said caking bituminous coal particles, a pitch binder and said solid distillation residue of coal particles at said elevated temperatures into said tumbling zone,

tumbling said finely divided caking bituminous coal particles, said pitch binder and said finely divided solid residue of coal under nonoxidative conditions until agglomerates are formed,

withdrawing said agglomerates from said tumbling zone,

separating said agglomerates into three preselected size fractions, a small size fraction capable of passing through a screen having ⅞" openings, an intermediate size fraction capable of passing through a screen having 2¼" openings and being retained on a screen having ⅞" openings, and a large size fraction capable of being retained on a screen having 2¼" openings,

combining said small size fraction and said large size fraction,

comminuting said small size fraction and said large size fraction so that all of said agglomerates in said combined fractions have a size capable of passing through a 14 mesh Tyler Standard Screen,

introducing the comminuted agglomerates into said heater and combining said comminuted agglomerates with other solid distillation residue of coal particles in said heater,

heating said comminuted agglomerates in said heater to a temperature of about 1100° F.,

introducing a mixture of said heated agglomerates and said other solid distillation residue of coal particles from said heater into said tumbling zone and introducing other caking bituminous coal and other pitch binder into said tumbling zone,

tumbling said comminuted heated agglomerates and said other solid distillation residue of coal particles and said other caking bituminous coal particles and other pitch binder under nonoxidative conditions until agglomerates are formed having a size capable of being retained on a screen having ⅞" openings and containing said comminuted agglomerates,

calcining said intermediate size fraction in a calciner,

recovering formcoke from said calciner, and

recovering a vaporous product from said calciner, a portion of which is condensed to serve as a part of said pitch binder.

9. The method of agglomerating discrete carbonaceous particles in a tumbling zone of a rotating retort including carbonaceous particles previously subjected to agglomeration in said tumbling zone comprising,

introducing finely divided coal particles and finely divided carbonaceous particles previously subjected to agglomeration into said tumbling zone, said carbonaceous particles having substantially the same size spectrum as said coal particles,

maintaining said tumbling zone under agglomerative conditions,

tumbling said finely divided coal particles and said finely divided carbonaceous particles in the presence of a pitch binder under non-oxidative conditions until agglomerates are formed,

withdrawing said agglomerates from said tumbling zone,

separating said agglomerates into preselected size fractions including a desirable size fraction and an offsize fraction,

recycling finely divided carbonaceous particles having a size spectrum substantially the same as said finely divided coal particles and obtained from said offsize fraction,

separating and calcining in a calciner said desirable size fraction,

recovering formcoke from said calciner, and

recovering a vaporous product from said calciner, a portion of which is condensed to serve as a part of said pitch binder.

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