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CLEANING COAL

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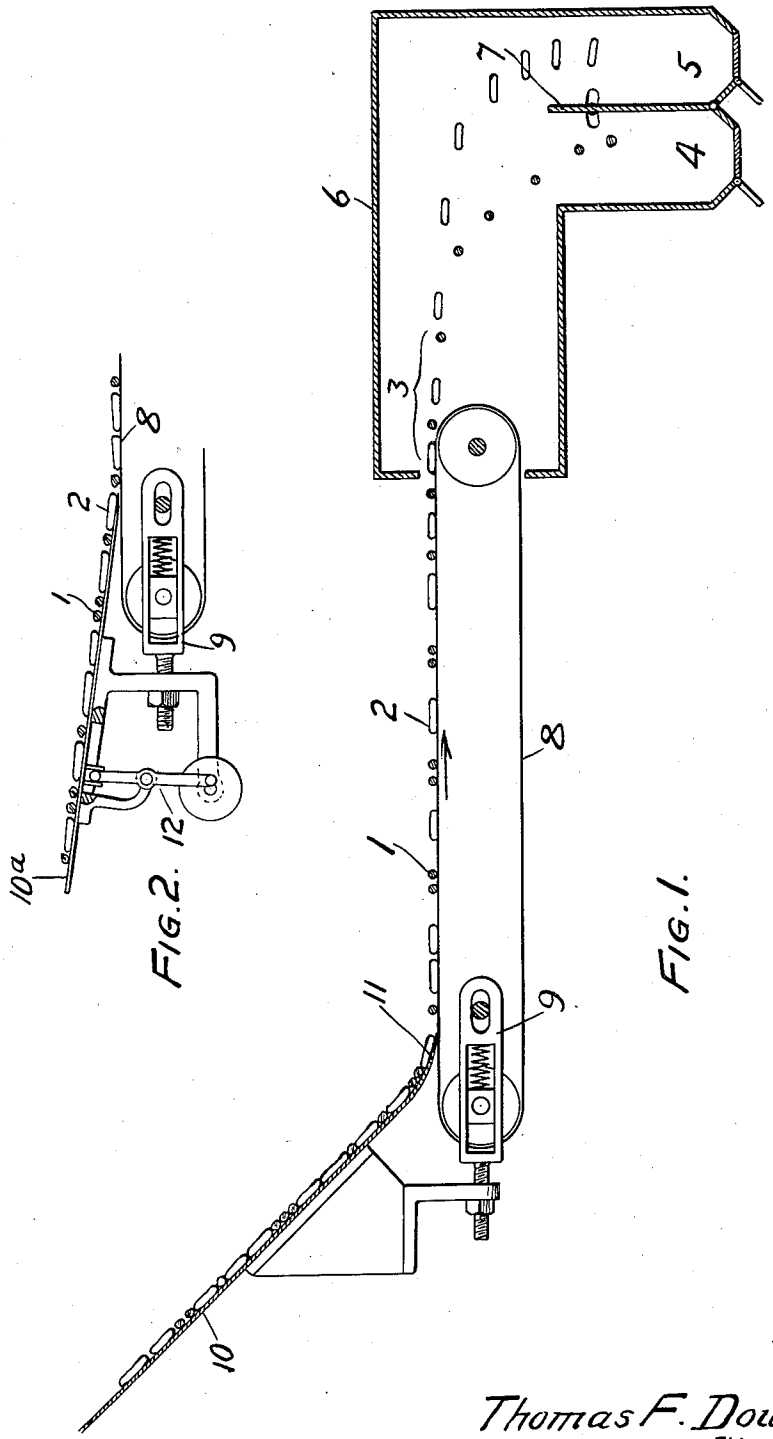


FIG. 2.

FIG. 1.

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CLEANING COAL

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10 Claims. (Cl. 209—120)

The principal object of the present invention is to provide for thoroughly cleaning coal at comparatively little expense.

In the present invention use is made of the known principle of projecting bodies of the same kind or material from a rapidly moving belt in order to classify them according to size or grade. The adaptation of that principle to cleaning coal which involves the separation of different materials, one from the other, has not been undertaken and presents difficulties due to the differences in shape, configuration, distribution of weight and like physical properties of the bodies present which include beside coal, slate which occurs in flat form, and pyrites and in some cases free ash previously dumped from a power house into the coal pile, and due to the tendency of such materials to form compact masses.

By the present invention these difficulties are overcome by spreading the bodies of coal and of impurities apart in a single layer with the heavy ends of the particles disposed in advance or ahead of the lighter ends, and projecting the bodies, so disposed, into quiescent or controlled air so that the bodies notwithstanding differences in distribution of weight, shape and configuration, individually travel in their respective trajectories without interference one with another.

In the accompanying drawing Figure 1 illustrates diagrammatically a type of apparatus suitable for the practice of the invention; and

Fig. 2 illustrates a modification of that apparatus.

Referring to the drawing, reference will be made particularly to bodies of coal 1 and slate 2 because they are the principal ingredients. These bodies spread apart in a single layer as at 3, with the heavy ends of the particles disposed in advance of the lighter ends are projected into a protected air space so that the bodies notwithstanding differences in the distribution of weight, shape and configuration and tendency to form compact masses, individually travel in their respective trajectories and fall, the coal into the bin 4, and the slate and impurities into the bin 5. To avoid breakage these bins may contain water or other cushioning material. It may be remarked that if the bodies were not projected in the manner described they would collide with one another and they would ride one upon another, for example, a lump of coal on a flat piece of slate, and, to the extent that this occurred, the separation would be interfered with and rendered unsatisfactory. Furthermore if the heavy ends of particles go first the particles will travel further than if the light ends go first, and therefore it is important that particles in which the distribution of weight is not symmetrical, be projected heavy ends first. If the heavy ends go last they will drop, increasing the air resistance and shortening the trajectory, consequently in the case of the same material, it is important that the particles go heavy end first. If some of the described particles go heavy end first and some light end first it is evident that satisfactory separation may not be attained. The enclosure 6 serves to exclude drafts and provide quiescent or controlled air. In cases where the sizes cleaned are large enough to be uneffected by ordinary drafts the enclosure 6 is not necessary. 7 is a partition which may be adjustable in order to suit its position to the velocity of the belt 8 from which the coal is projected into the air with its components spread apart in a single layer. The belt 8 is of course driven at a comparatively high rate of speed and it is shown as provided with a tightener 9 which operates to maintain the upper reach of the belt in flat position. The coal to be cleaned is fed down the chute 10 provided with a curved end 11, and in descending the heavy ends of the particles under the operation of gravity go first. The curved end of the chute delivers the particles, without disturbing their described disposition onto the belt which thus receives the bodies spread apart or scattered in a single layer with their heavy ends first upon its flat rapidly moving surface, and the bodies acquire substantially the velocity of the belt so that they are projected at the end of the belt at the same velocity and scattered in a single plane or layer, with the heavy ends of the individual particles in advance, as distinguished from being superposed one upon the other or in contact with each other in such a way that the final separation would be rendered imperfect, and as distinguished from some disposed with their heavy end first and others with their heavy end last. It is also possible to place the feed chute near enough to the discharge end of the belt to permit the heavy impurities to acquire the velocity of the belt and thus travel the maximum distance, while the lighter coal does not have sufficient time to acquire quite the same speed and lands closer to the end of the belt, thus widening the separation which would be obtained if all the particles left the belt at the same speed.

Specific examples of my process are the following.

The first essential of separation along ballistic

principles is speed, a speed greater than objects can obtain by sliding by gravity down chutes. My experiments to date have indicated that, for coal and its impurities, such speed must be in excess of five hundred feet per minute. To obtain such a speed I use a conveyor. When objects jump, or are thrown, into space at an angle off the vertical with relatively slow speed gravity predominates and the objects will not change relative positions in flight but when their speed is sufficient to separate them by ballistic principles inertia force becomes most important. Wm. Bollay, in Journal of Applied Mechanics, vol. 5, No. 3, says, "At high speeds the inertia forces are, however, the most important and thus as a first approximation the gravity forces can be neglected compared to the inertia forces."

If materials which, by ballistic principles, would travel the shortest distance were thrown with less speed than the other materials the separation would be greater than that obtained by pure ballistics and a wider range of material size be thus made possible.

One material used was 2" nut slack, i. e. pieces ranging in size from 2" in thickness to zero, from the bituminous coal Pittsburgh vein.

It was found impossible to clean such a mass by allowing all of it to attain the full speed of the conveyor running at 893 ft. per minute. The technical reason for such failure is that surface area does not increase in direct proportion to weight. The 2" size coal presented less surface area to weight than say a ¼" piece of slate, with the result that large pieces of coal traveled over into the refuse section while small pieces of refuse matter fell short into what should be the clean coal bin.

The feed chute, on 35° pitch, was then moved up to deliver the materials to the conveyer 4 feet from the discharge point of same. The material was fed in such quantity that it formed a single layer upon the belt which was set to 893 feet per minute speed. The four foot feed point was decided upon after considerable experimenting at different distances. The result was that the slate and sulphur, which were more or less of flat configurations, attained the full speed of the belt while the coal, which had many sided shapes, did not have time to entirely acquire full belt speed and was thrown with less velocity than the slate and other impurities. The smallest pieces of impurities were thrown further than the largest pieces of coal with the result that the pure coal section was lower in ash content than is obtained with present commercial cleaning equipment on coal from the mine the materials used came from.

Bituminous coal from the Miller vein of Central Pennsylvania was tried under the same conditions as before described for the Pittsburgh coal. It was the same size, viz. 2" nut slack. Results were unsatisfactory because the impurities in this coal would not acquire the full speed of the conveyor in 4 feet. The feed point was moved back a few inches at a time until a point was found where the impurities settled upon the belt. This point was found to be 5' 10" back of conveyor discharge, and from that point, the separation was as satisfactory as that obtained on the Pittsburgh coal.

Other illustrations could be cited but the two here given should be sufficient to enable those skilled in the art to practice the process without experimentation or invention.

Coals and their impurities from different locations differ greatly in configuration and density. It would be necessary to test coals from every producing district in the world before definite limits of feed point could be set out. Therefore, I do not confine my claims to the limits given in the illustrations. It may be advantageous to feed nearer or farther from the conveyor discharge, increase or decrease speed of conveyor, or change the inclination of the feed chute to suit the natural conditions of the material being treated.

Roughly, to obtain the controlled speed differential, the feed should be set at a distance which will allow heavier and flatter materials to settle upon the conveyor and take relatively full speed while lighter, or bulkier, materials do not have time upon the belt to acquire the speed of the other materials.

In the modification shown in Fig. 2 the material is put heavy end first by use of a reciprocating chute 10a. 12 indicates means for reciprocating the chute 10a. Since such a chute can be placed so that its discharge end is over, near, and substantially parallel with the moving belt it would need no curved end. In fact, a curved end here would defeat the object. Thus we have two distinctly separate combinations of apparatus.

First.—The combination of a gravity chute long enough to permit particles, or pieces of coal, slate, or other impurities to arrange themselves heavy end foremost, said chute having a curved end which will permit particles to be deposited in a single layer upon the conveyor in such a manner so that the force, or speed, of the rapidly moving belt will not toss them about and so place the heavy ends in directions other than that of travel.

Second.—The combination of a reciprocating chute, or conveyor, long enough to allow individual pieces of coal, slate, or other impurities to arrange themselves heavy end front and which will deposit them thus in a single layer upon a rapidly moving belt heavy end in line of direction of travel upon the moving conveyor.

It will be obvious to those skilled in the art that modifications may be made in details of procedure without departing from the spirit of the invention which is not limited to such matters or otherwise than the prior art and the appended claims may require.

I claim:

1. For the separation of bodies of coal and of impurities of greater specific gravity than coal by projection from the flat unobstructed surface of the face of a rapidly moving generally horizontal belt, the method which consists in projecting the bodies after traveling the bodies on the belt for a distance in which the heavier ones acquire substantially the speed of the belt and the lighter ones acquire less speed than the speed of the belt into the air in spaced apart relation and in a single layer and heavy ends first at the end of the belt and through their respective complete trajectories without substantial interference and the impurities projected further than the coal and limiting the time of travel of the bodies on the belt by feeding them in the described relation at a point near enough to the discharge end of the belt for opposing substantial collision of the heavier bodies with the lighter bodies and consequent disturbance of the described relation of the bodies before and after leaving the belt.

2. For the separation of bodies of coal and of impurities of greater specific gravity than coal by projection from the plane surface of a rap-

idly moving belt, the method which consists in depositing the coal and impurities heavy ends first and in spaced apart relation and in a single layer on the plane surface of the moving belt and after traveling the bodies on the belt for a distance in which the impurities acquire substantially the speed of the belt and the coal does not acquire the speed of the impurities projecting the bodies in spaced apart relation and in a single layer and with their heavy ends first at the end of the belt throughout the completion of their respective trajectories without substantial interference and the impurities projected further than the coal and limiting the time of travel of the bodies on the belt by feeding them in the described relation at a point near enough to the discharge end of the belt for opposing substantial collision of the heavier bodies with the lighter bodies and consequent disturbance of the described relation of the bodies before and after leaving the belt.

3. For the separation of bodies of coal and of impurities of greater specific gravity than coal by projection from the flat unobstructed surface of the face of a rapidly moving belt into the air, the method which consists in depositing the bodies in spaced apart relation near enough to the discharge end of the belt for imparting the velocity of the belt to the relatively heavy impurities, thus throwing them the maximum distance through the air, while the velocity of the belt is not imparted to the lighter particles which by reason of their weight do not acquire the same speed in the available time and are not thrown through the air the same distance as the heavier particles, and limiting the time of travel of the bodies on the belt by feeding them in the described relation at a point near enough to the discharge end of the belt for opposing substantial collision of the heavier bodies with the lighter bodies and consequent disturbance of the described relation of the bodies before and after leaving the belt whereby the bodies complete their respective trajectories and separation is widened.

4. For the application of the principle of projecting bodies from a rapidly moving belt to cleaning coal, the method which consists in, depositing the bodies of coal and of impurities of heavier specific gravity than coal and having differences in shape and configuration and distribution of weight on the plane surface of a rapidly moving constant speed belt with their heavy ends first and in spaced apart relation and in a single layer, moving the bodies while in said relation by riding them freely on the plane surface of the belt from positions of relative rest in respect to the speed of the belt to positions where the impurities travel at substantially the speed of the belt and are substantially at rest with respect to the plane surface of the belt and where the coal travels slower than the speed of the belt, and projecting the bodies in the described arrangement and with the described speed differential from the end of the belt into the air and individually through their respective trajectories in the air of which the trajectories of the coal are shorter than the trajectories of the impurities and limiting the time of travel of the bodies on the belt by feeding them in the described relation at a point near enough to the discharge end of the belt for opposing substantial collision of the heavier bodies with the lighter bodies and consequent disturbance of the described relation of the bodies before and after leaving the belt.

5. A process of cleaning coal by separating the bodies of coal from the bodies of impurities of greater specific gravity than the coal mixed therewith, which process comprises, forming the bodies into a loose stream of single bodies by spacing the bodies individually apart from one another both lengthwise and crosswise of the stream and with their heavy ends in one direction, imparting an individual velocity to each body peculiar to its properties by traveling the bodies on a constant speed belt for a distance in which some acquire substantially the speed of the belt and others do not acquire substantially the speed of the belt, and projecting the bodies through the air and through their individual trajectories according to their acquired individual velocity, thereby separating the bodies into separate classifications with the heavy bodies more distant than the lighter bodies and limiting the time of travel of the bodies on the belt by feeding them in the described relation at a point near enough to the discharge end of the belt for opposing substantial collision of the heavier bodies with the lighter bodies and consequent disturbance of the described relation of the bodies before and after leaving the belt.

6. The method of separating bodies of coal and impurities of greater specific gravity than the coal in their passage through the air which consists in projecting the bodies respectively at different velocities into the air by the application of a uniform dynamic force and in spaced apart relation and in a single layer and heavy end first through their respective complete trajectories which for the coal are shorter than for the impurities by traveling them on a moving belt for a distance in which the impurities acquire and the coal does not acquire the speed of the belt and limiting the time of travel of the bodies on the belt by feeding them in the described relation at a point near enough to the discharge end of the belt for opposing substantial collision of the heavier bodies with the lighter bodies and consequent disturbance of the described relation of the bodies before and after leaving the belt.

7. The method of separating bodies of coal and impurities of greater specific gravity than the coal in their passage through the air which consists in projecting the bodies into the air by the application of a uniform dynamic force and respectively at controlled predetermined different velocities in spaced apart relation and in a single layer through their respective complete trajectories which for the coal are shorter than for the impurities by traveling the bodies on a moving belt for a distance in which the full dynamic force of the moving belt is applied to the impurities and not to the coal and limiting the time of travel of the bodies on the belt by feeding them in the described relation at a point near enough to the discharge end of the belt for opposing substantial collision of the heavier bodies with the lighter bodies and consequent disturbance of the described relation of the bodies before and after leaving the belt.

8. The method of separating bodies of coal and impurities of greater specific gravity than coal in their passage through the air which consists in projecting the bodies into the air by the application of a uniform force and respectively at different predetermined velocities faster for the heavier bodies and slower for the lighter bodies, in spaced apart relation and in a single layer

through their respective complete trajectories which for the coal are shorter than for the impurities and limiting the time of travel of the bodies on the belt by feeding them in the described relation at a point near enough to the discharge end of the belt for opposing substantial collision of the heavier bodies with the lighter bodies and consequent disturbance of the described relation of the bodies before and after leaving the belt.

9. The method of separating bodies of coal and of impurities of heavier specific gravity than coal which consists of projecting the bodies into the air from the face and at the end of a belt moving at substantially constant speed, and controlling the velocity at which the coal and impurities respectively are projected into the air by feeding all the bodies to the face of the belt at substantially the same point and traveling the bodies on the belt for a distance in which the impurities acquire substantially greater speed than the coal and limiting the time of travel of the bodies on the belt by feeding them in the described relation at a point near enough to the discharge end of the belt for opposing substantial collision of the heavier bodies with the lighter bodies and consequent disturbance of the described relation of the bodies before and after leaving the belt.

10. In the ballistic separation of bodies of different specific gravities by projecting them from the end of a rapidly moving belt, the improvement which consists in projecting the bodies at different initial velocities and widening the separation by traveling the bodies on the belt for a distance within which the bodies of greater specific gravity substantially attain and the bodies of lighter specific gravity do not substantially attain the speed of the belt and limiting the time of travel of the bodies on the belt by feeding them in the described relation at a point near enough to the discharge end of the belt for opposing substantial collision of the heavier bodies with the lighter bodies and consequent disturbance of the described relation of the bodies before and after leaving the belt.

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