PROCESS OF AND APPARATUS FOR THE TREATMENT OF MATERIALS SUCH AS COAL, LIGNITE, ASPHALT, ETC

Original Filed Feb. 28, 1929

2 Sheets-Sheet 2

Randolph J. McRae

By his Attorneys

Edmund Conger Brown
Elizabeth E. Brown
My invention relates to methods and processes of treating various materials such as above mentioned, and to apparatus for carrying out said processes, for the purpose of modifying said materials and producing different forms of material from the same, all as hereinafter more particularly set forth. Further objects and advantages of the invention will be in part set forth in the following specification, and in part will be obvious therefrom without being specifically pointed out, the same being realized and attained by means of the methods, instrumentalities and combinations pointed out in the claims hereof.

One of the principal objects of my invention, which may serve as a general suggestive illustration as to the nature and scope of the same, is the treatment of coal waste, sometimes called slack, which consists of more or less finely broken or even pulverized coal, usually mixed with some percentage of dirt or other impurities, and which it is almost impossible to utilize in heat production with any degree of efficiency. In order to utilize such material, it is desirable to consolidate the same into more or less compact masses, either with or without the admixture of other combustible materials and with or without the employment of a suitable binder for compacting and holding together the loose material, and many processes and forms of apparatus for treating such material have been suggested and are well known in the art. For various reasons, however, few if any of such methods and apparatuses have achieved the desired degree of efficiency and commercial practicability which has been desired. My invention consists, I believe, in the application of radically new principles to this problem, and employs an apparatus embodying a combination of elements and parts radically different from anything which has been employed in the prior art.

With the above mentioned and other objects of the invention in view, my invention consists in the novel steps and proceedings in treating such material and the novel construction, arrangement and combination of various devices, elements and parts, as set forth in the claims hereof, one embodiment of the same being illustrated in the accompanying drawings and described in this specification.

In the accompanying drawings,

Fig. 1 is a transverse vertical section of an apparatus embodying my invention and designed to carry out my improved process;

Fig. 2 is a horizontal section of the same;

Fig. 3 is a fragmentary view showing in perspective a detail of the apparatus which will be hereinafter fully described.

In carrying my invention into effect in the embodiment thereof which has been selected for description in this specification and illustration in the accompanying drawings, and referring particularly to Figs. 1 and 2, which illustrate the apparatus which I have devised for the purpose of carrying my improved process into effect, I provide an internally heated cylinder 11, supported rotatably on trunnions 12 and adapted to be rotated in a counterclockwise direction by a pinion gear 13 which engages with a gear 14 fixed on the periphery of the cylinder 11. An idler cylinder 15 is supported rotatably by a shaft 16 journaled in bearings 17. A metallic belt 18 passes around the cylinders 11 and 15 and travels in the direction indicated by the arrows in Fig. 1 as the cylinders rotate.

The bearings 17 in which the shaft of the cylinder 15 is journaled, are provided with flanges 20 and are slideable upon members 21. I provide rods 22, which are fitted with adjustable guide members 23 and are rigidly connected to the bearings 17. The ends of the rods 22 are screwthreaded, and nuts 24 are provided thereon so as to permit of the adjustment of the guides 23 so as to contact with rocker arms 25. These rocker arms are rigidly connected to a shaft 26, to which are also rigidly secured levers 27. I provide weights 28 which are connected with the levers 27 by rods 29, these weights acting through the levers 27 and rocker arms 25 to exert a pull on the rods 22 thereby tending to move the cylinder 15 and thus keeping up a constant tension on the belt 18.

A framework is provided for supporting the various moving parts above described, as well as other stationary and moving portions to be hereafter described, the said framework being designated 30.

The belt 18 is provided with a series of interrupted transverse ribs 49, on the side which is nearest to the cylinders 11 and 15. These ribs are best shown in Fig. 1, but are also shown in detail in the fragmentary view Fig. 3, which shows the same in perspective.

The cylinder 11 is provided with a series of peripheral ribs 48, which, in connection with the ribs 49, provide that the belt 18 shall not come into direct contact with the peripheral surface itself of the cylinder 11, but that there shall...
always be a slight space between said cylinder and said belt, the object of which will be made clear hereafter. The cylinder 15 may also be provided with ribs 48 similar to those on the cylinder 11, which, although not necessary for the same operative reasons as is the case with the cylinder 11, still provide that the belt 18 does not ride directly upon the periphery of the cylinder.

As will be fully explained hereafter when describing the operation of the machine, the material to be operated on is fed on to the inside surface of the belt 18 and spread thereon before reaching the cylinder 11. The mechanism for depositing material and spreading the same into a layer of suitable thickness comprises a conveyor 31 adapted to deliver material upon said belt and an adjustable scraper 72, the operation of which will be well understood.

I also provide a hopper 33 adapted to receive material which has been treated while passing between the belt 18 and the cylinder 11. The material is being removed from said cylinder by a scraper 34 supported by a shaft 55. A suitable conveyor carries away the said material from the hopper 33. In order to carry out the operation of treating material as herein described, it is necessary to heat the cylinder 11 to a substantially high degree. This may of course be done in any suitable way and by any structure which will accomplish the purpose, but the devices which I employ in my invention for heating the cylinder are as follows:

I provide a rigid stationary element of substantially cylindrical external form, situated inside of the cylinder 11 and adapted to guide and distribute the gases of combustion or other heating means which are introduced into the apparatus. This cylindrical element is mounted upon a hollow shaft 38 which extends laterally out beyond the ends of the cylinder 11 and is supported by uprights 70 (see Fig. 2). From said shaft extend radially spokes 41 which support a rim 40.

I provide fire-brick or other heat-resisting material in connection with a portion of said rim 40, the same being shown at 42. A pipe 43 (see Fig. 2) carries fuel to tuyères 44, where said fuel is mixed with air admitted through perforations 45, and combustion of said commingled gas and air takes place in the space 60, the hot gases of combustion entering space 61 through slots 62. Perforations 46 in the pipe 38 permit the flow of air into the interior of the casing 40, and perforations 47 permit the escape of the exhaust gases of combustion into the member 39.

The movable parts above described are enclosed within a shell or housing of substantially cylindrical form, which is designated 55. This housing is preferably substantially gas-light, except for necessary openings for the products of combustion and also for the passage of the hollow shaft 38, suitable packing, as 75, being provided where necessary. Suitable manholes will also be provided, as 53 and 54, and a slot, as 58, will be required in the practical apparatus for the purpose of introducing the belt 18. Rods, as 59, may be provided for strengthening the casing 55 by holding the ends thereof in position, and devices as 57 may be provided to permit of expansion and contraction.

The material to be treated is shown in the drawings and designated 80. This is shown as being deposited on the inside of the belt 18 and as being reduced to a uniform layer by the scraper 72. It will be understood of course that means must be provided for the escape of gases or other volatile matters, either recoverable or waste matters, which may escape from the material during the process of treatment. In the drawings I have shown in Fig. 1 an opening, as 84, which is adapted for this purpose. I have not described any such means in detail, as such are well known in the art and can easily be supplied by persons familiar with the art to which this invention relates.

The operation of my invention is as follows: The cylinder 11 having been raised to the proper temperature, as well as the general space within the housing 55, the material to be treated is introduced into the apparatus and placed upon the belt 18 as above explained. The cylinders are rotated during the heating operation, and the interior of the housing 55 is cleared of air by the admission of steam or inert gases. The conveyors for introducing and for removing the material are also operated, during the heating of the apparatus, so that the temperatures of all the moving parts will approximate to the working temperatures. The cylinders are then kept in rotation at the desired speed, preferably at about from three to twelve or more revolutions per hour, depending on the thickness of the layer of material being treated, the temperature, and the character of the product desired. The greater the speed of rotation, the shorter the period during which the material will be subject to heat treatment, and the slower the rotation the longer the period of heat treatment.

The material is carried towards the cylinder 11 by the belt, the thickness of the layer depending upon the height of the adjustable scraper 72 above the belt. As the material proceeds between the belt and the cylinder 11, it is subjected to compression and is held firmly against the periphery of the drum by the belt, where it remains in an undisturbed condition and under pressure during a part of the rotation of the cylinder.

As the cylinder proceeds in its rotation, the material is gradually subjected to increasing heat until it reaches the tangential point of departure of the belt. The belt now assumes a straight line, as it unwinds from the drum, and substantially all of the material remains on the drum. The material remains on the drum because the belt unwinds away from it, changing from an arc of a circle to a straight line in a direction away from the arc of the treated material, and also because the slope of the ribs 49 on the belt is greater than the slope of the peripheral ribs 38 on the cylinder. Any material, however, which may adhere to the belt, will merely pass over the cylinder 15 and be fed through on the belt for further treatment, being first commingled with fresh material from the hopper 31.

As the cylinder 11 continues its rotation, the material carried thereby is removed by the scraper 34 and is dropped into the hopper 33 and removed therefrom by the conveyor connected therewith.

In treating material containing a low percentage of volatile matter, such as asphaltic coal or coke, a hydrocarbon or other binder may be mixed with the material if desired. This binder may be crude oil, treated oil, still bottoms, tar, or other material capable of acting as a binder.
The advantages of my invention have been to a considerable extent indicated in what has been above stated with regard to the construction and operation of the apparatus, but other advantages will be obvious to anyone skilled in the art to which this invention relates, and it is unnecessary to discuss the same in detail.

The continued successful and efficient operation of an apparatus such as has been above described, depends in large measure upon the life of the metallic belt. In addition to the strain on the belt caused by the tension of the ideal cylinder, an increased tension is caused by the expansion of the material being treated under heat and also by the expansion of the cylinder 11 itself. When the belt reaches the tangential point of contact with the cylinder 11 and first assumes a curved position over the cylinder, the material is comparatively cool and that portion of the cylinder is cooler than in the following zones. As the hottest zones are approached, the cylinder expands proportionately, and each degree of arc is then slightly larger than it was at said tangential point. The result is that the belt, being cooler than the drum, will be subjected to increased tension in these hotter zones, and this effect will be also increased by the tendency to expansion of the material being treated. This factor is in itself a favorable one, since as a greater pressure is thereby applied to the material during its melting or softening stage, but on the other hand a belt of unusual characteristics is required to withstand the strains so set up. It has also been found that the cylinder warps and its shape is distorted under heat and other conditions of operation of the apparatus, and the belt must be adapted to conform generally to such distortion.

I have found that the preferable material for the metallic belt is a chrome iron consisting of a layer of material, the material is comparatively low.

Such a material has a high tensile strength of the order of 170,000 pounds per square inch, an elastic limit of more than 140,000 pounds per square inch, and a large elongation factor at the break. It is little affected appreciably by heat treatment, does not absorb carbon, and is practically rustless and resistant to corrosion by gases. However, the rate of increase is slow and the material is generally used in the form of a series or series of sheets, one of which being directed substantially at right angles to the direction of the ribs of the other series, and the ribs of one series being interrupted.

In an apparatus of the kind described, a structure as specified in claim 1, in which the said belt is composed of a material of high tensile strength.
strength, high resistance to heat and corrosion, high resistance to fatigue and to injury caused by the flexing of the belt.

9. In an apparatus of the kind described, a structure as specified in claim 1, in which said belt is composed of a material of high tensile strength.

10. In an apparatus of the kind described, a structure as specified in claim 1, in which said belt is composed of a material of high resistance to heat and corrosion.

11. In an apparatus of the kind described, a structure as specified in claim 1, in which said belt is composed of a material of high resistance to fatigue and to injury caused by the flexing of the belt.

12. In an apparatus of the kind described, a structure as specified in claim 1, in which said belt is composed of a material consisting of over twelve per cent. of chromium and less than eighty-eight per cent. of iron.

13. In an apparatus of the kind described, a structure as specified in claim 1, in which said belt is composed of a material consisting of over twelve per cent. of chromium and less than eighty-eight per cent. of iron and in which the carbon content is low.

14. In an apparatus of the kind described, a structure as specified in claim 1, in which said belt is composed of a material consisting of approximately sixteen per cent. of chromium and the remainder of an alloy of iron and any other suitable material.

RANDOLPH J. McRAE.