UNITED STATES PATENT OFFICE.

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METHOD OF MANUFACTURING BRIQUETS.

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To all whom it may concern:

Be it known that I, CHARLES HOWARD SMITH, a citizen of the United States, and a resident of Short Hills, in the county of Essex and State of New Jersey, have made certain new and useful Improvements in Methods of Manufacturing Briquets, of which the following is a specification.

The invention relates to the manufacture of smokeless, carbonized briquets and one object of the invention is directed to the utilization of bituminous coals of a non-caking type and also certain lignites for said purpose.

Non-caking coals so called are bituminous coals which do not soften or undergo apparent fusion during distillation or carbonization as contrasted with caking coals so called which are bituminous coals of the character that soften and undergo apparent fusion when subjected to said heat treatment.

I have found it possible to make carbonized briquets from bituminous coals of a non-caking type by the admixture of material which provides what is properly termed "binding material" so-called since it is the material—included in the mixture comprising the non-caking coal and the admixture and from which raw briquets are made—that is employed or relied upon during the subsequent carbonizing of the raw briquet formed from the mixture to enable or make possible the formation or development of certain cementing or binding properties which are set up or developed during said carbonizing operation, whereby the resulting briquet or other product is a firm coherent structure.

A specific admixture which I have found satisfactory to provide the required binding material is one comprising bituminous coal of a caking type and pitch. In other words, an admixture which contains volatile hydrocarbon ingredients, and the percentage of the hydrocarbon volatile ingredients as compared with the content of the final briquet appears to be the controlling factor in determining the amount of materials which shall be added to provide the binding material. At any rate, it is possible to form the desired carbonized briquets from non-caking bituminous coals by relying upon the volatile content of such materials, as are employed to supply binding materials in the admixture, as a guide in determining the amount of materials to be added to the non-caking coal, whereby when the briquet carbonizing operation is performed the desired structure will result.

According to the present process I convert bituminous coals of a non-caking type and also certain lignites into a relatively fine or powdered form, if said coals are not in said form, and add thereto an admixture comprising caking coal in finely divided or pulverized form, and also pitch. The several coals or materials just referred to are thoroughly and intimately mixed. The resulting mixture is molded into briquets, termed raw briquets, and said raw briquets are subjected to a heating operation at sufficient temperatures and for a length of time to carbonize the briquets; or, in other words, until there results carbonized briquets having a firm, dense, coherent structure of the same general shape as the original briquets.

The resulting or carbonized briquets are each somewhat smaller than the original uncarbonized raw briquets due to the shrinkage that takes place during the carbonizing.

In developing my process I have found that where the volatile matter of the admixture of caking coal plus the volatile matter of the pitch is greater than eleven per cent. (11%) and does not exceed twenty per cent. (20%) of the total content of the uncarbonized or raw briquets the raw briquets formed from the mixture which includes said admixture can be subsequently carbonized in a furnace retort to produce the desired resulting briquet. By such a method or process of forming briquets the coal of the carbonized briquet is subject to only a single distillation and I have found that with the proportions just mentioned the briquets will retain their shape during carbonization and will not run together in the furnace retort.

Briquets manufactured according to my process are smokeless, durable in character, and able to withstand rough handling; they also retain their shape during combustion. In combustion qualities they are somewhat similar to anthracite but they are consumed more readily than anthracite under the same or equal draft. They are fine grained, dense

and slightly porous, but if the briquets be well made this latter feature is not apparent to the naked eye.

Concerning the pitch which is employed, this can be relied upon to serve two functions: One function is the providing of a temporary binder which holds or assists in holding together the solid particles in the raw briquet prior to and during carbonization. In the forming of the raw briquets steam may be employed to assist in carrying out a mixing and a fluxing operation. The other or more important function of the pitch is to assist in providing the necessary volatile material that permits of a permanent binding or cementing of the particles constituting the solid matter of the carbonized briquets resulting from the distillation or carbonization.

The pitch has the volatile hydrocarbons therein and the pitch provides at least a part of the ingredients relied upon to enable or make possible the formation or development of the cementing or binding properties which are set up or developed during the carbonizing operation; that is, the operation wherein the raw briquets are heated until there result the desired carbonized briquets. Herein, where reference is made to a substance for providing a binding material is meant a substance which provides a material that insures or makes possible the cementing or binding qualities which are set up or developed during the carbonizing operation and such substances may or may not have temporary binding qualities. It will be understood, however, the raw briquets must be constructed so as to hold up or retain their shape during the carbonizing operation.

An example of the manner in which the invention may be carried out is as follows:

Form a mixture of—

70% finely divided non-caking bituminous coal containing 40% volatile matter,

22% finely divided caking coal containing 36% to 40% volatile matter, and

8% to 10% of pitch containing approximately 55% to 60% volatile matter.

Flux the mixture by the use of steam, until there results a mixture which can be readily pressed or molded. A mixing and fluxing method is well known and hence is not described in detail herein. The resulting mixture is pressed or molded into briquets and the raw briquets thus formed are charged into a retort or oven and subjected to a distilling or carbonizing operation at a temperature or temperatures up to a maximum of 1500 degrees F. to 1800 degrees F. The gases distilled off during the heating are withdrawn from the retort and collected or used as desired. The resulting product is carbonized briquets similar in shape to the uncarbonized raw or original briquets. The carbonized briquets contain approximately two and one-half per cent. (2½%) volatile matter—possibly more, possibly less. By carrying out the distillation or carbonization of the briquet at the temperatures above mentioned there is produced a strong, coherent, smokeless briquet. In other words, the resulting briquet is strong and will withstand rough handling.

It will be noted that the volatile matter of the twenty-two per cent, (22%) of caking coal that is employed in the admixture—the caking coal and the pitch constituting the admixture—approximates from 7.9% to 8.8% of the total raw briquent, while the volatile matter of the eight per cent. (8%) to ten per cent. (10%) of pitch approximates from 4.8% to 6% of the total raw briquet. The total volatile matter of these two ingredients would therefore approximate from 12.7% (practically 13%) to 14.8% (practically 15%) of the raw briquet content.

I have also found by experiments that I am not confined to exactly thirteen per cent. (13%) or fifteen per cent. (15%), as the case may be, for a satisfactory range of the volatile matter in the admixture which comprises both the caking coal and the pitch may run in some instances as low as eleven per cent. (11%) and in other instances as high as twenty per cent. (20%) of the total weight of the raw briquet.

The total amount of the volatile matter in the admixture, as previously indicated, appears to be an important factor in determining the amount and character of the admixture which is employed to supply the binding material requisite to insure the proper cementing qualities that develop when the briquet is subjected to the heating or carbonizing operation. In other words, the volatile content of the admixture seems to control to a certain extent the final structure of the resulting carbonized briquet. Since, as previously pointed out, the binding or cohesive or cementing qualities existing in the carbonized briquets are derivable from or dependent upon the volatile materials in the admixture these volatile materials in the admixture may broadly be referred to as the binding material. Therefore, the caking coal and the pitch may be referred to as material providing the binder.

It will be here noted that the seventy per cent. (70%) of non-caking coal, to which the admixture just described was added, contained approximately forty per cent. (40%) volatile matter. The percentage of volatile matter in the non-caking coal seems to be an element which can be more or less disregarded. The carbonization of the raw briquets of course eliminates most of this volatile matter and that which takes place during carbonization is difficult to predict,

but so far as I have been able to learn from my investigations the percentage of volatile matter in the non-caking coal appears to be a thing that can be disregarded in calculating or determining the admixture of binding material which is to be ultimately employed. I have ascertained that it is necessary in the manufacture of carbonized briquets, if a bituminous coal of non-caking type is to be used as a basis of such briquets, to have a binding material that is provided by an admixture of other hydrocarbon matter which I mix with the non-caking coal.

In the carbonizing of the briquets made according to the process just described a substantial shrinkage takes place and there are yielded by such carbonization strong, coherent smokeless, carbonized briquets.

In order that a fuller understanding of the invention may be available to the public there is herein referred to results of tests which I have made on samples of coal, such samples being commercially known as the Grand Ridge coal from the State of Washington, and the Ladysmith coal from Vancouver Islands, British Columbia, each having the characteristics enumerated.

The Grand Ridge coal is a lignite non-caking coal containing 38.2% of volatile matter, the Ladysmith coal is a caking coal containing 37.3% volatile matter. The tests are listed below. The compositions entering into the briquet tested are listed. The raw briquets were carbonized at about 1700 degrees F. and the result of the carbonizing operation on the briquets thus made appears in the comments as to each test.

		Volatile matter.	Percentage of volatile matter relative to raw briquet.
Grand Ridge coal	65%	38.2%	
Raw Ladysmith coal	25%	37.3%	9.3%
Pitch	10%	55-60%	6 } 15.3%
	100%		
Good briquets.			
Raw Grand Ridge coal	60%	38.2%	
Raw Ladysmith coal	30%	37.3%	11.2%
Pitch	10%	55-60%	6 } 17.2%
	100%		
Good briquets.			

Tests also seem to bear out the fact that when the volatile matter in the admixture, as far as is ascertained from the particular coals so far tested, is substantially less than eleven per cent. (11%) of the content of the raw briquet the volatile content is too low to produce the desired carbonized briquet, whereas when the volatile matter in the admixture reaches substantially above twenty per cent. (20%) of the content of the raw briquet the volatile content is too high. The lowermost and uppermost limits for the proper amount of volatile matter in the admixture are therefore, respectively, approximately eleven per cent. (11%) and twenty per cent. (20%) of the content of the raw briquet.

Of course it is difficult to state a general law which is controlling as to all cases as to the exact amounts and proportions of volatile matter to be supplied by the admixture, but the amounts and proportions can be readily determined by experiment for any particular coal.

The present invention is particularly directed to the utilization of bituminous coals (viz. high volatile coals) of the non-caking type in the manufacture of carbonized briquets and applicant has solved how this can be done. It is possible to change the admixtures employed for providing the binding material from the proportions stated. As to some non-caking bituminous coals it may become practicable to supply the volatile material solely from an admixture of pitch, and as to other non-caking bituminous coals to supply the volatile matter solely from an admixture of caking coals. The possibility of such procedure can, however, be readily ascertained for any particular case.

It has just been pointed out that the percentage of the volatile matter contained in the mixture from which the raw briquet is formed may vary. One cause of the varying percentage may be the percentages of ash and moisture in the coal and also the individual characteristics of any particular coal. It will probably be advisable to use steam as a means of fluxing prior to briqueting whereby the briqueting operation can be readily performed, and as previously indicated I do not include the percentage of water utilized as a portion of the requisite percentage of volatile matter in the raw briquet.

Briquets made according to the process above outlined can be given a smooth finish and can be made relatively clean to handle. While I have referred to the possibility of using raw coal alone as an admixture to be used with non-caking coal, still I have found it preferable to utilize an admixture formed of caking coal and pitch for the reason that depending solely on water for binding, there is not sufficient strength in the raw briquet to insure the briquets standing the necessary handling into the retorts without serious breakage, which objection is overcome by using the pitch as a portion of the admixture. Too much volatile in the admixture, *i. e.* more than twenty per cent. (20%) of the total volatile matter of the briquet, will cause the briquets to distort and stick together during the distillation.

There have therefore been referred to the percentages which have been found to produce satisfactory results. For example, by mixing a certain percentage of bituminous

coal of the non-caking type with a certain percentage of bituminous coal of the caking type and with a certain percentage of pitch there can be formed from the resulting mixture briquets which can be carbonized in a manner whereby the solid ingredients of the briquet can be formed into a strong, dense block of the same shape as the raw briquet that was subjected to the carbonizing operation.

Reference has heretofore been made to the fact that the process applies to certain lignites as well as to bituminous coals of a non-caking type and the lignites thus referred to are such as respond to the treatment herein outlined for the manufacture of carbonized briquets from non-caking coal. These lignites are to be considered as the equivalent of or broadly as non-caking bituminous coals, and the claims herein are to be construed as broadly covering such lignites.

The improvements herein set forth are not limited to the precise construction and arrangement shown and described for they may be embodied in various forms and modifications without departing from the spirit and scope of the invention.

What I claim is:

1. In the manufacture of briquets the method which comprises rendering non-caking bituminous coal in finely divided form and mixing therewith an admixture of caking coal and pitch so that the volatile matter of the admixture approximates eleven per cent. (11%) to twenty per cent. (20%) of the total weight of the mixture, molding briquets from the mixture and carbonizing the briquets.

2. The method which comprises mixing with finely divided non-caking bituminous coal an admixture in which the hydrocarbon volatile matter thereof approximates eleven per cent. (11%) to twenty per cent. (20%) of the entire resulting mixture, forming the resulting mixture into briquets and carbonizing the briquets until there results a briquet having a firm coherent structure.

3. The method which comprises mixing with non-caking bituminous coal when in finely divided form an admixture for providing a binding material in which admixture the volatile matter approximates from eleven per cent. (11%) to twenty per cent. (20%) of the resulting mixture, molding the resulting mixture into briquets, and carbonizing the briquets.

4. The method which comprises mixing the non-caking bituminous coal when in finely divided form an admixture for providing a hydrocarbon binding material and in which admixture the volatile matter approximates eleven per cent. (11%) to twenty per cent. (20%) of the resulting mixture, molding the resulting mixture into briquets, and carbonizing the same, the carbonizing operation being carried out at temperatures from approximately 1500 degrees F. to 1800 degrees F. until there is formed a smokeless briquet having a firm coherent structure.

5. The method which comprises adding to and mixing with bituminous coal of the non-caking type of material providing a binder, in which added material the volatile matter thereof approximates from eleven per cent. (11%) to twenty per cent. (20%) of the resulting mixture, and carbonizing the resulting mixture.

6. The method which comprises adding to and mixing with bituminous coal of the non-caking type of material providing a binder, in which added material the volatile matter thereof approximates from eleven per cent. (11%) to twenty per cent. (20%) of the resulting mixture, and carbonizing the resulting mixture under conditions to form each individual mass of the mixture in a firm coherent structure.

7. The method which comprises adding to and mixing with non-caking high volatile coal material providing a binder, in which added material the volatile matter thereof approximates from eleven per cent. (11%) to twenty per cent. (20%) of the resulting mixture, and carbonizing the resulting mixture at temperatures approximating 1500 degrees to 1800 degrees F.

8. The method which comprises adding to and mixing with bituminous coal of the non-caking type material providing a binder, in which added material the volatile matter thereof approximates from eleven per cent. (11%) to twenty per cent. (20%) of the resulting mixture, and carbonizing the resulting mixture under such temperature conditions and for such a length of time as will produce a fused coherent residue.

9. The method which comprises mixing with non-caking bituminous coal an admixture comprising caking coal and pitch, the admixture being such that the volatile matter contained therein approximates from eleven per cent. (11%) to twenty per cent. (20%) of the resulting mixture, and carbonizing the resulting mixture.

10. The method which comprises mixing with non-caking bituminous coal an admixture comprising caking bituminous coal and pitch, the admixture being such that the volatile matter contained therein approximates from eleven per cent. (11%) to twenty per cent. (20%) of the resulting mixture, and carbonizing the resulting mixture at temperatures approximating from 1500 degrees to 1800 degrees F.

11. The method which comprises mixing with non-caking bituminous coal an admixture comprising caking bituminous coal and

pitch, the admixture being such that the volatile matter contained therein approximates from eleven per cent. (11%) to twenty per cent. (20%) of the resulting mixture, and carbonizing the resulting mixture until the resulting residue has a firm coherent structure, the gases being conducted from the heating zone as given off during said carbonizing.

12. The method which comprises mixing with high volatile non-caking coal an admixture of caking coal and pitch, forming said resulting mixture into briquets, and carbonizing the briquets thus formed.

13. The method which comprises mixing with bituminous non-caking coal having a volatile content of approximately thirty-eight per cent. (38%) to forty per cent. (40%) an admixture containing pitch, briqueting the resulting mixture, and carbonizing the briquets in a manner to form firm coherent briquets.

14. The method which comprises mixing with non-caking bituminous coal having a volatile content of approximately thirty-eight per cent. (38%) to forty per cent. (40%) an admixture of caking bituminous coal, briqueting the resulting mixture, and carbonizing the briquets in order to form firm fused carbonized briquets.

15. The method which comprises mixing with high volatile non-caking coal an admixture containing pitch, forming the mixture into briquets and subjecting the briquets thus formed to a carbonizing operation, the admixture providing sufficient volatile matter to insure the desired resulting carbonized briquets.

16. The method which comprises mixing with bituminous non-caking coal an admixture containing bituminous caking coal, forming the mixture into briquets and carbonizing the raw briquets thus formed, the admixture providing sufficient volatile matter to insure the desired resulting carbonized briquet.

17. The method which comprises mixing with non-caking bituminous coal an admixture containing pitch and caking bituminous coal, fluxing, forming the resulting mixture into raw briquets, and subjecting the raw briquets thus formed to carbonizing temperatures approximating 1500 degrees to 1800 degrees F. and for a sufficient length of time to form each briquet into a strong, coherent structure, the admixture containing hydrocarbon volatile matter which approximates eleven per cent. (11%) to twenty per cent. (20%) of the weight of the raw briquet.

18. The method which comprises mixing with finely divided non-caking bituminous coal an admixture containing caking bituminous coal and pitch, the admixture providing volatile matter which approximates eleven per cent. (11%) to twenty per cent. (20%) of the raw briquet subsequently formed from the mixture, forming the mixture into raw briquets and subjecting said raw briquets to carbonizing temperature approximating from 1500 degrees to 1800 degrees F. to remove a substantial portion of the volatile matter contained in the materials constituting briquets.

19. The method which comprises mixing with finely divided bituminous high volatile non-caking coal an admixture containing caking coal and pitch, the admixture providing volatile matter which approximates eleven per cent. (11%) to twenty per cent. (20%) of the raw briquet subsequently formed from the mixture, forming the mixture into raw briquets and subjecting said raw briquets to carbonizing temperatures until the volatile matter remaining in the briquet approximates two and one-half per cent. (2½%).

20. The method which comprises mixing with high volatile non-caking coal an admixture containing caking coal and pitch of such proportions that when the resulting mixture is formed into briquets and the briquets are carbonized, strong coherent briquets will result, forming the said resulting mixture into raw briquets, and subsequently carbonizing in a manner to produce the desired resulting briquet.

21. The method which comprises mixing with high volatile non-caking coals an admixture of caking coal and pitch, forming the resulting mixture into briquets, and carbonizing the raw briquets in a manner to produce carbonized briquets each having a firm coherent structure.

22. The method which comprises mixing high volatile non-caking coal, a high volatile caking coal and pitch in such proportions that a firm strong carbonized briquet can ultimately be formed therefrom, briqueting the resulting mixture, and carbonizing said raw briquets in a manner to produce low volatile smokeless briquets, without distortion of the charge or the briquets sticking together.

23. The method which comprises mixing non-caking coal having a volatile content of approximately thirty-eight per cent. (38%) to forty per cent. (40%) high volatile caking coal, and pitch, forming the resulting mixture into briquets, and carbonizing the resulting briquets in a manner to form carbonized low volatile briquets.

24. The method which comprises mixing approximately sixty per cent. (60%) to seventy-five per cent. (75%) non-caking coal having volatile content of approximately thirty-eight per cent. (38%) to forty per cent. (40%), twenty-two per cent. (22%) to thirty per cent. (30%) caking coal having volatile content of approximately thirty per

cent. (30%) to forty per cent. (40%), and six per cent. (6%) to ten per cent. (10%) pitch having volatile content of approximately fifty-five per cent. (55%) to sixty per cent. (60%), the proportions being such that the caking coal and the pitch provide volatile matter approximating eleven per cent. (11%) to twenty per cent. (20%) of the resulting mixture, forming said mixture into briquets and carbonizing the briquets at temperatures approximating 1500 degrees F. to 1800 degrees F. and for a length of time to form a strong coherent briquet structure.

25. The method which comprises forming a mixture of approximately sixty-five per cent. (65%) non-caking bituminous coal, twenty-five per cent. (25%) caking coal and ten per cent. (10%) pitch, forming the mixture into briquets and carbonizing the briquets at temperatures approximating 1500 degrees F. to 1800 degrees F. for a period sufficient to drive off a substantial portion of the volatile matter.

26. Carbonized briquets each having a firm coherent structure and resulting from the method which comprises mixing with high volatile or bituminous non-caking coal an admixture of caking bituminous coal and pitch, forming said mixture into briquets, and carbonizing the raw briquets.

27. A raw briquet comprising a mixture of raw high volatile non-caking coal, high volatile caking coal and pitch.

28. A raw briquet comprising a mixture of finely divided raw bituminous non-caking coal, caking coal and pitch, the caking coal and pitch providing volatile matter approximating eleven per cent. (11%) to twenty per cent. (20%) of the briquet.

29. The method which comprises mixing with bituminous caking coal an admixture containing pitch so that the volatile matter of the admixture approximates eleven per cent. (11%) to twenty per cent. (20%) of the total weight of the mixture, briqueting the resulting mixture after it has been fluxed, and carbonizing the briquets in a manner to form firm coherent briquets.

This specification signed and witnessed this 16th day of February, A. D., 1918.

CHARLES HOWARD SMITH.

Signed in the presence of—
ARTHUR P. VERMILYA,
EDWIN A. PACKARD.