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COOLING LOW TEMPERATURE COKE

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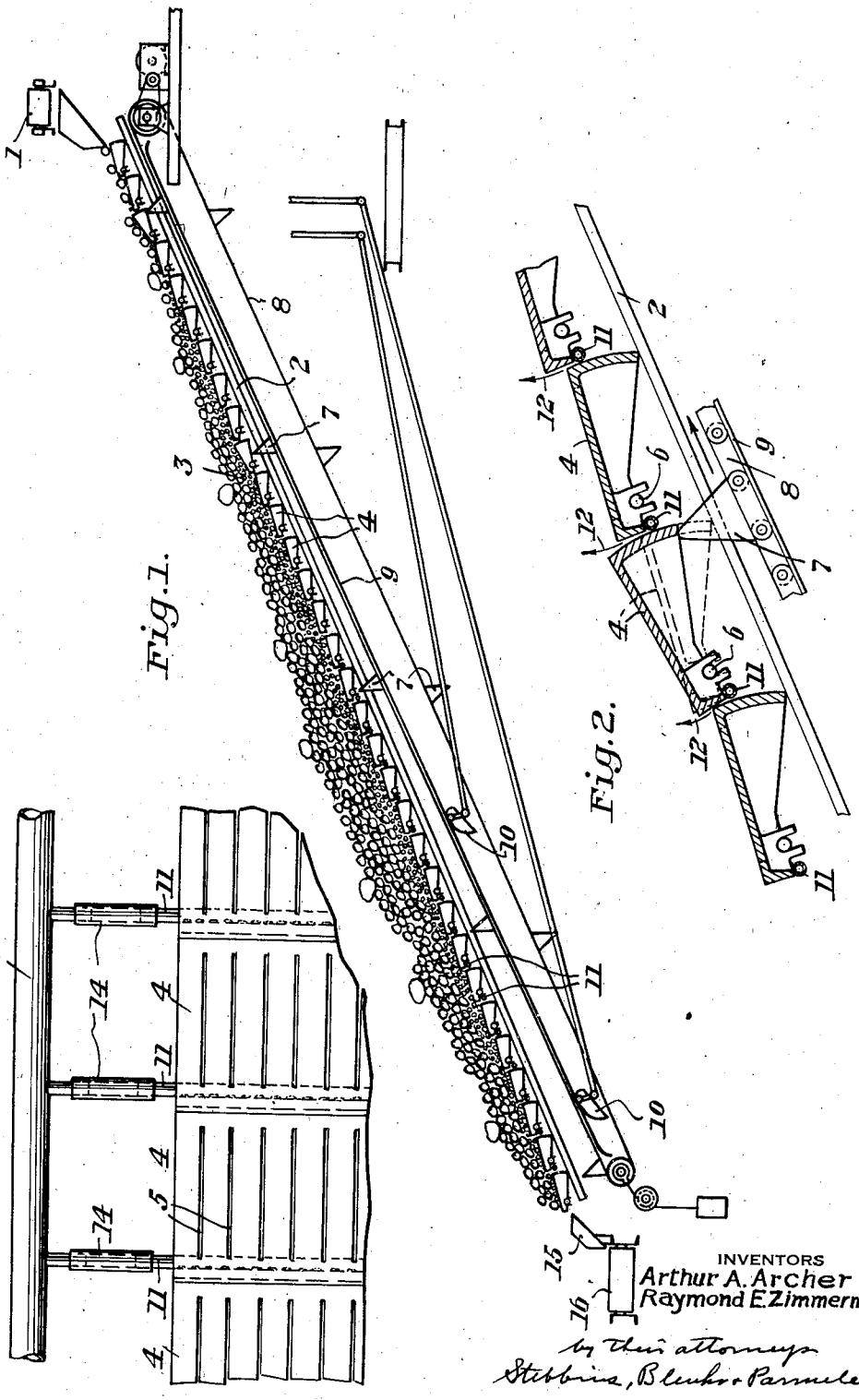


Fig. 1.

Fig. 2.

Fig. 3.

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COOLING LOW TEMPERATURE COKE

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8 Claims. (Cl. 202—37)

The present invention relates to the cooling of low temperature coke and more particularly to the cooling of low temperature cokes which are highly reactive to oxygen and to which water cooling is not applicable.

The present invention will be described with particular reference to the cooling of the carbonized coal balls produced by the process described in the Lesher Patent No. 2,080,946 of May 18, 1937. As described in the Lesher patent, coal is subjected to a low temperature coking process in a rotary retort while tumbling it so as to form what is known as "carbonized coal balls." The "coal balls" are discharged from the rotary retort or carbonizer at a temperature of about 800° to 850° F. for coal balls made from the Pittsburgh seam coal, although this temperature varies somewhat depending upon the size of the retort, the nature of the coal to be carbonized and the quality of the product desired.

The coal balls are dense and strong in their resistance to fracture but not strongly resistant to abrasion. They have an extremely low heat conductivity and at the same time are extremely reactive to oxygen. The temperature at which they are discharged from the carbonizer is very close to their ignition point. If the coal balls are placed upon a metal plate out of contact with each other in an atmosphere at room temperature, the balls lose their heat without taking fire. On the other hand, if the coal balls lie in a bed in contact with each other, the temperature at the points of contact rises above the ignition point and the coal balls take fire. When the heated coal balls are exposed to the atmosphere, some oxidation takes place at their surfaces. Where the surfaces are free and exposed to the air, the heat is dissipated rapidly enough to prevent a rise in temperature above the ignition point. However, where the two surfaces lie in contact with each other, dissipation of the heat by radiation and/or convection is retarded and an increase in temperature takes place until the temperature of ignition or rapid combustion is reached, whereupon the coal balls take fire.

Since the coal balls have extremely low conductivity, considerable time, a matter of two or three hours, is required to cool the coal balls when exposed to air at room temperatures to a point where they can be safely run into railway cars without danger of combustion. It is therefore impracticable on any large scale production to spread out the coal balls and to allow them to cool out of contact with each other.

Attempts to water-cool the coal balls result in ruining the product. The coal balls are dense and do not have the water absorbing porous structure of the ordinary high temperature coke, so that the wetting is apparently confined to the exterior portions of the coal balls. The wetting of the exterior causes shrinkage cracks which result in progressive disintegration of the coal balls.

We have found that such carbonized coal balls may be satisfactorily air cooled or quenched on a large scale commercial production by the following method. The coal balls as discharged from the carbonizer are exposed to a cooling circulation of air while they are moved relatively to each other so as to prevent continuously maintained points of contact between them at which ignition would occur. It is not necessary that the movement of the coal balls relative to each other be continuous; an occasional movement will prevent ignition. Almost continuous movement is required for the initial cooling to be safe. However, after the balls have become cooler, less frequent movement is required. The coal balls should be maintained in a relatively thin bed of only one or two pieces deep for the initial cooling, but as the cooling progresses the depth of the bed may be safely increased.

While we have illustrated in the drawing a preferred apparatus for carrying out our method, the method may be carried out with other forms of apparatus or even by hand.

In the drawing:

Figure 1 is a diagrammatic elevation of a preferred apparatus for carrying out the method;

Figure 2 is a detail vertical longitudinal section; and

Figure 3 is a plan view showing the tilting plates.

Referring now to the specific procedure illustrated in the drawing:—The low temperature coke or "coal balls" from the carbonizer is discharged by a conveyor 1 to the upper end of a cooling bed 2, which we may term a "cooling wharf" by analogy to the cooling wharves of the high temperature coke plants. The cooling bed consists of an inclined support for holding the bed 3 of coke. The coke moves down the inclined support in a continuous bed which is relatively thin at the upper end of the support and increases in thickness toward the lower portion therof. The cooling bed or wharf is preferably made as illustrated of a plurality of tilting plates 4 shown in detail in Figures 2 and 3. These plates have slots 5 to allow for the passage of

air upwardly through them. The plates are pivotally mounted on supports 6. They are arranged to be tilted by means of dogs 7 carried on an endless chain 8. The dogs contact with the edges of the plate, as shown in Figure 2, and raise the plate individually as the dogs travel beneath them, preferably in the direction indicated by the arrow in Figure 2. The chain 8 is carried on a track 9 which is adjustable to vary the amount of movement imparted by the dogs 7 to the plates 4. As shown in Figure 1, such adjustment is diagrammatically indicated by adjustable cams 10, although any suitable means can be employed for adjusting the position of the chain 8 with relation to the tilting plates 4. As illustrated, the track 9 is adjusted so as to give the maximum lift to the tilting plates 4 at the upper end of the cooling bed or wharf and this movement is gradually decreased until at the lower end of the wharf the plates 4 are stationary.

The coke is subjected to a cooling circulation of air. Since the coke is hot, a natural induced upward flow of air takes place through the bed of coke, the air passing through the slots 5 and the spaces between the plates 4. An auxiliary forced circulation may be provided by means of air pipes 11 which extend across the cooling bed near the joints between the tilting plates 4 and which have perforations to direct a stream of air upwardly as indicated by the arrows 12 in Figure 2. As shown in Figure 3, the air is supplied by a header 13 and flexible connections 14 to the pipes 11. As illustrated in Figure 1, the pipes for the forced circulation are shown only at the lower part of the cooling bed where the bed of coke is thicker and cooler, the natural induced circulation being relied upon at the upper part of the bed where the coke is spread out in a thin but more highly heated layer.

If desired, the natural induced draft through the bed of coke may be supplemented or replaced by a forced draft from a hopper beneath the bed and/or a fan induced draft into a hood above the bed.

The operation of the apparatus is as follows: The hot coke from the carbonizer is delivered by the conveyor 1 to the upper part of the cooling wharf and travels downwardly over the wharf in the form of a bed whose thickness is indicated generally in Figure 1. The chain track 9 is adjusted so that the tilting plates at the upper part of the cooling wharf are given the maximum movement and the feed is more rapid at the upper part of the bed. Toward the middle portions of the bed the movement is decreased and the feed is more gradual to allow the bed to become gradually thicker. At the lower portion of the bed no movement is required and the coke is pushed along by the pressure of the stream delivered from the upper part of the bed. The coke at the lower part of the bed is delivered through a chute 15 to a conveyor 16 which transports it to a railway car or storage bin. The tilting plates 4 not only feed the coke along the cooling wharf but also periodically agitate the bed by lifting localized portions of the bottom of the bed and thereby cause relative movement between the pieces of coke and prevent continuously maintained points of contact between them. The lifting movement of a tilting plate causes a localized pulsation in the bed of coke which breaks the existing contacts between the coke particles. The bed of coke is moving down the cooling bed which is formed by the plates, the top surfaces of which form discontinuous planes separated by short drops or steps, somewhat like a flight of stairs. The movement of the coke down a step from one plate to the other prevents the return of the same contacting surfaces into contact with each other after the pulsation has passed. As above stated, if the pieces of coke are allowed to remain in contact with each other long enough, a temperature rise will take place at the points of contact and spontaneous combustion will occur. The agitating movement of the tilting plates 4 also causes a stratification of the coke, the smaller particles settling to the bottom of the bed and the larger pieces going to the top. The smaller particles at the bottom of the bed are thus subjected to the mechanical action of the tilting plates and to the friction of sliding over the plates, and the larger and more valuable part of the product is thus shielded by the underlying layer of smaller particles from abrasion and fracture. The cooled product is passed over a screen before delivery to the railway cars and the finer particles separated from the larger coal balls which are shipped. As described in the Lesher patent, it is desirable to mix a certain proportion of finely ground coke with the raw stream of coal to be carbonized. The fines recovered by the screening of the product can be advantageously employed as a part or all of the finely ground coke used for this purpose.

If desired, the coke may be crushed and screened between the carbonizer and the cooling bed.

After the coke is initially cooled in the relatively thin layer at the upper part of the cooling bed, less movement is required to prevent the spontaneous combustion and the thickness of the coke bed may be increased to a depth of several feet. As shown diagrammatically in Figure 1, the amount of movement is progressively decreased and the thickness of the bed is progressively increased as the coke becomes progressively cooler. At the upper part of the bed the tilting plates 4 are given their maximum movement and the coke on the stationary plates slides along with its maximum movement of translation, thus insuring a substantially continuous agitation and preventing the points of contact from being maintained long enough to cause ignition. As the coke passes to the lower portions of the bed it is subjected to less mechanical agitation from the tilting plates and is also subjected to less sliding movement of translation and friction against the plates. As the bed becomes thicker a greater proportion of the coke accumulates in the layers above the bottom where it is not subjected to the direct contact with the tilting plates, and is thus subjected to a minimum of abrasion. Also the capacity of the apparatus is increased by having the thin, more rapidly moving part of the bed only where the coke is hottest and allowing the bed to build up in thickness as the coke becomes cooler.

While, as above stated, the application of water for cooling the hot carbonized coal balls would result in cracking and disintegration of the coke, nevertheless after the coke has become partially cooled, water may be used for the final cooling. Thus, if desired, water sprays may be applied to the lower end of the bed of coke where the temperature has been sufficiently reduced.

While the process has been described with particular reference to the cooling of carbonized coal balls made by low temperature carbonization in a rotary retort, the process may be advantageous-

ly used for cooling other kinds of low temperature coke which are reactive to oxygen and to which water cooling is not applicable.

Generally speaking, cokes are spoken of as high temperature and low temperature cokes. The high temperature cokes are made by coking at a high temperature in the usual coking ovens, from which the coke is discharged in a highly heated and incandescent state. Air cooling is not applicable to such high temperature coke because it takes fire when discharged from the coking oven and therefore it is necessary to immediately quench the coke with water. Because of the strong porous structure of the high temperature coke, the water quenching is entirely satisfactory, as well as the most economical method of quenching. The low temperature cokes are produced by low temperature coking operations. As contrasted with the high temperature cokes, not all of the volatile matter is distilled from the low temperature cokes, so that the low temperature cokes are highly reactive to oxygen and will ignite at a relatively low temperature. The low temperature cokes, however, are discharged from the coking retorts in a non-incandescent condition and generally at a temperature below their ignition point in air, so that air quenching may be employed provided suitable precautions are taken to prevent the spontaneous combustion due to their extremely reactive properties with oxygen.

While our method may be employed for cooling low temperature cokes in general, it is particularly applicable to the low temperature cokes which are discharged from the coking retorts at a temperature close to but less than the temperature at which the coke will burn when exposed to the air in a thin layer, but which will take fire when piled in a bed in which the pieces are in contact with each other, and which coke from its physical properties cannot be satisfactorily quenched by water.

While we have specifically illustrated and described the preferred embodiment of our invention, it is to be understood that the invention may be otherwise embodied and practiced within the scope of the following claims.

We claim:

1. A method of cooling highly reactive low temperature cokes which ignite when exposed to the air hot as discharged from a carbonizer if the pieces of coke are allowed to remain continuously in contact with one another, which comprises exposing the hot coke to a cooling circulation of air in a bed of such thickness that pieces of coke are in contact with one another, and while the coke is so exposed moving relatively to one another the pieces of coke which are in contact and thereby preventing continuously maintained points of contact therebetween.

2. A method of cooling highly reactive low temperature cokes which ignite when exposed to the air hot as discharged from a carbonizer if the pieces of coke are allowed to remain continuously in contact with one another, which comprises exposing the hot coke to a cooling circulation of air in a bed of such thickness that pieces of coke are in contact with one another, and while the coke is so exposed moving relatively to one another the pieces of coke which are in contact and thereby preventing continuously maintained points of contact therebetween, and decreasing the amount of such relative movement as the coke becomes cooler.

3. A method of cooling highly reactive low temperature cokes which ignite when exposed to the air hot as discharged from a carbonizer if the pieces of coke are allowed to remain continuously in contact with one another, which comprises exposing the hot coke to a cooling circulation of air in a relatively thin bed of such thickness that pieces of coke are in contact with one another, and while the coke is so exposed moving relatively to one another the pieces of coke which are in contact and thereby preventing continuously maintained points of contact therebetween, and increasing the thickness of the bed as the coke becomes cooler.

4. A method of cooling highly reactive low temperature cokes which ignite when exposed to the air hot as discharged from a carbonizer if the pieces of coke are allowed to remain continuously in contact with one another, which comprises exposing the hot coke to a cooling circulation of air in an advancing bed of such thickness that pieces of coke are in contact with one another, and while the coke is so exposed moving relatively to one another the pieces of coke which are in contact and thereby preventing continuously maintained points of contact therebetween, and decreasing the speed of advance of the bed as the coke therein becomes cooler whereby the depth of the advancing bed is increased as the coke therein becomes cooler.

5. A method of cooling highly reactive low temperature cokes which ignite when exposed to the air hot as discharged from a carbonizer if the pieces of coke are allowed to remain continuously in contact with one another, which comprises exposing the hot coke to a cooling circulation of air in an advancing bed of such thickness that pieces of coke are in contact with one another, and while the coke is so exposed moving relatively to one another the pieces of coke which are in contact and thereby preventing continuously maintained points of contact therebetween, and controlling the amount of such relative movement as the advancing coke becomes cooler so that there is less of such movement in a relatively advanced portion thereof where the coke has partially cooled than in the portion thereof where the coke is still hot.

6. A method of cooling highly reactive low temperature cokes which ignite when exposed to the air hot as discharged from a carbonizer if the pieces of coke are allowed to remain continuously in contact with one another, which comprises exposing the hot coke to a cooling circulation of air in an advancing bed of such thickness that pieces of coke are in contact with one another, and while the coke is so exposed moving relatively to one another the pieces of coke which are in contact and thereby preventing continuously maintained points of contact therebetween, decreasing the speed of advance of the bed as the coke therein becomes cooler whereby the depth of the advancing bed is increased as the coke therein becomes cooler, and controlling the amount of said relative movement as the advancing bed becomes thicker and cooler so that there is less of such movement in a relatively advanced thicker portion thereof where the coke has partially cooled than in the thinner portion thereof where the coke is still hot.

7. A method of cooling highly reactive low temperature cokes which ignite when exposed to the air hot as discharged from a carbonizer if the pieces of coke are allowed to remain continuously in contact with one another, which comprises exposing the hot coke to a cooling circula-

tion of air while traveling down an inclined support in a bed of such thickness that pieces of coke are in contact with one another, and while the coke is so exposed moving relatively to one another the pieces of coke which are in contact and thereby preventing continuously maintained points of contact therebetween.

8. A method of cooling highly reactive low temperature cokes which ignite when exposed to the air hot as discharged from a carbonizer if the pieces of coke are allowed to remain continuously in contact with one another, which comprises exposing the hot coke to a cooling circulation of air in a bed of such thickness that pieces of coke are in contact with one another, and while the coke is so exposed agitating it from the bottom of the bed so as to cause stratification of the finer particles at the bottom of the bed and to cause relative movement between the pieces of coke which are in contact and thereby preventing continuously maintained points of contact therebetween.

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