Dec. 22, 1936. K. C. APPLEYARD ET AL 2,065,205

SEPARATION OF COAL AND THE LIKE

Filed March 11, 1935 4 Sheets-Sheet 1

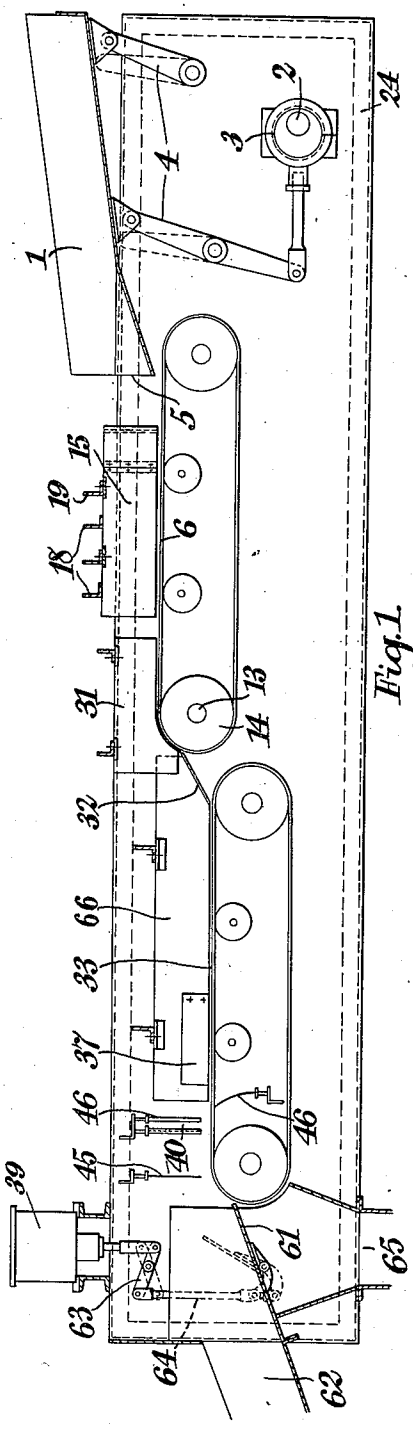


Fig. 1.

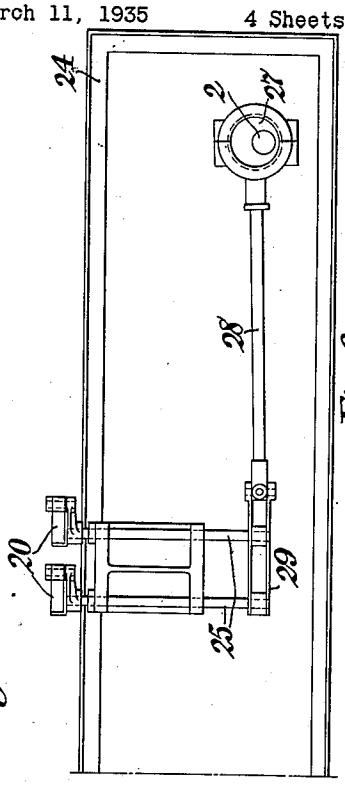


Fig. 3.

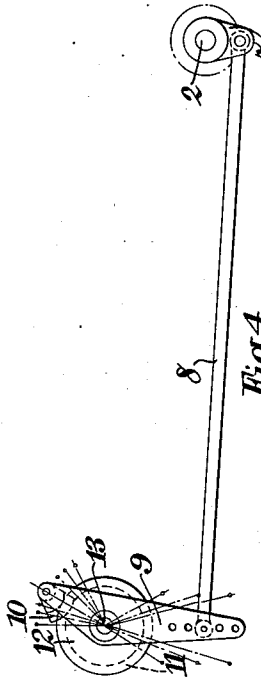


Fig. 4.

K. C. Appleyard
A. Flint
Inventors

By: Glascock Downing & Seebold
Attys.

Dec. 22, 1936. K. C. APPLEYARD ET AL 2,065,205

SEPARATION OF COAL AND THE LIKE

Filed March 11, 1935 4 Sheets-Sheet 2

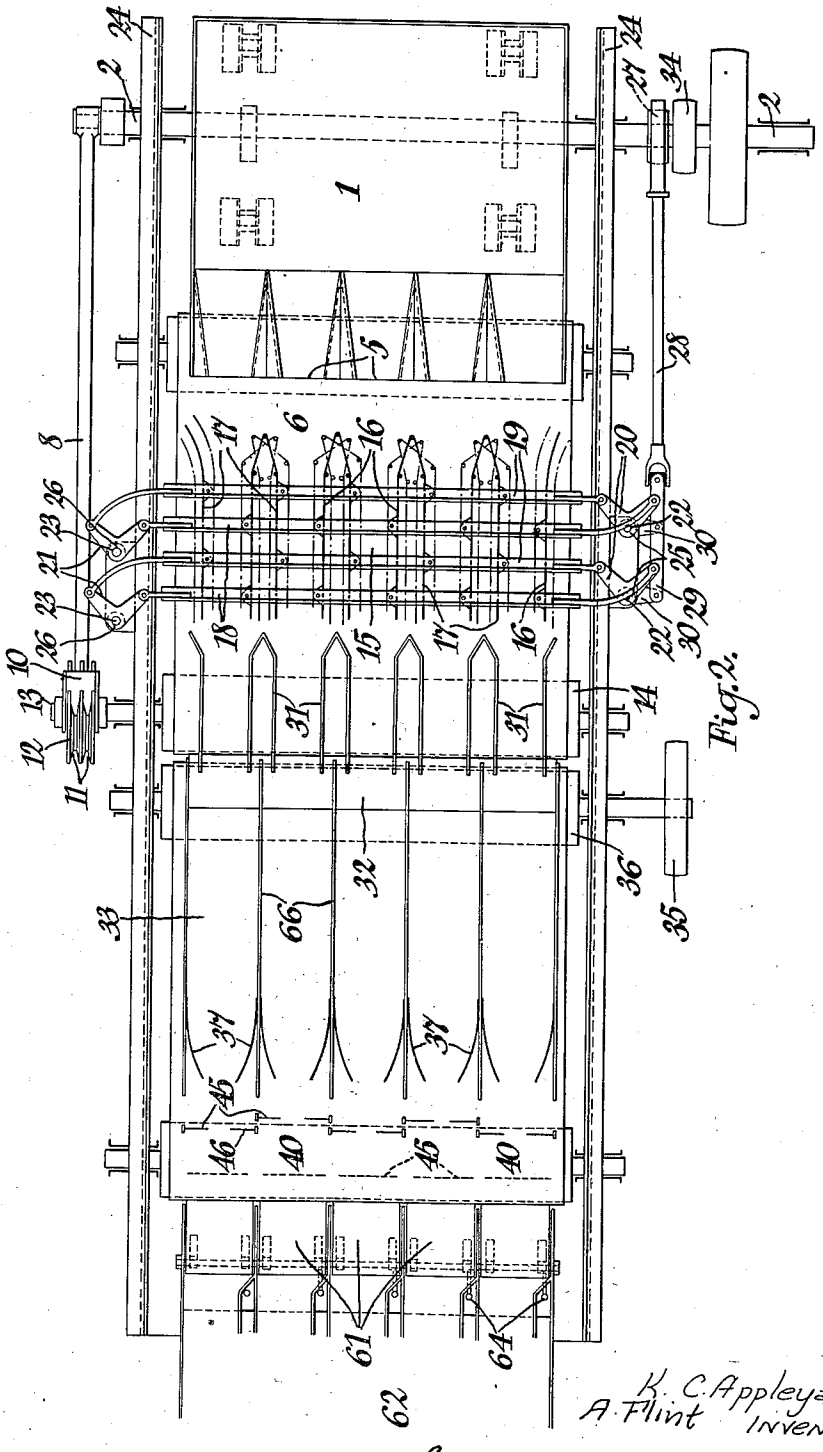


Fig. 2.

K. C. Appleyard
A. Flint
Inventors

By: Glascock Downing & Seebold
Attys.

Dec. 22, 1936. K. C. APPLEYARD ET AL 2,065,205

SEPARATION OF COAL AND THE LIKE

Filed March 11, 1935 4 Sheets-Sheet 3

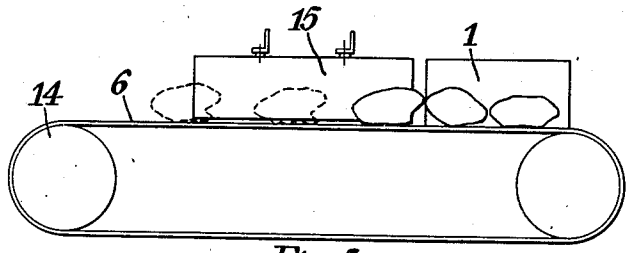


Fig. 5.

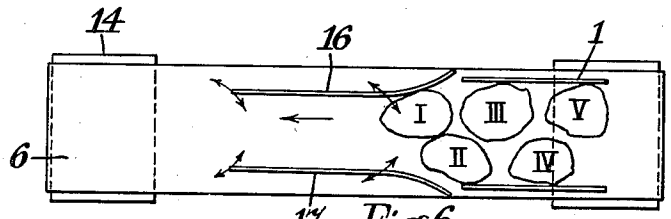


Fig. 6.

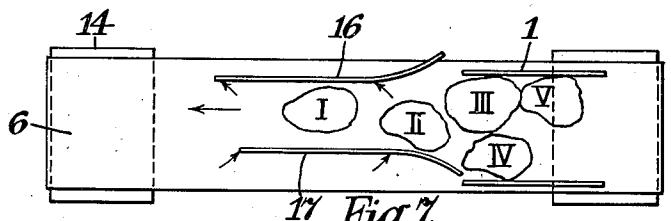


Fig. 7.

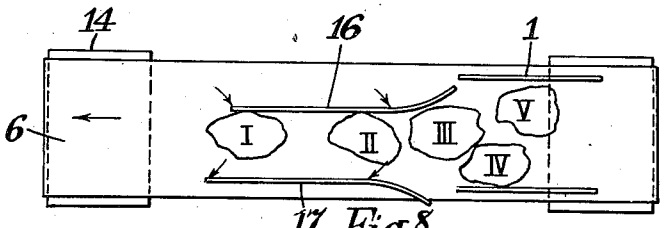


Fig. 8.

K. C. Appleyard
A. Flint
INVENTORS

By: Glascock Downing & Seebold
ATTYS.

Dec. 22, 1936. K. C. APPLEYARD ET AL 2,065,205

SEPARATION OF COAL AND THE LIKE

Filed March 11, 1935 4 Sheets-Sheet 4

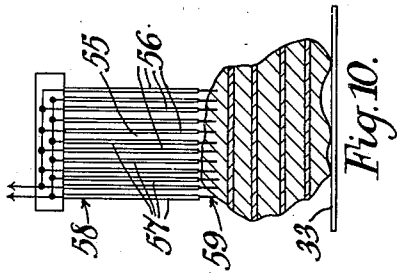


Fig. 10.

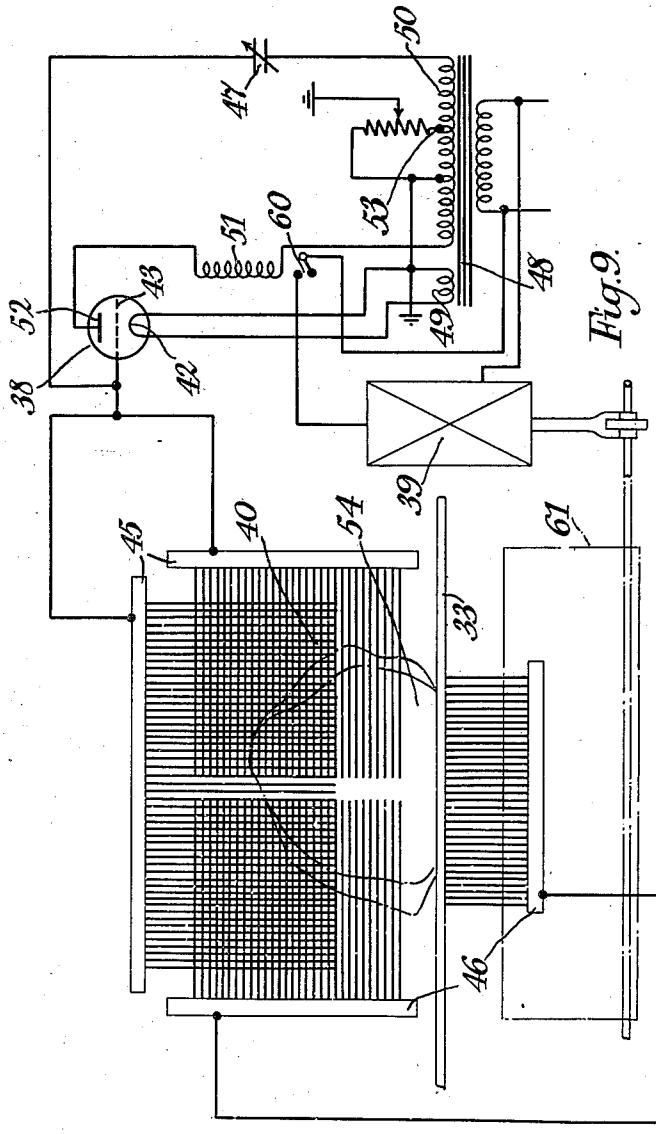


Fig. 9.

K. C. Appleyard
A. Flint
INVENTORS

By: Glascock Downing & Seebold
Attys.

Patented Dec. 22, 1936 2,065,205

UNITED STATES PATENT OFFICE

2,065,205

SEPARATION OF COAL AND THE LIKE

Kenelm Charles Appleyard, Birtley, and Alfred Flint, Low Fell, England, assignors of one-third to The Birtley Company Limited, Birtley, England

Application March 11, 1935, Serial No. 10,576
In Great Britain March 12, 1934

4 Claims. (Cl. 198—30)

This invention relates to the separation of mixed materials and will be hereinafter described with reference to the separation of coal mixtures into various classes of clean coal, shale, and possibly intermediate products such as pieces consisting of laminations of coal and shale.

The object of the invention is the provision of reliable methods of effecting the above separation and the provision of apparatus for carrying these methods into effect.

The present invention consists in a method of separating mixed materials such as coal with shale into classes which comprises feeding the raw material from a source to a marshalling device, marshalling the individual pieces into single file, spacing them apart and conveying them singly past an electrical discriminating device which operates to select different paths for the different constituents of the mixture.

The invention also consists in apparatus for carrying out the above method including a feeding device which preferably has a reciprocating motion and is adapted to receive the mixed material and deliver it via a chute to a marshalling device associated with a first conveyor belt, a second conveyor belt adapted to receive the material piece by piece from the first conveyor belt by way of a chute or the like and running at a peripheral speed greater than that of the first mentioned conveyor, an electrical contacting device adapted to make contact with each piece of material in turn so that the piece of material bridges the poles of an electrical circuit and means responsive to the current in the electrical circuit for selecting the path of each particular piece.

The invention further consists in apparatus as above described wherein the marshalling device comprises a pair of substantially vertical plates or walls between which the material is conveyed, the plane of the plates or walls being substantially parallel to the direction of travel of the material, means for imparting an oblique curved reciprocating motion to both plates and means for imparting an intermittent motion to the first conveyor belt.

The invention further consists in apparatus as above described, including guiding members or plates adapted to prevent the pieces of material from deviating substantially from a predetermined path.

The invention further consists in apparatus as above described wherein the first conveyor belt has an intermittent motion whilst the second belt, which is preferably of electrically conductive material, moves uniformly at a greater velocity than the mean velocity of the first conveyor belt.

One way of carrying the invention into effect will now be described with reference to the accompanying diagrammatic drawings of which:—

Figure 1 is a diagrammatic elevation of a separating machine.

Figure 2 is a plan view of Figure 1.

Figure 3 is a detailed elevational view of the mechanism for driving the marshalling plates.

Figure 4 is an elevational view of the mechanism for imparting an intermittent motion to the conveyor belt of the marshalling device.

Figures 5, 6, 7 and 8 are diagrams illustrating the action of the marshalling device; Figure 5 being in elevation and Figures 6, 7 and 8 in plan.

Figure 9 is a more detailed diagram of the electrical circuit.

Figure 10 is a modified form of the electrical contact member indicated in Figures 1 and 9.

Referring to Figures 1 to 4 of the drawings, a reciprocating feeding device 1, jigged from a main shaft 2 by an eccentric 3 and system of pivoted levers 4, terminates in a multiplicity of chutes 5 so as to distribute the particles of the material to be separated as nearly as possible into streams parallel with one another in a horizontal plane on to a conveyor belt 6 which is moved intermittently by appropriate gearing and conveys the particles away from the feeding device 1.

The gearing causing the intermittent drive of the conveyor belt 6 is shown in Figure 4. It comprises a crank 7 on the main shaft 2 adapted to rock a pivoted lever 9 by means of a rod 8 connected to one arm of the lever.

At the other end of the lever 9 a pair of wedge-shaped pawls 10 are pivoted so as to engage peripheral grooves 11 in a wheel 12 when the lever 9 moves in one direction and to slide in the grooves 11 when the lever 9 moves in the opposite direction.

The point of attachment of the lever 9 to the rod 8 is made adjustable so that the travel of the conveyor can be varied.

The wheel 12 is mounted on a shaft 13 which carries one roller 14 of the endless conveyor belt 6. A marshalling device 15 situated above the upper surface of the conveyor and substantially in contact with it is provided for the purpose of marshalling the separate particles into rows of unit particle width and depth, the rows being parallel to the motion of the conveyor.

The marshalling device comprises a plurality of

pairs of vertical plates 16, 17 preferably faced with resilient material to reduce risk of breakage of the coal, and pivotally suspended from two pairs of cross members 18, 19, all the vertical plates 16 being suspended from the cross members 18 and the plates 17 from the cross members 19.

In order to impart the necessary curved reciprocating motion to the vertical plates 16, 17 two pairs of bell crank levers 20, 21 are mounted by their centres at 22 and 23 respectively to two pairs of vertical shafts 25 and 26 respectively, one pair on each side of the framework 24 of the machine as shown in Figures 2 and 3.

Upon rotation of the main shaft 2 the shafts 25 with the bell crank levers 20 are rocked through a certain angle by the eccentric 27, connecting rod 28, pivoted link 29 and levers 30 attached to the lower ends of the shafts 25.

The cross members 18, 19 are connected to corresponding ends of the bell crank levers 20, 21 so that upon rocking the levers 20, the levers 21 perform a similar rocking motion and the vertical plates 16, 17 pivotally suspended from the cross members 18, 19 are caused to traverse arcuate reciprocating paths whilst maintaining their longitudinal aspect parallel to the direction of travel of the particles upon the conveyor belt 6.

The effect of the marshalling plates 16, 17 is shown diagrammatically in Figures 5 to 8; various positions of one pair of plates 16, 17 being shown in Figures 6, 7 and 8 with respect to the conveyor belt 6. In Figures 6, 7 and 8 the straight arrow denotes the direction of travel of the conveyor belt 6 whilst the curved arrows show the movements of the vertical plates 16, 17.

The progress of five pieces of material (I to V) from the feeding device 1 on the conveyor belt 6 and through the reciprocating vertical plates 16, 17 and the resultant marshalling into single file being clearly shown.

As will be noted in Figure 2, the ends of the vertical plates 16, 17 are adapted to prevent access of the material to the spaces separating the pairs of plates by curving the ends of the plates at the receiving end as shown by the outermost plates or by connecting their ends by pairs of vertical plates as shown by the remaining plates 16, 17.

The particles having been separated into rows as described by the reciprocating marshalling device 15 are conveyed between skirt plates 31 which extend past the end of the conveyor belt 6 and feed the particles on to a chute 32 down which they slide to the upper surface of a continuously moving conveyor belt 33.

The conveyor belt 33 is belt driven from a pulley 34 on the main shaft 2 to a pulley 35 on the shaft of the roller 36 and the peripheral speed of the conveyor belt 33 is arranged to be greater than the mean speed of the intermittently moving conveyor belt 6. The belt 33 is made electrically conductive and, by reason of having a greater mean speed than the intermittently moving conveyor belt 6, ensures that the successive particles in each row are sufficiently widely spaced to permit of subsequent individual selection and rejection without interference with the preceding or following particles.

The spaced particles pass between guide plates 66 and are finally centralized on the conveyor 33 by deflecting fingers 37 so as to ensure contact with brush gear 40 which is so arranged in circuit with an amplifying valve 38 and a solenoid 39 that as each individual particle makes contact between the conductive belt 33 and the brush gear 40 the current passing through the circuit will suffice to cause the solenoid 39 to operate a movable trap door 61 or other discharging device only if the resistance of the particular particle is less than a predetermined minimum value, otherwise the path of the particle is not affected by its contact with the electrical device.

An electrical circuit for carrying out the discrimination, between particles on a resistance basis is shown diagrammatically in detail in Figure 9, wherein it will be seen that a decrease in the resistance of the lead from the grid 43 of the valve 38 to earth, through the members 45, 46 which contact with the particles of material, will reduce the negative potential imparted to the grid by the circuit through the condenser 47.

The valve 38 is preferably of a type which will only permit anode current to flow when a limiting value of grid potential is reached.

Referring to Figure 9, a transformer 48 supplies from one of its secondary windings 49 heating current for the cathode 42 of the thermionic valve. One end of a further secondary winding 50 is connected through a relay coil 51 to the anode 52 of the valve; the other end of this winding being connected through the condenser 47 to the grid 43.

An intermediate point 53 of the winding 50 is connected to earth together with one end of the secondary winding 49. The grid 43 is connected to the conductive comb-like contacting members 45 which are insulated from earth, whilst a further pair of contacting members 46 are connected to earth.

The lower of the contacting members 46 is arranged to make electrical contact with the lower surface of the conductive conveyor belt 33 and the uppermost of the insulated members 45 is arranged so that it contacts with the particle of material under test passing on the belt 33 after the said particle has passed the opposed members 45 and 46.

By this means the particle 54 first bridges with its horizontal dimension the poles of the grid earth circuit and subsequently bridges the same circuit with its vertical dimension.

In the modified contact apparatus shown in Figure 10 the bridging takes places with a single comb-like contacting member 55, alternate teeth 56 and 57 of which are connected to the two poles of the grid earth circuit, i. e. one set 56 to the grid 43 and the other set 57 to earth, or to the cathode 42. In this modification the teeth of the comb 55 are preferably covered with flexible insulating material 58 excepting for the extreme ends 59 which contact with the particles of material.

The coil 51 may be, as above mentioned, the energizing coil of a relay which operates to close a main switch 60 for operating the solenoid 39 or the coil 51 may form the winding of the solenoid.

In some cases it may be possible to eliminate the thermionic valve relay device and to connect the relay coil 51 or the coil of the solenoid 39 in a simple circuit including in series the contact mechanism 40 and a source of electrical energy.

After a particle of high resistance has passed the discriminating contacts of the device 40 it leaves the belt 33 and passes over the hinged trap door 61 to the delivery chute 62.

If, however, a particle of comparatively low resistance passes the discriminating device 40 the solenoid is energized and raises the hinged trap door 61 by means of the pivoted lever system 63, 64 and allows the particle to fall into the chute 65. The reciprocating feeder may in some cases

be dispensed with and the material fed to the marshalling device 15 directly from means such as a jigging screen.

The skirt plates 31 referred to above are not essential to the operation of the device but are preferably used to keep the material from rolling to one side whilst moving from the first to the second conveyor.

The second and conductive conveyor band 33 may be constructed from steel wire and may be interwoven if desired with, say, camel hair belting, or it may be of fabric interwoven with wire.

The solenoid which forms part of the electrical device may operate through a relay as described with reference to Figure 9 or may operate the deflecting gate mechanism directly.

The travel of the first conveyor for each stroke should be less than the size of the smallest particle handled so that it would not be possible for two particles to leave the belt on the same stroke, whilst the speed of the second conveyor belt should be such as to leave a space between particles of about three times the length of the particles concerned.

It is preferable that the motions of the various parts of the device should be interconnected, for instance by being derived from the rotation of a single main shaft, so as to synchronize and maintain a definite relation between their speeds and to reduce complications in the driving mechanism.

Regarding the mechanical operation of the diverting gates, as the time interval between the particles may be only one third of a second, the actual opening and shutting of the gate should occupy say only one sixth of a second. Small departures from the horizontal plane are permissible with regard to the upper surfaces of the two conveyor belts for, say, economy in head room, but any departure must not be such as to involve risk of causing the particles to roll on the surfaces.

As an example of the actual and relative speeds of the device, the following may be adduced:—

For treating raw coal which has been screened to a size approximating 6" cube.

Stroke of the first conveyor belt is 5" at 190 strokes per minute, i. e. a speed of travel of 80 feet per minute.

For a length of 4 feet, this gives the time of a particle on the first conveyor belt of 3 seconds without allowing for any retarding action of the marshalling gear.

It is possible for a particle then to come off at approximately every stroke, and this would give a time interval of about ⅓ second between each particle, and on this basis when treating 6" coal, the capacity of a single stream would be 10 tons per hour.

Assuming a speed of the second conveyor belt of 270 feet per minute, a length of 4 feet would give a time on the belt of one second.

With this speed the spacing of particles on the belt would be about 1'6", but as it is really the time element that counts, the speed of this belt could be made any to suit the brush gears, and the gate operating gear.

As will be seen, no risk of breakage of material is likely since the action involves no free falls, and is almost equivalent to a picking belt.

In order to facilitate the operation of the electrical device, a source of heat may advantageously be provided so as to maintain the temperature above the dew point and a warm air supply or other means for removing surplus moisture might be provided.

The electrical discriminating arrangements may be similar to those described in British Patent No. 421,401.

When the feeding device begins its backward stroke, the first conveyor belt should commence its forward stroke, and so take material away from the delivery point; to give satisfactory working the stroke of the feeding device would be adjusted to suit the nature of material being handled.

As will be seen from the foregoing the vertical plates of the marshalling gear, faced with a resilient substance to prevent breakage on contact with the material, are moved between predetermined positions inwards and outwards with a partial rotary action, thus imparting to the particles a rotating movement resulting in placing them in line within the mean of their dimension.

Having now described our invention, what we claim as new and desire to secure by Letters Patent is:—

1. Apparatus for marshalling pieces of coal and the like fragmentary materials comprising a conveyor, a pair of substantially vertical plates or walls between which the material is conveyed, the plane of the plates or walls being substantially parallel to the direction of travel of the material, means imparting to each plate simultaneously a reciprocating motion having a longitudinal component and a transverse component, the longitudinal components being in opposite directions and the transverse components in the same direction in the two plates or walls and means for imparting an intermittent longitudinal motion to the conveyor.

2. Apparatus as claimed in claim 1 wherein the surfaces of the vertical walls are faced with resilient material where they contact with the material to be marshalled.

3. Apparatus as claimed in claim 1 wherein the means for imparting the reciprocating motion to the plates comprises an eccentric mechanism, a bell crank lever on each side of the conveyor and a cross member supporting the plate, the eccentric mechanism being connected to one arm of one bell crank lever and the cross member being connected to the other arm of this bell crank lever and to the corresponding arm of the other bell crank lever.

4. Apparatus as claimed in claim 1 wherein the means for imparting the reciprocating motion to the plates comprises an eccentric mechanism, a bell crank lever on each side of the conveyor and a cross member supporting the plate, the eccentric mechanism being connected to one arm of one bell crank lever and the cross member being connected to the other arm of this bell crank lever and to the corresponding arm of the other bell crank lever, whilst the means for imparting the intermittent motion to the conveyor comprise an endless belt conveyor passing over two end pulleys and a crank and connecting rod operating a ratchet mechanism which racks round one of the said end pulleys step by step.

KENELM CHARLES APPLEYARD.
ALFRED FLINT.