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LINDELL T. BATES, OF MOUNT LEBANON, NEW YORK.

METHOD OF SEPARATING ASH FROM COAL BY FLOTATION.

No Drawing. Application filed March 21, 1921. Serial No. 454,195.

To all whom it may concern:

Be it known that I, LINDELL T. BATES, a citizen of the United States, and resident of Mount Lebanon, in the county of Columbia and State of New York, have invented certain new and useful Improvements in Methods of Separating Ash from Coal by Flotation, of which the following is a specification.

In the coal mining regions of Pennsylvania and elsewhere important deposits of low grade anthracite are frequently encountered, in which the coal is in a naturally finely divided state, usually the result of earth pressure but sometimes the result of defective mining methods. Such coal as it occurs in nature or as found usually contains high percentages (for example 30%) of various inorganic impurities such as bone or slate, pyrites or iron sulphid and the like, which may be collectively designated by the term "ash". Small-sized impure anthracite coal is also found in dumps and piles at rail transfer points or deposited in the beds of streams and rivers, reduced intentionally or unintentionally either by the action of handling or extracting. Larger sizes of mined coal of course also contain much ash. It is the primary purpose of this invention to present an improved method whereby such coal may be substantially freed from ash and so prepared for briquetting or other use as fuel.

Coal may be cleaned and freed by flotation from the noncarbonaceous impurities either in its actual state or when adapted thereto by chemical or mechanical means. It is often useful to wash the coal initially to separate out pyrites, as sulphides have a tendency to float with coal.

In general this invention presents a method of foam flotation to accomplish the desired result. The adaptation of the froth flotation method to this end is based upon certain practical observations: First, flotation treatment may be applied not only to the more common bituminous coals but also to anthracite coals. Second, carbonaceous material encountered in nature in small sizes may be used without further pulverization, as may materials specially reduced in dimensions. Third, for high recoveries it is advantageous that the anthracite coal before flotation should be detached from the impurities by disintegration along the natural lines of cleavage and fracture and that the carbon itself should be fractured in the directions of normal conchoidal fracture. Fourth, the problem of the subsequent dehydration of coal purified by flotation may be partially solved by allowing the oil a longer time than usual in minerals flotation to associate with the coal, for example, by pulverizing coal in or spraying coal with oil or a liquid mixture. Fifth, coal which has oxidized surfaces is difficult to float, but pulverization to expose unoxidized surfaces will counteract this as will also chemical treatment to reduce the oxygen. Sixth, neither a thick froth nor permanent bubbles are essential in the case of coal flotation, because coal has a much lower density than metal ores. Seventh, larger amounts of oil than ½% may be used, provided the aeration and agitation are suitably adjusted thereto, since oil is not wasted but adds calorific value to coal and inasmuch as the percentage of carbon in the coal mass is far greater than the percentage of metal in ores.

In view of the foregoing the improved process is this: Take coal, of a size such that most would pass a 16 to 32 mesh per linear inch screen. If the material is oversize in its natural state, either screen it down to this size or subject it to crushing or pulverizing until it complies with this specification. It is neither advantageous to use much coarser nor much finer material.

If anthracite coal is to be pulverized it is advantageous for the best recoveries that the coal be fractured along natural lines of weakness so that most of the bone, slate, etc., becomes physically detached from the carbonaceous walls. Likewise, if coal is fractured along the lines of structural weakness, the exposed surfaces are smooth and conchoidal, and such even surfaces permit the oil more readily to displace the water. The manner of pulverizing should therefore be selected with these ends in view. Reduction by pressure, multiplicity of minor impacts or non-violent attrition is preferred to occasional violent impact. The long tube mills using many small cylinders or rods are the best for such purposes. The use of a ball mill in which a few heavy balls are rotated at high speed or a disk mill is not advocated. Certain combination mills may be used in which the coal is first reduced by balls and then finally reduced by rods or cylinders. Grinding in oil or in the presence of oil is preferred to milling in water

or dry, because this facilitates natural cleavage or fracture by permeating the soft spots in the coal and allows the oil a better chance to associate with coal and thus prevent water from so doing. If coal is pulverized in water alone, it is very difficult for oil to displace during the brief flotation operation, all or most of the water associated with the coal. Moderate heat, for example around 150° F., is also useful to advance the association of oil and coal.

If the fine coal to be used has been exposed to air and its surfaces have become oxidized, it is desirable either to expose some unoxidized surfaces on the same particle by pulverizing it further or by cleaning off oxygen from the surfaces in their actual state. To do so chemically, substances may be used in the mill or separately which have a preferential affinity for oxygen. While various sulphur compounds display such qualities, it is unwise to employ these since sulphur in coal is already an annoying impurity.

A mild treatment of this sort is usually sufficient to adequately remove a thin oxigenated film from the surface of the coal. It is of course possible to pulverize the coal in such a solution and so remove oxygen from old surfaces at the same time that new surfaces are exposed.

The oil used for flotation may be mineral, animal or vegetable, such as petroleum, creosote, eucalyptus oil, pine oil, or one or more of the various oil substitutes. Between ½% and 3% of oil by weight of material treated is usually employed. Larger amounts tend to form coal granules which normally sink in water and must be removed from the bottom or side of the flotation vessel, or floated with an up current. If coal is pulverized in oil or with oil, excess oil may be removed prior to flotation by distillation, evaporation, or mechanical separation.

The nature of the requisite bubble mass to float coal depends not only upon the amount of oil, but principally upon the aeration and agitation. Since coal is lighter than metals, a thick or consistent froth need not be made to sustain the particles. An ephemeral foam is quite sufficient, as distinguished from a persistent froth. To this end the type of flotation vessel known as the "callow" cell is suitable. Other sub-aeration mechanism or combined aeration and moderate agitation apparatus may be employed. Instead of air a gas may be used to "aerate".

As in minerals separation it is useful that the water should be adapted to the froth formation. While acidulated water is not excluded from use, sulphuric acid is not favored because comparatively large amounts are required in the case of coal and because sulphur should not be used with fuels. On the other hand such modifying agents as alcohol, or alkali or soap solutions, are useful. Such agents added to the flotation water appear to augment the affinity of the water for the ash in the coal. There is no reason why an acid should not be selected which at the same time acts to clean somewhat the coal surfaces.

With these indications those familar with the flotation of metallic ores will readily understand the adaptation of the process of flotation to anthracite and other coal.

What I claim is:—

1. That method of purifying coal, which consists in simultaneously pulverizing and heating the same in the presence of oil and in the substantial absence of water in a manner to physically detach impurities from the coal, thereupon subjecting the solid material with oil to moderate agitation and aeration in an aqueous medium until a foam forms on the upper surface of the medium carrying the purified coal from which ash separated, and finally removing the foam.

2. That step in a flotation process of separating ash from coal which consists in pulverizing and heating coal above normal atmospheric temperature in the presence of oil.

3. Those steps in a flotation process of separating ash from coal which consists in pulverizing and heating coal above normal atmospheric temperature in the presence of oil and thereafter removing part of the oil from association with the coal so treated.

Signed at Paris, in the Republic of France, this 8th day of March, A. D. 1921.

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Certificate of Correction.

It is hereby certified that in Letters Patent No. 1,552,197, granted September 1, 1925, upon the application of Lindell T. Bates, of Mount Lebanon, New York, for an improvement in "Methods of Separating Ash from Coal by Flotation," an error appears requiring correction as follows: Page 2, after line 101, insert the following as claim 4:

4. That method of purifying coal to render the same suitable for briquetting, which comprises pulverizing the coal in oil, thereafter subjecting the mass to a distilling operation to drive off a portion of the oil, and separating the ash from the mass by subjecting the same to agitation and aeration in water.;

and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 27th day of October, A. D. 1925.

[SEAL.]

KARL FENNING,
Acting Commissioner of Patents.

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