Aug. 28, 1962 E. GORIN ETAL 3,051,629

PREPARING METALLURGICAL FUEL BRIQUETS FROM NON-CAKING COAL BY PRESHRINKING CHAR

Filed July 7, 1958 2 Sheets-Sheet 1

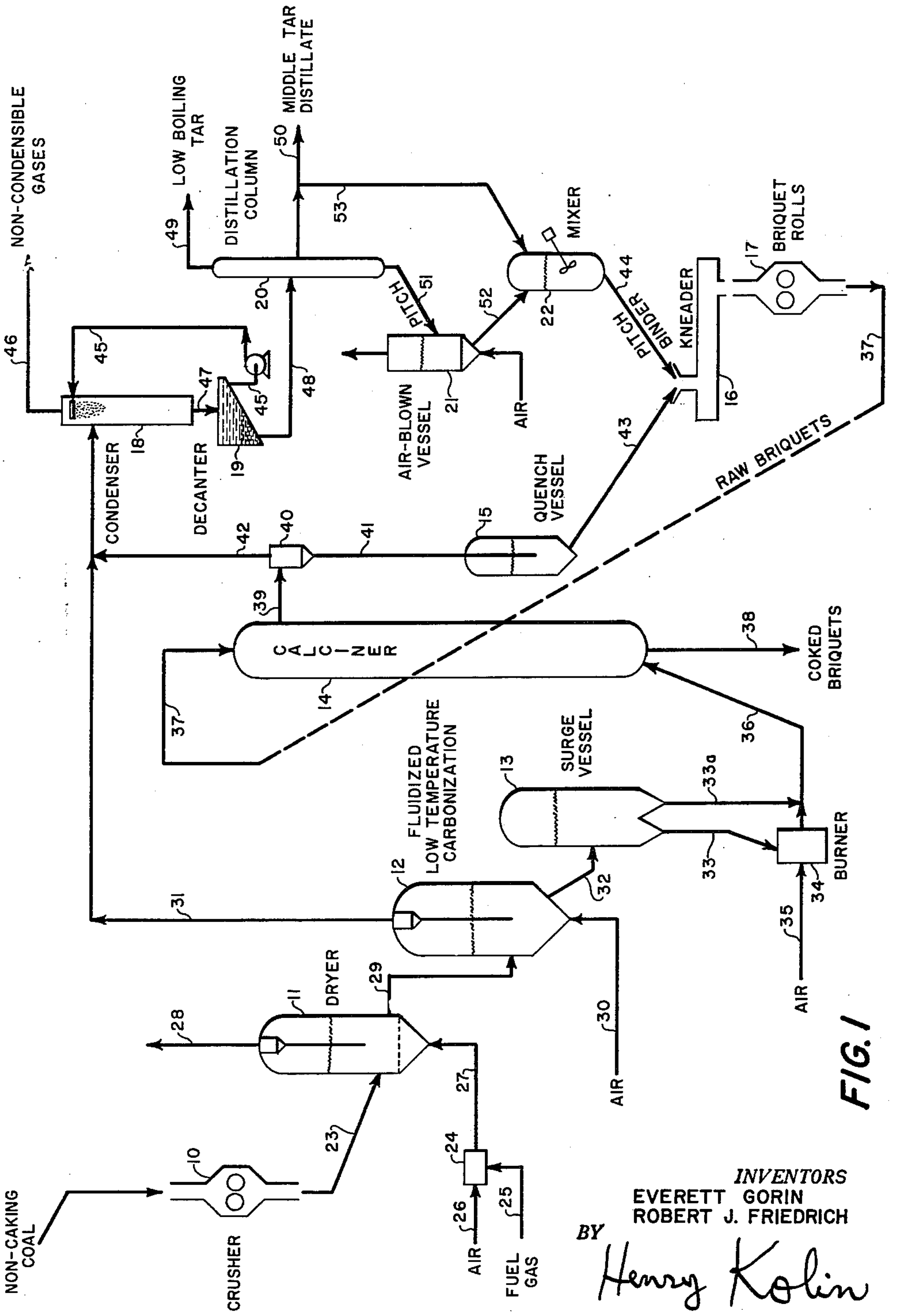

FIG. 1

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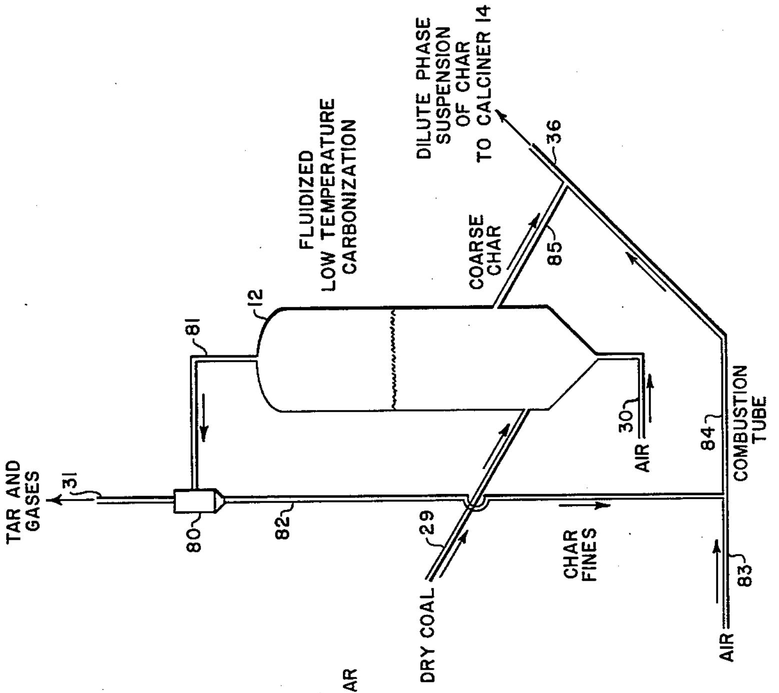

FIG. 3

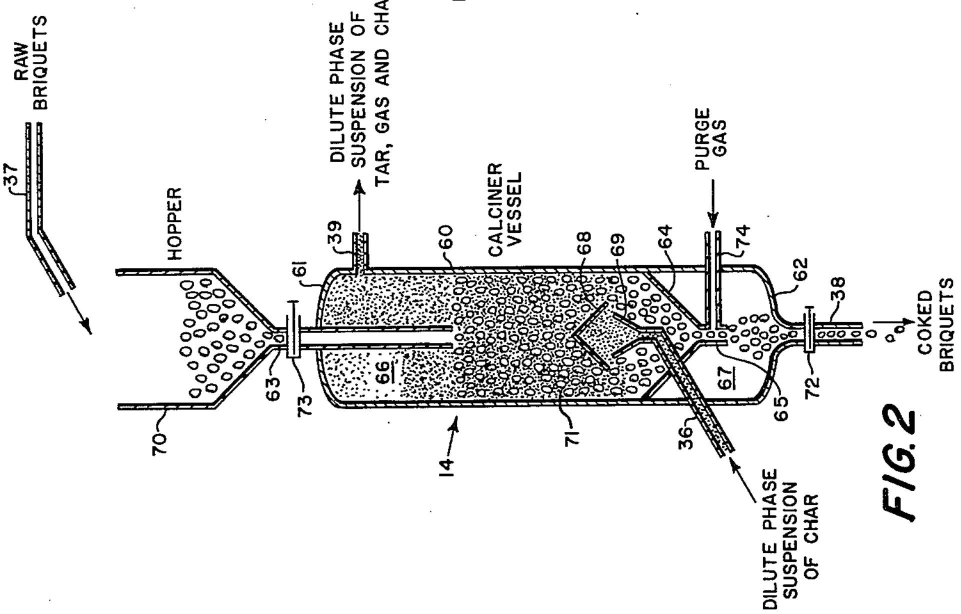

FIG. 2

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United States Patent Office

3,051,629
Patented Aug. 28, 1962

3,051,629

PREPARING METALLURGICAL FUEL BRIQUETS FROM NON-CAKING COAL BY PRESHRINKING CHAR

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Filed July 7, 1958, Ser. No. 746,990
5 Claims. (Cl. 202—26)

The present invention relates to the preparation of metallurgical fuel from non-caking and weakly caking bituminous and sub-bituminous coal.

There are substantial reserves of non-caking coals throughout the world which, because of their non-caking property, cannot be converted into metallurgical fuels by conventional coking processes. Attempts have been made to utilize non-caking coals in the production of metallurgical coke by a process sequence involving: first, low temperature carbonization of the coal; second, briquetting the resulting char with suitable binders; and third, coking and calcining the prepared briquets. Coke produced in this manner has been too weak for metallurgical use. The weakness of such coke can be attributed to the differential shrinkage of the char particles away from the briquet binder which occurs during the calcining of the briquets. Addition of substantial quantities of strongly caking coal into the briquet formulation yields coke of satisfactory strength. However, the addition of strongly caking coal is not a generally satisfactory expedient because of its relatively high cost and non-availability in geographical areas where non-caking coal is found.

By preliminarily shrinking the char prior to briquet formation, the adverse effects of differential shrinkage can be avoided and coke of satisfactory strength can be prepared. The char can be shrunk by heating it to an elevated temperature at which particle contraction occurs. This elevated temperature of shrinking will be above the temperature at which the char was generated from the starting coal, and, in general, will be in the range of 1350 to 1800° F. The shrinking treatment is accompanied by devolatilization of the char which yields substantial quantities of combustible gases rich in hydrogen and methane.

The present invention is directed to the preparation of coked briquets via the last-mentioned route. According to the present invention, non-caking bituminous or sub-bituminous coal is dehydrated and carbonized to produce gas, tar and char. The char is heated to a temperature in the range of 1350 to 1800° F. to effect devolatilization and shrinking. While still at this elevated temperature, the heated char is brought into contact with freshly formed briquets to provide the heat requirements for briquet coking. Following contact with the briquets undergoing coking, the shrunk char is recovered and cooled for use in briquet formulation. A suitable briquet binder is prepared from the high boiling portion of the carbonization tars. The carbonization and devolatilization gases can be burned to supply heat. Briquets comprising the shrunk char and tar briquet binder are thereafter coked as described by contact with heated shrunk char.

It is possible to prepare coked briquets of satisfactory metallurgical strength by directly carbonizing, devolatilizing and shrinking the non-caking coal in a single high temperature carbonization treatment. However, the yield of tar from high temperature carbonization is inadequate to provide the pitch binder requirements of the subsequent briquet formulation. Low temperature carbonization at temperatures from about 800 to 1100° F. maximizes the yield of tar and assures the provision of the required pitch binder. The pitch obtained directly from low temperature carbonization, unfortunately, does not possess satisfactory binder properties for briquet formulations. Subsequent treatment of such pitch is necessary to increase its fixed carbon content. Preferably the subsequent treatment involves air blowing the pitch.

Thus the object of the present invention is to prepare suitable metallurgical fuel from non-caking coal by thermally shrinking char derived from said coal and utilizing the stream of heated shrunk char to supply the heat requirements for briquet coking.

A further object of this invention is to provide a method for preparing suitable metallurgical fuel entirely from non-caking coal, i.e., the briquet ingredients are derived from the starting material.

A typical non-caking coal available in Wyoming has the following analysis:

TABLE I

Properties of Typical Non-Caking Coal

Proximate analysis:	Weight percent
Moisture	19.20
Volatile matter	38.44
Fixed carbon	39.68
Ash	2.68
Ultimate analysis (moisture-free basis):	
H	5.02
C	74.41
N	1.28
O	15.04
S	0.93

The high percentage of oxygen in the coal is characteristic of non-caking coals. Non-caking coal, when heated to elevated temperatures, merely crumbles and evolves gases and tar vapors. It does not soften to form agglomerate particles which would form a strong cellular coke, but instead leaves a soft powdery mass as a residue. Numerous well-known tests have been developed to distinguish caking coals from non-caking coals. Lowry, "The Chemistry of Coal Utilization," vol. I (1945), pages 73, 77–79.

Non-caking coal can be comminuted to a fluidizable size and carbonized at low temperature (850 to 1100° F.) to produce gas, tar and a char residue. Because the starting coal is non-caking, no preliminary decaking treatment is required and hence substantial tar yield can be achieved.

The present invention will be described in detail by reference to the accompanying drawings in which:

FIGURE 1 is a schematic flow diagram illustrating apparatus adapted to the practice of the invention;

FIGURE 2 is a detailed cross-sectional illustration showing construction features of a calcining vessel shown in FIGURE 1; and

FIGURE 3 is a schematic flow diagram illustrating apparatus adapted to the practice of an alternative char shrinking embodiment.

In the drawing, the principal apparatus includes a coal crusher **10**, a fluidized coal dryer **11**, a fluidized low temperature carbonization vessel **12**, a surge vessel for product char **13**, a briquet calcining vessel **14**, a hot char quenching vessel **15**, a kneading apparatus **16** for briquet formulation, a briquet making apparatus **17**, a tar condenser **18**, a tar decanter vessel **19**, a tar distillation vessel **20**, a pitch air blowing vessel **21** and a briquet binder mixing vessel **22**.

The starting coal is introduced into the coal crusher **10** where it is comminuted to a fluidizable size, for example, capable of passing through a 14-mesh Tyler standard screen. A typical particle size distribution (wet screen analysis) for a comminuted non-caking coal is:

TABLE II

Particle Size Distribution

Tyler screen sizes:	Weight percent
On 14 mesh	0.0
Through 14 on 28 mesh	17.1
Through 28 on 48 mesh	31.1
Through 48 on 100 mesh	23.9
Through 100 on 150 mesh	8.1
Through 150 on 200 mesh	5.2
Through 200 on 325 mesh	6.0
Through 325 mesh	8.6

Suitably comminuted non-caking coal is recovered from the coal crusher **10** and transferred through a conduit **23** into the fluidized coal dryer **11**. Hot gases for fluidizing and drying the coal are generated in a combustion vessel **24** and by combustion of fuel gas with air introduced through conduits **25** and **26** respectively. The hot combustion gases are transferred through a conduit **27** for drying and preheating the comminuted coal in the dryer **11**. Since the coal is non-caking, the dryer **11** may also serve as a preheater. Accordingly, the coal is not only dehydrated but also preheated in the dryer **11** to a temperature of about 300–600° F. The spent fluidizing gases are removed from the dryer **11** through a conduit **28**. Preferably any entrained solids in the spent fluidizing gases are recovered by passing the gases from the conduit **28** through suitable recovery equipment.

Preheated dehydrated coal is recovered from the dryer **11** through a conduit **29** and is introduced into the fluidized low temperature carbonization vessel **12**. The coal is maintained in a fluidized state in the fluidized low temperature carbonization vessel **12** at a temperature of about 800 to 1100° F. (preferably about 850 to 950° F.). Air, employed as the fluidizing gas, is introduced through a conduit **30**. The coal is maintained in the low temperature carbonization vessel **12** for about 10 to 60 minutes until substantially complete tar evolution has occurred. Gases, tar vapors and oxygen-depleted air are recovered through a conduit **31** and are transferred to the tar condenser vessel **18** for further treatment to be hereinafter described.

The heat required for carbonization is supplied by partial combustion of the coal with the oxygen content of the fluidizing air. Because of the non-caking property of the starting coal, there is no tendency for particle size agglomeration. Accordingly, the product char, recovered through a conduit **32**, has a free-flowing particulate character.

The product char is transferred without deliberate cooling through the conduit **32** into the product char surge vessel **13**. The char is maintained within the surge vessel **13** substantially at the carbonization temperature. One portion of the product char is withdrawn through a conduit **33** and introduced into a char burner **34** for turbulent contact therein with air from a conduit **35**. The partially burned char and air are transferred at an elevated temperature as a dilute phase suspension from the burner **34** into a transfer conduit **36**. The remainder of the char from the surge vessel **13** is withdrawn through a conduit **33***a* and introduced into the transfer conduit **36** to supplement the dilute phase suspension of heated char and air. The final temperature of the dilute phase stream must be sufficient to effect the desired char shrinking, i.e., from about 1350 to 1800° F. Hence the air and char stream leaving the char burner **34** should be at a temperature of about 1600 to 2250° F. The preshrinking treatment of the char permits production of briquets therefrom which will possess satisfactory high temperature strength following suitable calcining treatment. Heating of the char to temperatures above the carbonization temperature at which it was generated results in further devolatilization of the char yielding significant quantities of combustible devolatilization gases rich in hydrogen and methane.

The calcining treatment for briquets occurs within the calciner vessel **14**. Cold, freshly produced briquets are introduced into the top of the calciner vessel **14** through a conduit **37**. The briquets pass downwardly through the calciner vessel **14** and are contacted with the dilute phase suspension of hot preshrunk char and hot gases. The preshrunk char and gases are cooled and the briquets are heated by heat interchange within the calciner vessel **14**. The briquets, following calcining, are withdrawn from the bottom of the calciner vessel **14** through a conduit **38** at a temperature between 1400 and 1700° F., preferably about 1600° F. The final briquet temperature, of course, is lower than the temperature of the dilute phase suspension of shrunk char and gases which enters the calciner vessel **14** through the transfer conduit **36**.

The fresh briquets which enter the calciner vessel **14** are at first heated very rapidly, i.e., shock-heated, by virtue of their sudden exposure to the elevated temperatures therein. Thereafter the briquets are more slowly heated to calcining temperatures. The residence time of the briquets in the calciner vessel preferably is from about one-half to two hours. This rapid initial heating serves to coke the briquet binder quickly and to set the binder as a matrix for confining the char particles. Appreciable quantities of tar vapors are evolved during this coking. The tar vapors are carried along with the heated gases and entrained shrunk char. The dilute phase supension of shrunk char is recovered from the top of the calciner vessel **14** through a conduit **39**. The shrunk char is recovered in a cyclone separator **40** and transferred through a conduit **41** into a quench vessel **15**. The hot gases and tar vapors, substantially free of entrained shrunk char particles, are recovered from the cyclone separator **40** through a conduit **42** and are introduced into the tar condenser vessel **18** along with the primary carbonization tar vapors for further treatment as will be hereinafter described.

The shrunk char particles are cooled in the char quench vessel **15** to a temperature of about 500° F. Suitably, the carbonization liquor can be sprayed into the quench vessel **15** to quench the hot char particles while extracting the volatilization heat of the liquor. The quenched char is recovered at about 300 to 400° F. from the char quench vessel **15** through a conduit **43** and introduced into the briquet kneading apparatus **16**. Suitable quantities of pitch binder are introduced into the briquet kneading apparatus **16** through a conduit **44**. The mixture of hot char and pitch binder is kneaded in accordance with conventional briquet making procedures, i.e., at a temperature about 40° F. above the melting temperature of the binder pitch.

The kneaded mixture of char and pitch binder is recovered from the kneading apparatus **16** and introduced into briquet making apparatus **17** wherein the mixture is pressed at suitable mechanical pressures into uniform shapes preferably from ½- to 3-inches in maximum transversal dimension. Formed briquets are recovered from the briqueting apparatus and transferred through a conduit **37** to the calciner vessel **14** as already described. It is customary in briqueting practice to provide slight cooling of the fresh briquets below the melting point of the binder pitch before they are subjected to vigorous mechanical movement.

The present process autogenously provides the required pitch binder from the tar which is inherently produced. This process will be briefly described. Referring to the tar condenser vessel 18, tar vapors and non-condensible gases introduced through conduit 31 are quenched by a recirculating liquid spray introduced through a conduit 45. The liquid spray preferably is the carbonization liquor. Non-condensible gases are recovered overhead through a conduit 46. The non-condensible gases may be burned to provide the hot gases required for the coal dryer 11. The condensible tar products are recovered along with the condenser spray liquid through a bottom conduit 47. The condensed liquids are separated in a decanter vessel 19. Supernatant aqueous liquids are recovered and recirculated through the conduit 45 to the condenser vessel 18. Condensed liquid tar is recovered through a conduit 48 and introduced into a distillation vessel 20 for separation. The valuable low boiling tar components, e.g., those boiling below about 230° C., are recovered as a distillate product through a conduit 49. A middle boiling tar distillate, for example boiling from about 230 to 350 or 375° C., is recovered through a conduit 50. The high boiling pitch components, for example those boiling above about 350 to 415° C., are recovered as a bottom product through a conduit 51.

Freshly prepared pitch from non-caking coal has been found to be unsatisfactory as a briquet binder. However, it can be employed as a pitch binder if subjected to a preliminary air blowing treatment at elevated temperatures, for example 500 to 900° F. The air blowing should be carried out at a sufficient pressure to avoid volatilization of the pitch components. Accordingly, the pitch is transferred from the conduit 51 into the air blowing vessel 21 maintained at an elevated temperature. Air is introduced into the air blowing vessel 21. The pitch is contacted with air for about 20 minutes. An air blown pitch product, suitable as a briquet binder, is recovered through a conduit 52. The solids-free pitch should have a fixed carbon content (Conradson carbon) between 25 and 50 percent.

The air blown pitch binder recovered through the conduit 52 may have an excessive melting point. It is desirable that the pitch should become molten at briquet kneading temperatures in order to wet the char particles completely during the kneading treatment which is customarily carried out with steam heating. Hence the pitch may be blended with middle boiling tar distillate to provide a suitable melting point binder for use in briquet making. A melting point of about 90 to 120° C. is preferred. Accordingly, a portion of the middle boiling tar distillate is withdrawn from the conduit 50 and transferred through a conduit 53 to the binder mixing vessel 22 for blending with air blown pitch to produce a pitch binder of satisfactory melting properties for use in briquet formulations. The binder pitch tends to be unstable when stored in liquid form. Hence it is cooled below its melting temperature and stored as a solidified mass. Prior to use, the solid pitch is comminuted and blended into the briquet formulation as solid particles.

FIGURE 2 illustrates in detailed cross-section view construction features of a vessel suitable for use as the calciner vessel 14. Corresponding numerials in FIGURE 2 refer to corresponding elements of FIGURE 1 including the conduits 36, 37, 38 and 39.

As shown in FIGURE 2, the calciner vessel 14 comprises a vertical cylindrical shell 60 constructed of heat-resistant material such as refractory lined steel. The shell 60 has a top wall 61 and a bottom wall 62. A briquet feeding conduit 63 extends through the top wall 61 into the interior of the vessel 14. A coked-briquet withdrawal conduit 38 extends through the bottom wall 62.

Within the vessel 14 a funnel-shaped baffle 64 extends from the inner wall of the shell 60 to a restricted throat 65. The funnel-shaped baffle 64 separates the interior of the vessel 14 into an upper calcining chamber 66 and a lower coked-briquet surge chamber 67.

Mounted within the calcining chamber 66 near the funnel-shaped baffle 64 is a conical baffle 68 positioned above a flared conduit 69 which communicates with the conduit 36 through which a dilute phase suspension of preshrunk char and hot gases is transported.

In operation, raw uncoked briquets are introduced into a lock-hopper or surge vessel 70 whence they are withdrawn through the briquet feeding conduit 63 for introduction into the calcining chamber 66. The briquets settle upon one another and form a free-flowing bed 71 in the bottom portion of the calcining chamber 66. The briquets within the bed 71 move downwardly under the influence of gravity through the restricted throat 65 into the briquet surge chamber 67. A valve means 72 in the coked briquet withdrawal conduit 38 regulates the outward flow of briquets which is correlated with the briquet feed rate through corresponding valve means 73 in the briquet feeding conduit 63. Since the briquets in the bed 71 are of uniform size and shape, a maximum void space exists in the interstices. The void space is sufficient to permit the upward passage of a dilute phase suspension of heated preshrunk char particles which exchange their sensible heat to provide the thermal requirements for coking and calcining the briquets. The dilute phase suspension of heated preshrunk char particles is introduced through the conduit 36 into the flared opening 69 for escape beneath the conical upright baffle 68 into the interstices of the bed 71.

A supply of purge gas is introduced into the restricted throat 65 through a conduit 74 to maintain a sufficient upward gas flow in the restricted throat 65 to prevent downward flow of heated char particles into the briquet surge chamber 67.

The vaporous products including gas and tar resulting from briquet coking are swept along with the upwardly moving dilute phase suspension of char and are recovered from the calcining chamber 66 along with the char through an exit conduit 39 above the bed 71.

An alternative embodiment of the present char shrinking method is illustrated in FIGURE 3. Corresponding numerals in FIGURE 3 refer to corresponding elements of FIGURE 1. The fluidized low temperature carbonization vessel 12 in FIGURE 3 differs from that of FIGURE 1 in that a cyclone separator 80 is provided externally of the carbonization vessel 12 to permit separate recovery of relatively fine char particles for selective partial combustion to provide the shrinking preheat. Gases, tar vapors and entrained char particles pass from the carbonization vessel 12 through an effluent conduit 81 into the external cyclone separator 80. Entrained, relatively fine char particles are recovered through a cyclone dipleg 82 and the tar vapors and gases, freed of the bulk of entrained fine char particles, are recovered through a conduit 31 as described in connection with FIGURE 1. The char fines from the dipleg 82 are entrained in an air conduit 83 and are partially burned in a combustion tube 84 to provide a dilute phase suspension of relatively fine char at an elevated temperature. Additional product char is withdrawn from the fluidized bed of the carbonization vessel 12 through a withdrawal conduit 85 and introduced into a transfer conduit 36 to supplement the dilute phase suspension of air and char fines which have been heated in transit through the combustion tube 84. The resulting dilute phase suspension of char attains an equilibrium temperature in the range of 1350 to 1800° F., sufficient to effect the desired char shrinking.

EXAMPLE

The following example is presented to illustrate a material balance and operating conditions for a briquet making plant as illustrated in FIGURE 1. The following data are derived from a briquet plant processing 50 tons per hour of non-caking coal having the properties listed in Table I. The coal is preliminarily crushed to the size distribution listed in Table II.

The coal is introduced into a fluidized dryer **11** maintained at a temperature of 400° F. 33,000 cubic feet per minute of gases at 205° F. are recovered from the dryer through conduit **28** containing 510 pounds of entrained solids. 80,420 pounds per hour of dried preheated coal at 400° F. is introduced into a fluidized carbonization vessel **12** and maintained therein for 30 minutes. 4,750 cubic feet per minute of air is introduced into the carbonization vessel through a conduit **30** as fluidizing and partial combustion gas. A temperature of 925° F. is maintained within the carbonization vessel. The linear velocity of the fluidizing gases is about 1.65 feet per second.

The carbonization gases, recovered through conduit **31**, include:

	Pounds per hour
Dry tar	12,110
Solids	3,600
Gas	26,000
Water vapor	8,380

50,500 pounds per hour of char at 925° F. is introduced into a char surge vessel **13**. The char has the following analysis:

TABLE III

Char Properties

	Weight percent
(A) Proximate analysis:	
Volatile matter	22.22
Fixed carbon	72.74
Ash	5.04
(B) Ultimate analysis:	
H	3.16
C	79.94
N	1.36
O	9.69
S	0.81
(C) Particle size distribution (wet screen):	
On 14 mesh	0.0
Through 14 on 28 mesh	10.2
Through 28 on 48 mesh	27.4
Through 48 on 100 mesh	29.8
Through 100 on 150 mesh	13.1
Through 150 on 200 mesh	6.1
Through 200 on 325 mesh	8.5
Through 325 mesh	4.9

It is apparent that substantially no agglomeration occurs during carbonization when the particle size analysis of the product char (Table III) is compared with that of the starting coal (Table II).

28,600 pounds per hour of char from conduit **33** are partially burned with 5,680 standard cubic feet per minute of air from conduit **35** to produce a dilute phase suspension of hot char in combustion gases at a temperature of about 2200° F. This dilute phase suspension is blended with 21,900 pounds per hour of char from conduit **33*a*** to produce a dilute phase stream of char suspended in gases in the conduit **36** at a temperature of about 1800° F. At this temperature, the char is further devolatilized and experiences a shrinking to effect increased strength. The entire stream of char and hot gases is blown upwardly through a calciner vessel **14**. 61,500 pounds per hour of raw briquets are introduced into the top of the calciner vessel. By interchange of heat, the briquets leave the bottom of the calciner vessel at a temperature of about 1650° F. and are cooled to produce 52,050 pounds per hour of dry coke. The shrunk char and hot gases are cooled via heat interchange within the calciner vessel to a temperature of 740° F. and withdrawn through a conduit **39**. The bulk of the entrained shrunk char is recovered from a cyclone separator **40** and introduced into a quench drum **15** where it is cooled to about 490° F. for subsequent use in briquet formulation. The effluent stream, recovered through a conduit **42**, from the cyclone separator **40** comprises:

	Pounds per hour
Dry tar	8,180
Solids	4,260
Gas	30,200
Moisture	5,290

This effluent stream is blended with the carbonization effluent gases and introduced into a condenser **18**.

The blended vapor stream recovered from the calciner and carbonization vessel is quenched by water spray to a temperature of about 170° F. The non-condensible gases are recovered at a temperature of about 90° F. and comprise 59,000 pounds per hour of gas having a net heating value of about 208 B.t.u. per cubic foot. The condensed tar product includes 20,300 pounds per hour of dry tar, 7,860 pounds per hour of entrained solids and 1,185 pounds per hour of moisture. The tar is dehydrated to remove the moisture and introduced into a distillation tower **20** at a temperature of about 720° F. The pitch product boiling above 415° C. contains 9,080 pounds per hour of pitch and 7,860 pounds per hour of entrained solids. This material is introduced into an air blowing vessel **21** maintained at 710° F. About 90 standard cubic feet per minute of air is blown into the air blowing vessel and the effluent vapors are recombined with the lower boiling distillate fractions of the tar. The product air blown pitch, recovered through conduit **52**, comprises 8,010 pounds per hour of pitch and 7,860 pounds per hour of entrained solids. This material is blended with 4,210 pounds per hour of middle tar distillate from conduit **53** having a boiling range between 300 and 415° C.

Thus a total of 20,100 pounds per hour of briquet binder pitch is produced and is cooled to solidification. The solid pitch is comminuted to simplify its subsequent blending with product char in the briquet formulation. The small quantity of coal which was entrained in the dryer effluent conduit **28** (510 pounds per hour) preferably is also combined into the briquet formulation. In addition, the fine particles of product briquets resulting from abrasion are recovered by screening and are incorporated in the briquet formulation. Typically these briquet recycle fines will amount to 5,720 pounds per hour.

The shrunk char, recycle coke fines, coal fines from the dryer and pulverized binder pitch are introduced into a briquet kneader at about 260° F., i.e., slightly above the melting point of the pitch binder. The briquets are pressed in a briquet making apparatus **17** and cooled below the pitch melting point for mechanical strength. A total of 61,500 pounds per hour of raw briquets results. These are the briquets which are introduced into the calciner vessel **14** for coking.

FURTHER EXAMPLES

Three tests are reported herein to illustrate the effect of preliminary char shrinking on product metallurgical coke obtained from non-caking coal.

Test 1.—A briquet formulation was prepared according to the present invention. A binder pitch was produced from the low temperature carbonization pitch boiling above 375° C. The pitch was air blown to a fixed carbon value of 38 percent by weight. The pitch was blended with middle boiling tar distillate (300 to 375° C.). Char from fluidized low temperature carbonization of non-caking coal was heated to 1800° F. to effect shrinking. The briquet formulation was as follows:

	Parts
Preshrunk char	80.7
Air blown pitch	11.0
Middle tar distillate	8.3

One-inch briquets prepared from this formulation, when coked to 1800° F. showed a tumbler index of 95.8 (when quenched in nitrogen gas) and 94.5 (when quenched in water). Thus briquets of acceptable strength can be prepared according to this invention. The tumbler index is similar to that described in ASTM Test Designation D 294–50, modified to provide for the one-inch briquets.

Test 2.—The same pitch binder and middle boiling tar distillate were combined with char obtained from fluidized low temperature carbonization of the same non-caking coal used in Test 1. The char was not preshrunk, but instead was formulated into briquets without intervening thermal treatment. The briquet formulation was as follows:

	Parts
Char	86.0
Air blown pitch	8.4
Middle tar distillate	5.6

The tumbler index of the resulting coked briquets was 55.1. Thus the improved coke strength achieved by prelininary char shrinking is clear when the results of Tests 1 and 2 are compared.

Test 3.—Briquets were prepared from the same starting ingredients of Test 2 with the addition of a minor portion of caking coal. The caking coal was a Pittsburgh Seam high volatile, strongly caking coal obtained in nothern West Virginia. The formulation was as follows:

	Parts
Char	73.0
Air blown pitch	7.1
Middle tar distillate	5.7
Caking coal	14.2

The tumbler index of the resulting coked briquets was 80.0. Hence it is seen that improved briquets can be prepared from the char product of non-caking coal when a minor portion of strongly caking coal is incorporated into the formulation. However, the briquet strength achieved by addition of caking coal to the briquet is not as high as that resulting from the use of shrunk char.

While fluidized low temperature carbonization has been described in the foregoing specification as a preferred processing technique, nevertheless, other forms of low temperature carbonization may be employed, preceded or followed by crushing of the solids to a particle size suitable for effective shrinking treatment and heat interchange with pressed briquets.

While it is preferable to use tar fractions as the briquet binder, nevertheless, the briqueting art is replete with briquet binders which may be employed as substitutes. The autogenous character of the preferred process is dedesirable.

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

We claim:

1. The method of preparing metallurgical fuel briquets which comprises carbonizing a non-caking coal in a fluidized state at low temperature until substantially complete evolution of tar has occurred, whereby a particulate char is obtained as a residue, heating said char in particulate form as a suspension in hot gases to an elevated temperature above the carbonization temperature at which said char was generated to effect shrinkage of said char, passing said heated char at said elevated temperature as a dilute phase suspension through a coking zone in heat exchange relation with raw briquets whereby said briquets are coked, recovering char from the cooled dilute phase suspension, forming raw briquets from said char for transfer to said coking zone, and recovering coked briquets from said coking zone.

2. The method of preparing metallurgical fuel briquets which comprises carbonizing a non-caking coal in a fluidized state at low temperature until substantially complete evolution of tar has occurred, whereby a particulate char is obtained as a residue, suspending said particulate char in a gaseous medium, heating said char by the partial combustion of a portion thereof to an elevated temperature above the carbonization temperature at which said char was generated to effect shrinkage of said char, conducting said heated char at said elevated temperature as a dilute phase suspension without prior deliberate cooling through a coking zone in countercurrent heat exchange relation with raw briquets, whereby said briquets are coked, recovering char from the cooled dilute phase suspension, forming raw briquets from said char for transfer to said coking zone, and recovering coked briquets from said coking zone.

3. The method of preparing metallurgical fuel briquets which comprises carbonizing a non-caking coal in a fluidized state at low temperature until substantially complete evolution of tar has occurred, whereby a particulate char is obtained as a residue, recovering said char in two streams, partially burning one of said streams by combustion with air to raise the temperature thereof substantially above the carbonization temperature at which said char was generated, recombining the two streams of char in a dilute phase suspension at an elevated temperature above said carbonization temperature to effect shrinkage of said char, conducting said dilute phase suspension of char without prior deliberate cooling through a coking zone in countercurrent heat exchange relation with raw briquets, whereby said briquets are coked, recovering char from the cooled dilute phase suspension, forming raw briquets from said char for transfer to said coking zone, and recovering coked briquets from said coking zone.

4. The method of claim 3 wherein the two char streams comprise respectively a relatively fine particle size stream and a relatively coarse particle size stream, and the relatively fine particle size stream is partially burned.

5. The method of preparing metallurgical fuel briquets which comprise carbonizing a non-caking coal in a fluidized state at low temperature until substantially complete evolution of tar has occurred, whereby a particulate char is obtained as a residue, heating said char in particulate form as a suspension in hot gases to an elevated temperature above the carbonization temperature at which said char was generated to effect shrinkage of said char, passing raw briquets downwardly in direct heat exchange relation with said suspension of heated char in a coking zone while at said elevated temperature whereby said raw briquets are coked, recovering char from said coking zone, forming raw briquets from said char for transfer to said coking zone, and recovering coked briquets from said coking zone.

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