Patented Jan. 18, 1938 2,105,832

UNITED STATES PATENT OFFICE

2,105,832

METHOD OF COKING COAL BRIQUETTES

Joseph Becker, Pittsburgh, Pa., assignor, by mesne assignments, to Koppers Company, a corporation of Delaware

No Drawing. Application November 21, 1934
Serial No. 754,177

7 Claims. (Cl. 202—26)

The invention relates to improvements in the briquetting of coking-coals; and it has for an object the production of briquettes from coking-coal, and more particularly from low-volatile coking-coal, that are of high combustibility and yet have a density, and consequent weight in bulk nearly comparable to that of the raw original coal, and have a compression strength and fracture resistance far greater than such coal, and are also strongly resistant to spalling and abrasion; and the invention has for further objects the effective conversion into highly concentrated fuel, adapted to be economically shipped and readily and cleanly utilized, of the slack or fines of coking-coal that become great accumulations and in great part an economic waste, and more particularly the fines of low-volatile coking-coal that is generally of such expanding character as to preclude its employment in coking ovens or retorts in more than minor limited admixture to a preponderance of high-volatile non-expanding coking-coals; and the invention has for further objects such other improvements and advantages as may be found to obtain in the method or product hereinafter described or claimed.

The invention comprises: subjecting the coking-coal, in pulverized condition, to oxidizing, promoted by controlled elevated temperature or otherwise, to an extent that nearly or quite renders such coal substantially non-caking when it is afterwards carbonized at coking temperatures, but effecting such oxidizing without initiating softening or substantial gasification of the coal and so that the coal retains substantially all of its original volatile content until afterwards carbonized, and all of the coal employed, or a preponderatingly greater proportion of all of the coal employed, being subjected to the aforesaid oxidizing; admixing to the total coal employed, whether or not all pre-treated, a minor proportion of an adherent or adherable binder other than coal and preferably of the nature of pitch or the like; briquetting under high pressure; and carbonizing at coking temperatures, preferably in the range of the temperatures now regarded as the middle-temperature coking range or somewhat higher; the produced briquette retaining a volatile content of minor amount in proportion to that of the original coal but still substantial and considerable enough to impart high combustibility and low ignition-point to the briquette, and such briquette having a density, and consequent weight in bulk, nearly or quite that of the raw original coal, and having a compression strength and fracture resistance far greater than the raw original coal employed for the briquette manufacture method aforesaid. Particular adaptability of the invention to the utilizing of low-volatile coking-coals resides in the fact that they generally are what are known as expanding coals, that is to say, they not only swell, as does also high-volatile coking-coal, during the plastic or formative stage of the coking process, but, unlike the high-volatile coking-coal, they permanently expand and remain set in expanded condition at the finish of the coking process; so that such expanding coals cannot be employed in the usual charging of a chamber coke-oven without jeopardy of wrecking the structure, unless they are mixed with a greatly preponderating proportion of non-expanding high-volatile coal; and if such expanding low-volatile coking-coals were employed raw as the sole or preponderating coal constituent, or even approaching such proportion, in briquettes, the coking or carbonizing of such briquettes would cause them to rupture or burst, or even coalesce, and destroy them or render them useless as briquettes. But the aforesaid oxidizing pre-treatment of the expanding low-volatile coking-coals will take away or so greatly reduce their caking tendency that when subjected to coking temperature in a retort-oven they will no longer form a coherent coke-cake but carbonize in particulate form without the jeopardy of an expanding coke that bursts its bounds; and in such particulate form the treated coal is in some manner cemented together and carbonized along with the small proportion of admixed binder, such as the highly volatile pitch, and they together form briquettes of the high density and great strength before-mentioned, and without rupture or bursting or coalescing of the briquettes. With any considerable increase of the proportion of raw coal in the mix, such as, for instance, substantially over about one-fourth raw and three-fourths oxidized coal, the briquettes drop off materially in density, weight, strength and other advantageous characteristics. The employment of high-volatile coking-coal introduces other factors affecting the character of the briquettes, as for instance large shrinkage in carbonizing in consequence of the large volatile content expelled and which must be compensated economically by recovery of such expelled volatile but may nevertheless physically alter the briquettes. The distinction between low-volatile and high-volatile coking-coal is somewhat arbitrary but fairly definite, the distinctly high-volatile rang-

ing above about 25% volatile content and typically of about 30% or more, and the distinctly low-volatile ranging below about 25% volatile content and typically of about 20% or less, some good typical examples of low-volatile coking-coal being the well-known Pocahontas seam or similar coals having about 17% volatile content. Among briquetting binders there are many known, but one of the most available is hard briquetting pitch or the like, and another of many, though less suited in some respects, is waste sulphite liquor. Carbonizing capacity is of moment in the binders; and they should also be effective when employed in such minor proportion as to be only about 7% of the amount of the coal employed, so that the coal shall be by far the dominating constituent in the briquetting. The sequence of the above-indicated steps may be varied.

For purposes of exemplification, and without limiting the invention thereto, there is here given an illustrative instance of actual practice of the method of the invention, together with an illustrative instance of actual briquettes, that are a product of the invention, but without limiting the claimed invention to such instances or to less than all the possible ways in which it may be practiced or embodied within the claims hereinafter made.

In this example the expanding low-volatile coking-coal employed was from the well-known Beckley seam, which is closely related physically and in location to Pocahontas seam coal. Its total volatile content was about 17.4% and its ash content about 5.8%. It was pulverized in a mill, so that when screen-tested nearly all of it passed through 10-mesh screen (2 mm. openings), about 90% or more through 20-mesh (about 0.9 mm. openings), much less than half through 100-mesh and about a fourth through 200-mesh screen. The coal so pulverized was then charged into a rotary drum externally heated with hot gases, so that the coal itself within the rotating drum would become heated to about 400° Fahrenheit while a stream of air was being passed through the drum to effect the oxidation of such coal. A coal-charge into the drum was 1000 lbs., the air-stream rate about 650 cu. ft. per hour and the time of the run about two hours, average; whereupon a crucible-test showed that the coal had lost its caking quality, no longer forming a coherent coke-button in the test-crucible. There had been no softening of the coal and no substantial gasification, but only an expelling of water-vapor and the noted presence of a very small amount of CO_2 and a trace of CO in the off air-stream. Aside from measured water-vapor expelled and measured mechanical spillage, the coal loss in the oxidizing procedure was not observable to be over about 0.1 to 0.2%. The pulverization of the coal to particulate form, as above mentioned, exposed practically maximum coal surface to the air stream and secured practically uniform and effectively rapid oxidation.

The so oxidized coal was barrelled and shipped to another plant where a high-pressure roll-type briquetting machine, of well-known design, was available. There the coal was mixed with about 7% of its own weight of stamp-crushed hard briquetting pitch, the mix being in the proportion of about 34 lbs. of pitch to about 450 lbs. of the coal. This was passed through mixer and fluxer apparatus in which it was exposed for about ten minutes to live steam of a pressure of about 40 lbs. and so as to melt the pitch and thoroughly mix it with the coal in such manner as to coat the coal particles without having the coating film too thin to effect adhesion between the particles in the operation of forming the green briquettes. From the fluxer apparatus the mix so brought to proper consistency was passed into the roll-type briquetting machine and there formed under high pressure into lenticular briquettes about 2 inches square and of about 1¼ inch middle thickness, and having a compression strength, against point pressure applied through their middle thickness, of about 340 lbs., and having a smooth polished outer surface.

These green briquettes were shipped to a test coke-oven equipped with thermocouples and having an oven-chamber that was heated by lateral vertical flame-flues and was of an inside width of about 6½ inches. The green briquettes, in the particular instance here being detailed, were charged in bulk into the coking-chamber when its middle temperature was about 702° C., the heating-flues having at their bottoms a temperature of about 950° C. The temperature in the coking chamber of course dropped to a low figure when the cold briquettes were charged into the chamber, but the chamber was promptly sealed and the middle temperature of the chamber progressively rose, the rise being registered in an almost straight and uniform ascending line on the register of the thermocouple. The regularity of the rise was plainly due to the circumstance that the oven was charged with the loose briquettes, with interstices between them, instead of with a solid charge of coal as in ordinary coking. In about 2½ hours the middle temperature of the coking-chamber had reached 620° C. and its luted door was then unsealed and the charge of carbonized briquettes discharged. None were ruptured or deformed, save for limited shrinkage necessarily resulting from expelling of their volatile matter. None were stuck together, and none stuck to the heating-walls or floor of the coking-chamber. They were cooled by water-quenching and thereafter examined and tested. They showed a compression strength, against point-compression through their middle thickness, of over 400 lbs., which was the limit of the register of compression test apparatus that was then available. Substantially all of them were without any surface cracks, and were difficult to fracture with even a severe direct blow. Any fracture-face showed an extremely dense and uniform minutely pitted surface from middle to outer surface of the briquette and with a denser outer surface skin of scarcely perceptible thickness. These carbonized briquettes had a volatile matter content of about 6.9%, a fixed carbon content of about 86.9%, and an ash content of about 5.9% with an ash-fusion temperature of about 2800° F. Their ignition temperature was about 420° C., or lower than the usual range of anthracite (of 420° to 460° C.) and far lower than the ignition temperature of 520° C. for ordinary high temperature coke; so that their combustibility was far higher than that of high temperature coke and comparable to or higher than that of anthracite. The density, and consequent weight, of these briquettes was nearly comparable to that of the raw original coal, the weight per cubic foot being about 42.2 lbs. as compared with about 44 lbs. per cu. ft. for the raw original coal, and as against about 31.5 lbs. per cu. ft. for ordinary high-temperature coke. The advantage in weight per cu. ft. results both from the much higher apparent specific gravity, of over 1.17 for the

briquette as against under 1 for said coke and under 1.3 for the raw coal, and from the much more uniform and closer packing of the briquettes in bulk as against either the raw coal or the high temperature coke in bulk. Both the density individually and the compactness in bulk of the briquettes are increased still further by carrying their carbonizing to a higher end-temperature and through a longer carbonizing time than the before-mentioned 620° C. and 2½ hours, but this reduces their volatile content and somewhat raises their ignition point, though still holding it much below the ignition point of high-temperature coke unless their carbonizing is carried to a useless extreme. The original mix for forming the briquettes can be varied by substituting the pulverized raw coal for part of the oxidized coal, but the density and weight of the finished briquette are reduced, and if the substitution is carried to over about one fourth part, or a mix of about 25% raw and 75% oxidized, the briquette is deteriorated and the carbonizing of the higher proportion of raw low-volatile coal, with its expanding character, tends to rupture the briquettes and causes them also to coalesce and stick.

The density and the weight in bulk of the above described briquettes give them a shipping and handling advantage of some 35% over ordinary high-temperature coke, and this and their low ignition point and high combustibility and strength render them a fuel comparable with anthracite and in certain respects superior to it.

The possible theoretical basis of the improvements accomplished by the invention has not been discussed at length, for the theoretical aspect may undergo modification upon further extended study of the observed phenomena, but the more essential practical steps of the method and characters of the product have been indicated and so described as to enable carrying out an embodiment of the invention in actual practice.

The invention is of course not limited to the particular illustrative instance or instances hereinbefore set forth, but may be variously practiced and embodied within the scope of the claims hereinafter made.

I claim:

1. A method of making nearly in their entirety from coking-coal briquettes that are of higher combustibility than high temperature coke and of a density and weight nearly comparable to the raw original coal, comprising: treating low-volatile coking-coal by pulverizing and limited oxidizing, the oxidizing being effected at a temperature that is elevated to promote the action and render the coking-coal substantially non-caking and yet avoids softening it and leaves it substantially unfused and undecomposed as to its gas-making constituents, admixing an adherent binding material sufficient to bind together the oxidized coking-coal particles during the subsequent briquetting and yet too limited to form of itself a substantial proportion of the body of the finally finished briquette but with the oxidized coal in quantity sufficient to form the bodies of the green briquettes in nearly their entireties of the so oxidized coking-coal, and then briquetting substantially free of other admixture, the so prepared oxidized coking-coal but while the oxidized coking-coal still contains unvolatilized substantially all of its original content of gas evolving constituents, and thereafter carbonizing the formed briquettes while the oxidized coal content thereof still contains unvolatilized substantially all of its original content of gas evolving constituents, said carbonizing step being in effect the initial and the only carbonization step of substantial gasification by heat-decomposition of the employed coking-coal and being carried through at a temperature range and within a time period that reduce the pre-formed coking-coal briquettes to high-density carbonized condition and somewhat shrink them in size, to give them strength and weight, and yet leave in them a substantial proportion of their original volatile gas content to give them high combustibility.

2. A method of making nearly in their entirety from coking-coal briquettes that are of higher combustibility than high temperature coke and of a density and weight nearly comparable to the raw original coal, comprising: treating coking-coal by pulverizing and limited oxidizing, the oxidizing being effected at a temperature that is elevated to promote the action and render the coking-coal substantially non-caking and yet avoids softening it and leaves it substantially unfused and undecomposed as to its gas-making constituents, admixing an adherent binding material sufficient to bind together the oxidized coking-coal particles during the subsequent briquetting and yet too limited to form of itself a substantial proportion of the body of the finally finished briquette but with the oxidized coal in quantity sufficient to form the bodies of the green briquettes in nearly their entireties of the so oxidized coking-coal, and then briquetting substantially free of other admixture, the so prepared oxidized coking-coal but while the oxidized coking-coal still contains unvolatilized substantially all of its original content of gas evolving constituents, and thereafter carbonizing the formed briquettes while the oxidized coal content thereof still contains unvolatilized substantially all of its original content of gas evolving constituents, said carbonizing step being in effect the initial and the only carbonization step of substantial gasification by heat-decomposition of the employed coking-coal and being carried through at a temperature range and within a time period that reduce the pre-formed coking-coal briquettes to high-density carbonized condition and somewhat shrink them in size, to give them strength and weight, and yet leave in them a substantial proportion of their original volatile gas content to give them high combustibility.

3. A method of making briquettes from coking-coal, comprising: treating low-volatile coking-coal of under 20% volatile matter, dry basis, by pulverizing it to particles mostly under 1 mm. and by limited oxidizing of it, the oxidizing being effected at a temperature of a range around the order of about 400° F. to promote the action and render the coal substantially non-caking and yet avoid softening of it or substantial production of gas by heat decomposition of the coal, and admixing about 7% of pitch, fluxed in at its free-flowing temperature, and briquetting the mix, and thereafter carbonizing the briquettes, the carbonizing being effected at a temperature range and within a time that give an end-temperature, inside the carbonizing chamber, of between about 600° and 700° C. at the finish of a carbonizing period of about 2 to 5 hours and leave in the finished briquettes a volatile content of an amount under a half and near a third of

the amount of the volatile content of the original coal.

4. A method of making nearly in their entirety from coking-coal briquettes that are of higher combustibility than high temperature coke and of a density and weight nearly comparable to the raw original coal, comprising: treating coking-coal by pulverizing it and by limited oxidizing of at least about three-fourths of the total quantity of raw coal employed to constitute the bodies of the briquettes, the oxidizing being effected at a temperature that is elevated to promote the action and render the oxidized coking-coal substantially non-caking and yet avoids softening it and leaves it substantially unfused and undecomposed as to its gas-making constituents, preparing the briquetting mixture with adherent binding material and coking coal in quantity sufficient to form the bodies of the briquettes in nearly their entireties of coking-coal by admixing an adherent binding material sufficient to bind together the coal particles during the subsequent briquetting and yet too limited to form of itself a substantial proportion of the body of the finally finished briquette but with the oxidized coking-coal in quantity sufficient to form at least about three-fourths of the entireties of the coal content of the bodies of the green briquettes, and then briquetting the so prepared oxidized coking-coal but while the oxidized coking-coal still contains unvolatilized substantially all its original content of gas evolving constituents, substantially free of other than said coal admixture, and thereafter carbonizing the formed briquettes while the oxidized coal content thereof still contains unvolatilized substantially all of its original content of gas evolving constituents, said carbonizing step being in effect the initial and the only carbonization step of substantial gasification by heat-decomposition of the employed coking-coal and being carried through at a temperature range and within a time period that reduce the preformed coking-coal briquettes to high-density carbonized condition and somewhat shrink them in size, to give them strength and weight, and yet leave in them a substantial proportion of their original volatile gas content to give them high combustibility.

5. A method of making nearly in their entirety from coking-coal briquettes that are of higher combustibility than high temperature coke and of a density and weight nearly comparable to the raw original coal, comprising: treating expanding low-volatile coking-coal by pulverizing and limited oxidizing, the oxidizing being effected at a temperature that is elevated to promote the action and render the coking-coal substantially non-caking and yet avoids softening it and leaves it substantially unfused and undecomposed as to its gas-making constituents, admixing an adherent binding material sufficient to bind together the oxidized coking-coal particles during the subsequent briquetting and yet too limited to form of itself a substantial proportion of the body of the finally finished briquette but with the oxidized coal in quantity sufficient to form the bodies of the green briquettes in nearly their entireties of the so oxidized coking-coal, and then briquetting substantially free of other admixture, the so prepared oxidized coking-coal but while the oxidized coking-coal still contains unvolatilized substantially all of its original content of gas evolving constituents, and thereafter carbonizing the formed briquettes while the oxidized coal content thereof still contains unvolatilized substantially all of its original content of gas evolving constituents, said carbonizing step being in effect the initial and the only carbonization step of substantial gasification by heat-decomposition of the employed coking-coal and being carried through at a temperature range and within a time period that reduce the preformed coking-coal briquettes to high-density carbonized condition and somewhat shrink them in size, to give them strength and weight, and yet leave in them a substantial proportion of their original volatile gas content to give them high combustibility.

6. A method as claimed in claim 5 and in which the adherent binding material employed is pitch.

7. A method as claimed in claim 5 and in which the adherent binding material is hard pitch fluxed in at its free-flowing temperature.

JOSEPH BECKER.