

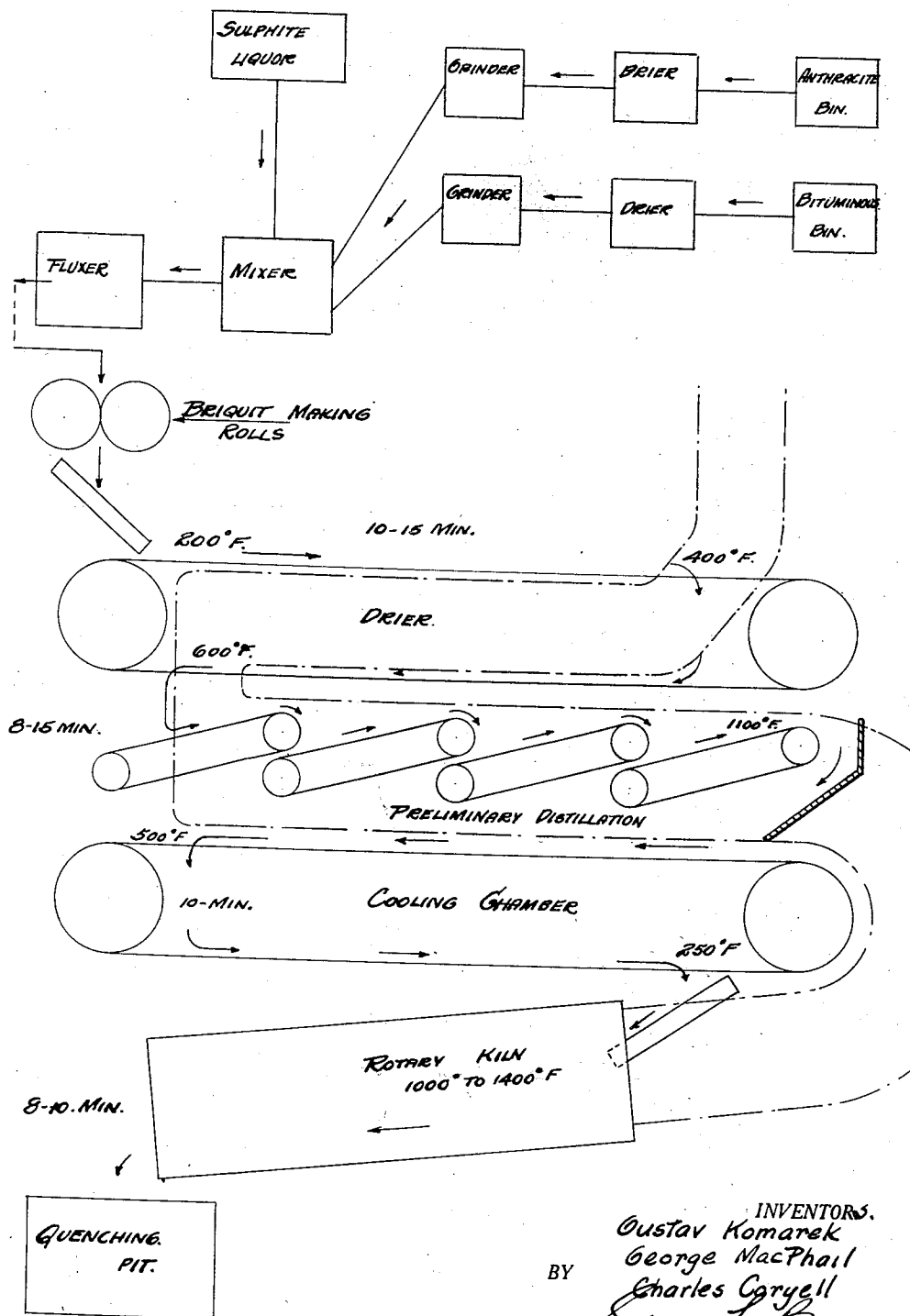
Jan. 10, 1933.

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1,893,555

METHOD OF MANUFACTURING BRIQUETTES

Filed July 16, 1926



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METHOD OF MANUFACTURING BRIQUETTES

Application filed July 16, 1926. Serial No. 122,868.

This invention relates to a method of making fuel briquettes. It is recognized that briquettes have heretofore been made from a mixture of anthracite and bituminous coal which has been coked by heating the same to relatively high temperatures. However, we believe that our improved method is entirely novel and results in a briquette which has entirely novel properties.

It has been proposed in the antecedent art to briquette mixtures of anthracite and bituminous comminuted coal, but so far as we are aware, the processes have been carried on in quite a different way. It has been recognized that where there is a large percentage of bituminous element a very serious problem of rupture of the briquettes is presented. It has heretofore been proposed to obviate this difficulty by reducing the volatile content of the fuel by a preliminary distillation to from 11 to 17%, then briquette the fuel and coke the briquette in a retort, where the volatile products are driven off and recovered and the residuary volatile products are reduced to approximately 2½%. It has also been proposed to mix anthracite and bituminous comminuted fuel with a dry binder, compress it into briquettes and then coke the briquette at such a heat and for such a length of time as to reduce the volatile content to about from 2 to 3%. It is found advantageous in this process that the bituminous ingredient be given a preliminary distillation before the mixture is made.

Again, it has been proposed to mix a percentage of about 25 to 30% of coking coal with anthracite or non-coking coal and coke the same at a relatively low temperature in a non-oxidizing atmosphere under such conditions as to leave a residuum of about 5% volatile products in the briquettes. It is recognized in this method that if the coking coal percentage is greater than 25 to 30%, difficulties will be met with in the rupture of the briquette.

Our improved method differs radically from these prior methods, which appear to be the closest approach of the known art, by reason of employing two distinct distillation steps after the briquetting of the

fuel. It also differs from the prior art in burning the hydro-carbons driven off from the briquettes themselves for the purpose of coking and driving off the volatile products of the briquettes.

This new process, when carried out under the approximate conditions as to heat, time, etc., hereinafter to be detailed, results in a briquette which we believe to be entirely new, and which has rather unusual properties. The briquette can be made from a mixture having a large percentage of bituminous coal or coking coal without the necessity of first distilling the raw coal. The briquette finally produced is smokeless and yet has a very high volatile content, reaching more than double the volatile content of anything proposed in the prior art in the way of a smokeless briquette. The reason for this is that the briquette, by reason of the special process which we employ, can be made from coals having a large percentage of volatile products, and this manufacture can take place without the rupture of the briquette. The smoke producing series of hydro-carbons, which are those volatile products that are driven off at the lower temperatures, can all be driven off from the exterior of the briquette, and still leave on the exterior of the briquette a relatively high content of volatile products, none of which, however, are smoke-producing hydro-carbons. On the interior of the briquette which is not materially carbonized, a very much higher percentage of volatile content remains, approximately double that on the exterior. However, the worst of the smoke-producing hydro-carbons have been driven out of the interior. There are, however, no doubt, left in the interior of the briquette hydro-carbons which if not located at the interior would result in smoking. However, the briquettes being very strong and not easily fractured or ruptured, this high-volatile-content core will go through combustion with a production of practically no appreciable smoke. This is due to the fact that the core containing the high volatile content is encased in a shell that approximates three-eighths of an inch, which is carbonized and in which the volatile

content has been so reduced as to eliminate all the smoke forming ingredients. Whatever smoke forming hydro-carbons remain in the core when the fuel approximates its raw state have to pass through an intensely hot shell. When the briquette is under combustion, in passing through this shell, these hydro-carbons are completely consumed. That is to say, the intense heat of the outer shell causes the hydro-carbons to be broken up into several gases, such as hydrogen and carbon-monoxide. Both of these gases are extremely oxidizable, consequently they both unite with oxygen and burn without appreciable smoke. This gives a briquette which is not only free-burning, but what appears to be a desideratum in this art: a smokeless, free-burning briquette of the long flame type, due to the larger percentage of volatile products under conditions which insure the complete combustion of all the smoke-producing hydro-carbons remaining in the briquette.

The figure is a diagrammatic view of the process or what is sometimes called a flow sheet.

The process, by reason of utilizing the gases driven off the briquettes to furnish the heat energy, is extremely economical. There are various ways that our improved process may be practiced, but we find that advantageous results can be obtained by taking the anthracite culm or silt as it arrives from the mines, passing it through a dryer and then grinding it to, say, such fineness that it will pass through a 10-20 mesh screen. The same operation is performed on the bituminous slack, although this may be slightly finer. This circumstance, however, being rather accidental than intended. These degrees of fineness are in no sense mandatory, but are simply given as directory of what we find achieves good results.

It will also be understood that from a broad standpoint other non-coking fuels such as charcoal, coke breeze or other carbonaceous non-coking substances can be used in place of the anthracite. The non-coking ground and dried fuel is then mixed with the coking ground and dried fuel. At this point the binder can be introduced. We find that sulphite liquor, which has been quite commonly used heretofore in the art as a binder, is very good for this purpose. However, we employ it solely as a temporary binder. The final binder is the bituminous element itself when it has become coked. We find that the sulphite liquor should be approximately 8 or 9% of the total mixture where the liquor is itself 50% solids and 50% water; that only 7 to 8% is required where the percentage is 55% solids and 45% water.

We introduce the sulphite liquor in this somewhat concentrated form, either in the mixer or in the fluxer. The fluxer is any suitable mechanism through which the mix-

ture, together with the binder, passes and is stirred and kneaded to thoroughly spread the binder over the fuel particles. It will be understood that suitable automatic machinery and conveyors can be utilized to carry the fuels or sulphite to the mixer and then to the fluxer. A fluxer which we find advantageous is one that has a plurality of shafts with arms which have intersecting paths of travel which are calculated to completely stir and knead the mass.

The mixture leaves the fluxer and then passes into the briquette-forming apparatus, which may be a press but is preferably a series of suitable revolving mold wheels. The thus formed briquettes, bound together by the temporary sulphite liquor binder, are then passed by a suitable conveying apparatus to a preliminary heating chamber, where they remain about 10-15 minutes and are gradually raised in temperature by passing from an initial heat zone of approximately 200° Fahrenheit, to zones which gradually increase to approximately 600° F. This affords the necessary heat to cause the evaporation of all the moisture which obtains in the briquette, due to the wet sulphite temporary binder. With a gradual increase in heat the moisture is caused to be gradually driven off instead of being quickly converted into steam that becomes pocketed or trapped in the briquette and explodes, rupturing the briquette, as is the case where briquettes are subjected directly to a high coking temperature. It is not intended that any substantial part of the volatile contents of the fuel should be driven off in this preliminary heating operation.

The briquettes then pass from the dryer conveyer onto a series of conveyers through a preliminary distillation chamber where the temperature is gradually raised to approximately 1100° F. It is preferable to use a number of successive conveyers as this tends to turn the briquettes and yet does not subject them to the rough treatment of a rotary kiln. This preliminary distillation chamber is freely provided with air for combustion, and it has stack connections with a rotary kiln about to be described. When the briquettes reach a temperature of approximately 650° F., they will ignite and the gases being driven off will furnish the necessary heat to raise the temperature of the briquettes to the desired coking point. This temperature of approximately 1100° F., and the time interval, is somewhat less than recommended in a good many of the patents of the prior art. The result is that only the exterior of the briquettes is carbonized. The briquettes remain in the preliminary distillation chamber from 8 to 15 minutes, depending upon the original volatile content of the briquette; then they pass onto a conveyer which takes them through a cooling chamber where the temperature is very much reduced. We be-

lieve that the temperature of the briquettes is about 800° F. As they reach the conveyer in the cooling chamber, they then gradually cool down to approximately 250°. However, at this point the briquette has not been sufficiently carbonized to give it the greatest possible strength, nor to eliminate sufficient volatile percentage to make the briquettes smokeless. Nevertheless this partial carbonizing of the briquette and then the cooling has formed a relatively hard crust on the briquette, which fortifies it against the rougher treatment that it is now about to receive in the rotary kiln. It is now passed into a rotary kiln which is a long cylinder about 30 to 70 feet long, and with one inch or one inch plus inclination for each foot. This kiln rotates from one to two revolutions per minute, and is heated from 1000 to 1400° F. The briquettes remain in the kiln about 8 to 10 minutes and are rolled over and over again in this kiln, exposing all parts of the briquettes and giving them a uniform carbonization,—something that is not exactly possible where they are loaded on conveyers in the preliminary distillation chambers. This kiln is provided with plenty of air and, in view of its high heat, the briquettes themselves are burning. Stack connections connect this kiln with the preliminary distillation chamber, and also with the dryer. Hence after the kiln has once been heated up the briquettes themselves afford all the energy necessary to keep the apparatus going. The briquettes now pass out the end of the kiln and are quenched with water.

We find that it is desirable not to try to remove more than 5% volatile products in the rotary kiln. For instance, if the volatile products left after the first distillation are 17% of the total fuel, it is unwise to try to reduce the volatile total to less than 12% in the second distillation. It is better to do the greater part of the driving off of the volatile products in the first distillation, if this has to exceed 5%. The reason for this apparently is that the dimensions of the rotary kiln are relatively limited while the preliminary drying chamber may be very much larger. Hence, if too severe a combustion is set up in the rotary kiln, the impinging of the flames and gases will be too severe on the briquettes.

We believe also there is novelty in the preliminary heating step when combined with the coking step, for coking the bituminous ingredient, especially in handling fuel mixtures which have a relatively high volatile content. It has been quite generally recognized in this art that the coking step is liable to rupture the briquette, especially where there is a high volatile content. In order to meet this difficulty, some of the processes of the prior art propose to subject the fuel to a preliminary distillation before it is briquetted, while others attempt to deal with the

difficulty by keeping the percentage of the coking coal down to such a ratio as to eliminate the trouble.

We overcome the difficulty not by keeping down the bituminous content, for in some localities it is more desirable to use up the bituminous slack than it is to import the anthracite culm. We are therefore able to suit the requirements of such localities by utilizing a bituminous content up as high as 70%, or more, if this is desirable. We utilize a preliminary heating step to gradually drive off the moisture inherent in the sulphite binder before the briquettes are subjected to the high coking heat. This causes the steam to be not generated so rapidly as to cause the rupture of the briquette. This is especially true in a briquette that is passing through the coking stage under the burden of a heavy volatile content. It is possible to get measurably good results by combining this preliminary heating step with only one distillation carried out over a longer period of time, but we find that we get very much superior results in splitting up the distillation in the way that we have already described, and having the intervening cooling step to harden the shell of the briquette. In view of these measurably good results, we therefore intend in some of the claims to claim the preheating step in connection with the distilling operation whether it is a single distillation operation or divided into several steps.

The character of the briquettes and the nature of the process can be properly understood only by giving a few examples, for instance: We find that 65% anthracite and 35% bituminous West Virginia coal furnishes a total volatile content of about 17.9%, the anthracite having about 10% volatile content and the bituminous about 34%. After going through the first distillation there was 13.3% volatile content left, and 8.9% content after passing through the rotary kiln.

A second example: 50% anthracite coal, 50% West Virginia bituminous coal, each having the same volatile content as in the first example, furnished a mixture with an original volatile content of 22%. This, after the first distillation had 16% volatile content and 11% after the second distillation.

A third example involved 30% anthracite and 20% West Virginia bituminous, and 50% Michigan bituminous non-coking coal, which has a volatile content of approximately 38%. This gave a total volatile content of 28.8%; after passing through the first distillation there was 19.4% volatile content left, and after passing through the second, 14.4%.

Now to show the nature of the briquette: A number of the briquettes made in accordance with the first example were analyzed. It was found that the shell or outer three-eighths inch of the briquette had an average volatile content of 6.17%, while the extreme center

had a volatile content of 12.1%, with some graduations, of course, intervening between the center and the outer shell. This, of course, gives a core which has a high volatile content, but which, as explained in the early part of the specification, is permissible because whatever smoke producing hydro-carbons are left are consumed in passing through the very intense heat of the outer shell. On the other hand, the reduction of the hydro-carbons in the outer shell is sufficiently great to eliminate any smoke here. It will also be apparent that in the other examples where a higher volatile content is started with, greater percentages will be had both on the shell and in the core. These will vary widely of course, depending upon the character of the original fuel. However, if the volatile content becomes so great as to still comprehend the hydro-carbons that give forth smoke, it is possible to obviate this trouble by altering the heat and time conditions in the process so as to drive off more of these hydro-carbons and obviate these objectionable conditions.

What we claim is:

1. The method of manufacturing fuel briquettes, which comprises mixing comminuted coking fuel with comminuted solid carbonizable non-coking fuel, pressing same together to form briquettes, then subjecting the briquette to a preliminary distillation of some of the volatile content followed by a cooling period and then a second separate destructive distillation under agitation.

2. The method of manufacturing fuel briquettes, which comprises mixing comminuted coking fuel with comminuted solid carbonizable non-coking fuel, pressing same together to form briquettes, then subjecting the briquettes to a preliminary distillation to partially coke the coking ingredient, then cooling the hot briquette and finally subjecting it to a final carbonizing step to complete the treatment.

3. The method of manufacturing fuel briquettes, which comprises mixing comminuted coking fuel with comminuted solid carbonizable non-coking fuel, pressing same together to form briquettes, then subjecting the briquette to a first distillation, then passing the briquette through a very much reduced temperature so as to cool the shell of the briquette, and finally passing the briquette through a rotating kiln where the briquette is further carbonized while being tumbled.

4. The method of manufacturing briquettes, which comprises pressing into briquette form a comminuted solid carbonizable fuel including a bituminous ingredient, then subjecting the briquette to a preliminary coking operation, then a cooling operation, and then a second coking operation.

5. The method of making fuel briquettes, which comprises the pressing of comminuted solid carbonizable fuel into briquettes with

the aid of a temporary binder, said fuel including a bituminous coking ingredient, then subjecting the briquettes to a first coking operation, then a cooling operation, and finally to a second coking operation.

6. The method of manufacturing briquettes, which comprises the pressing of comminuted solid carbonizable fuel including a coking bituminous ingredient into briquettes, then preliminarily heating the briquettes to drive off the moisture, then subjecting them to a coking operation, then a cooling operation, and finally a second coking operation.

7. The method of manufacturing fuel briquettes, which comprises the pressing of a comminuted solid carbonizable fuel including a coking bituminous ingredient into briquettes, then subjecting the same to a preliminary drying operation to drive off the moisture, then a separate preliminary destructive distillation operation at a temperature of the briquettes approximating 800° Fahrenheit, and for only sufficient time to carbonize the exterior of the briquette, then gradually reducing the temperature of the briquettes to permit the hardening of the shell, and finally subjecting the same to a second destructive distillation operation for several minutes at a temperature sufficient to effect further positive carbonization.

8. The method of making briquettes for fuel, which comprises the mixing of anthracite culm with a relatively large proportion of bituminous slack approximating at least 50%, then briquetting the mixture, preliminarily drying the briquette to expel the moisture, then subjecting the briquette to a first carbonizing operation followed by a cooling operation, and finished with a second carbonizing operation.

9. The method of making briquettes for fuel, which comprises the mixing of anthracite culm and bituminous slack, adding a binder, pressing the same into briquettes after the addition of a binder, drying the same at a temperature of approximately 200 to 400 degrees F., then preliminarily distilling the briquettes at a temperature of the briquettes of approximately 800 degrees F., then allowing the same to cool down to a temperature of approximately 250 degrees F., then carbonizing the briquettes and agitating them at a temperature of approximately 1000 to 1400 degrees F.

10. The method of making briquettes for fuel, which comprises the mixing of comminuted solid carbonizable fuel including a bituminous ingredient having a binder, pressing the same into briquettes, subjecting the same to a preliminary heat of from 200 to 400 degrees F., approximately for a period of ten to fifteen minutes, then subjecting the same to a preliminary distillation at a heat of the briquettes of approximately 800 degrees F.,

from approximately eight to fifteen minutes, then allowing the same to cool for approximately ten minutes down to a temperature of 250 degrees F., and then subjecting the same to a final carbonizing operation with agitation for a period of approximately eight to ten minutes at a temperature of 1000 to 1400 degrees F. in the chamber.

11. The method of manufacturing smokeless briquettes, which comprises mixing comminuted, solid, carbonizable non-coking and coking fuel, briquetting such mixture under conditions that leave moisture in the briquette, then subjecting the briquettes to a preliminary heating operation short of a coking temperature to slowly dry off the moisture, then continuously passing the briquettes through a separate chamber and subjecting them to a coking temperature for a length of time sufficient to only carbonize and form a shell around the briquette of predetermined depth, reducing the temperature of the briquette to harden the shell, and finally subjecting the briquette to a second higher heat to further carbonize said shell.

12. The method of manufacturing fuel briquettes, which comprises mixing coking fuel with comminuted, solid, carbonizable non-coking fuel, pressing same together to form briquettes, then subjecting the briquettes to a travel in a state of substantial quiescence through a preliminary distillation atmosphere where the briquettes are ignited and the temperature of the briquettes approximates 800° F., then interrupting the burning of the briquettes to form a carbonized shell, reducing the temperature of the briquettes to toughen the shell for the next step, and then passing the briquettes through a rotating kiln where the temperature approximates 1400° while being tumbled to further carbonize said shell.

13. The method of making fuel briquettes, which comprises the pressing of comminuted solid carbonizable fuel including a bituminous ingredient into briquettes with a temporary binder, then subjecting the same to a preliminary gradual heating step of approximately ten to fifteen minutes to gently expel the moisture of the binder, then coking the briquettes by subjecting the same to a greatly increased heat by fusing some of the bituminous ingredient, then interrupting the coking step and reducing the temperature of the briquettes to form a shell around each briquette and then subjecting the briquettes to a coking temperature to further carbonize said shell.

14. The method of manufacturing fuel briquettes, which comprises mixing anthracite silt with a relatively large proportion of bituminous slack, approximately 50%, then briquetting the mixture and subjecting the briquettes to two separate carbonizing operations with an intervening period of cooling.

15. The method of manufacturing briquettes, which comprises the pressing of comminuted, solid, carbonizable fuel including a coking bituminous ingredient into briquettes, preliminarily heating the briquettes to slowly dry off the moisture, subjecting the briquettes to a coking operation by igniting the briquettes, turning over the briquettes so that each side is slightly burned, interrupting the burning and reducing the temperature of the briquettes to harden the crust formed by the coking operation, and finally subjecting the briquettes to a second coking operation.

16. The method of manufacturing briquettes, which comprises the pressing of comminuted, solid, carbonizable fuel including a coking bituminous ingredient into briquettes, preliminarily heating the briquettes to slowly dry off the moisture, subjecting the briquettes to a coking operation by igniting the briquettes, turning over the briquettes so that each side is slightly burned, interrupting the burning and reducing the temperature of the briquettes to harden the crust formed by the coking operation, and finally subjecting the briquettes to a second coking operation by igniting the briquettes while being tumbled.

17. The method of forming non-smoking, free burning briquettes, which comprises the pressing of solid, carbonizable fuel including a coking ingredient into briquettes, forming a hard carbonized shell around the outer surfaces of the briquette by first subjecting the briquette to a preliminary coking operation by igniting the briquettes and interrupting the burning and reducing the temperature thereof at a predetermined time so as to form a relatively thin carbonized shell, interrupting the ignition for a sufficient period to allow the shell to harden, and then subjecting the briquettes to a final coking operation.

In testimony whereof we have affixed our signatures.

CHARLES CORYELL.
GEORGE MacPHAIL.
GUSTAV KOMAREK.