Dec. 7, 1937. K. C. APPLEYARD 2,101,381

APPARATUS FOR THE SEPARATION OF COAL AND THE LIKE

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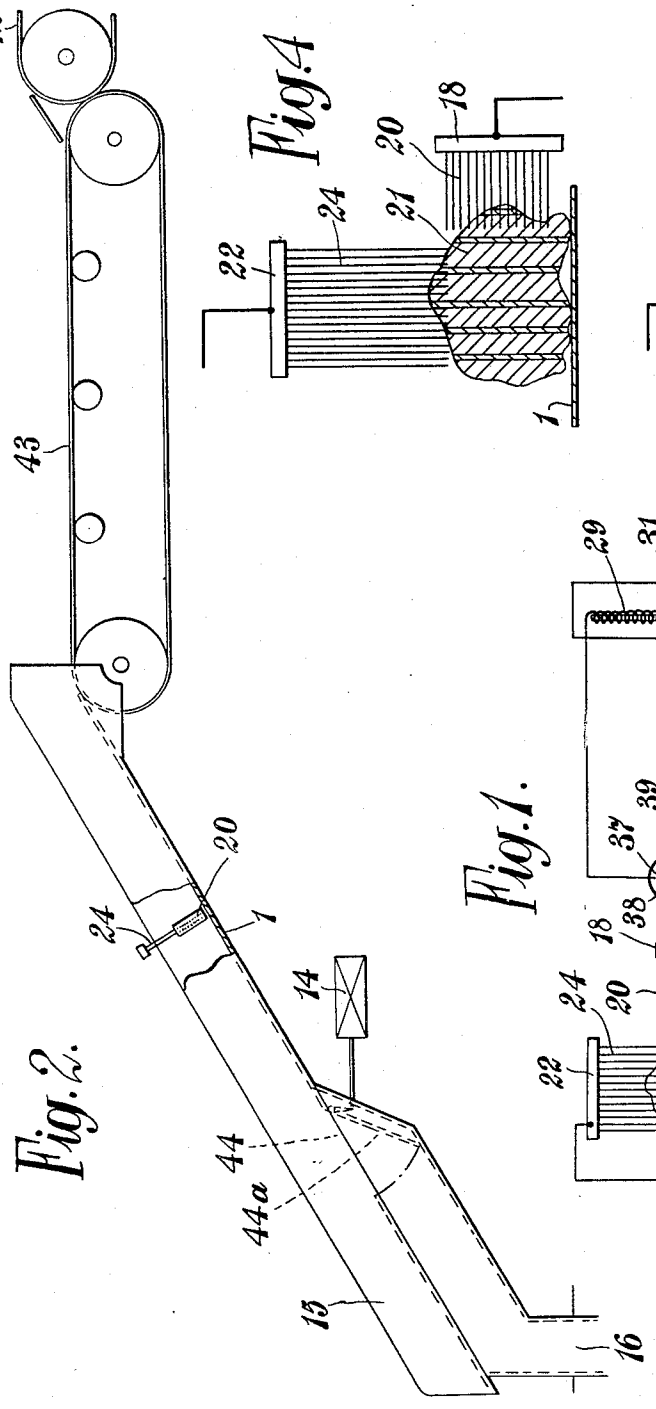


Fig. 2.

Fig. 4.

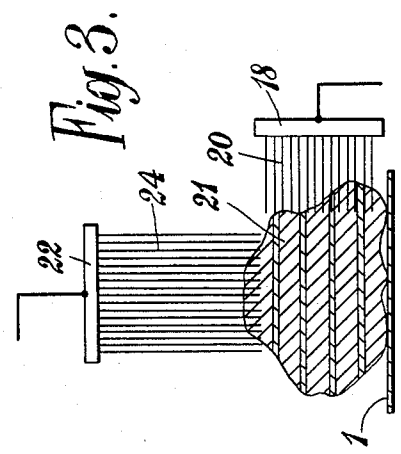


Fig. 3.

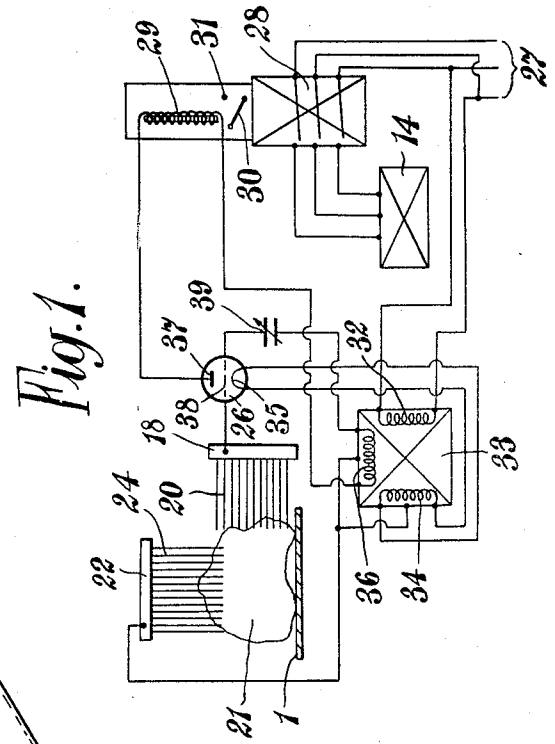


Fig. 1.

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APPARATUS FOR THE SEPARATION OF COAL AND THE LIKE

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1 Claim. (Cl. 209—81)

This invention relates to apparatus for the separation of coal and the like, especially for the separation of substantially dry "coal" which is a mixture or agglomeration of coal itself, together with impurities which may be classed as stone. Usually coal as received from the pits is sorted by hand, for the purpose of separating large pieces of coal and of stone, after which the "coal" receives some further treatment either wet or dry, for instance, dry pneumatic separation.

In investigating such further treatment, our researches have led us along the line of varying electrical effects of the constituents of "coal" for instance, resistance effects. Work has already been done in some of these directions and, for instance, results published on electrical conductivity in connection with this industry, for instance, in "A Textbook of Ore Dressing" by S. J. Truscott, London, 1923, page 562, and "A Textbook of Ore Dressing", by Richard & Locke, New York and London, 1925, page 4. In Truscott, for example, graphite is placed in the good conductors, and such matters as quartz in the bad conductors, but it is pointed out that impure minerals behave irregularly.

As a fact when ordinary "coal" comes into question, the electrical conductivity of the coal component is usually less than that of the "stone" component. By means therefore of some electrical process based on conductivity, one can visualize the possibility of separating a block of pure coal from a block of pure stone.

The problem of dealing with the separation of "coal" into its constituents is not as simple as the separation of pure coal from pure stone, because a large proportion of the material to be separated may be regarded as coal with streaks or seams of "stone", and a block of such material must be classed either as coal or as stone, in accordance with some reasonable classification, so that something which is mostly stone is not sorted as coal, and something which contains a large proportion of good coal is not rejected as stone. That makes the matter complicated, and a still further complication is introduced by the fact that the problem is not to separate blocks with plane faces and of uniform size, but blocks of irregular shape and of varying sizes.

The object of the invention is to discriminate between laminated material and coal or between laminated material and stone, and the invention will be pointed out in the accompanying claim.

The invention may perhaps be best first described in one form by way of example as used in a complete separating process in which the material is separated into three classes, the first consisting of pieces consisting mostly of coal, the second consisting of pieces formed of coal and stone in laminations, and the third consisting mostly of stone. Supposing that coal is less conductive than stone, the complete separation will be carried out by using two separating stages: the first in which the pieces consisting mostly of coal are separated from the remainder: the second in which this remainder is tested and the pieces consisting mostly of stone are removed. Corresponding stages are involved when stone is more conductive than coal. It is the second stage with which the invention is concerned, but an example of how the first stage as well as the second stage may be executed now follows, since not only is it desirable to explain the complete process, but it is to be observed that the mechanical arrangements may be applied also to the second stage with which the invention deals.

In the path of the "coal", means for discriminating or selecting are employed. A feeling or flexible spring finger assembly is placed, consisting, for instance, of two sets of spring fingers, one set formed by springs extending horizontally from the sides of the conveyor, and the other formed by vertically disposed springs. The spring finger assembly is electrically connected in an electrical circuit, for instance, to the terminals of a source of power, preferably at low voltage, say 20 volts. The electrical effect obtained, say, potential or current, is utilized in any suitable way for separation purposes, for instance, in the case of a current by means of an electrical circuit which may include an amplifier, for instance, the input side of a thermionic valve, adapted to operate with the voltage in question, and substantially to amplify the current without a large time lag, so that it is quick acting, and thereby enables a good rate of sorting to be secured. The output side of the amplifier is connected in circuit with a relay in turn operating a solenoid, the plunger of which controls discharge means for the material being sorted.

The electrical and mechanical adjustments are so made that (the coal being more conductive than the stone) on a piece of pure coal or laminated material with good coal content being "felt" by the brush gear, the current which passes is insufficient to cause any effect to be made on the discharge means, whereas on a block of "stone" being "felt" by the brush gear the current which passes is such that, having regard to the arrangements, the discharge means is operated to discharge the stone, for instance,

into a side chute. The mixture of substantially pure coal plus laminated material is then fed to the machine again, or to another machine, and the mechanical and electrical conditions are arranged so that in this instance substantially pure coal passes forward uninterrupted, whereas the laminated material is removed, for instance, by the side chute referred to above. In this way, the "coal" is separated into three constituents, namely, substantially pure coal, laminated material, and substantially pure "stone".

The accompanying diagrammatic drawing illustrates, by way of example, one way of carrying the invention into effect.

In the drawing:—

Figure 1 is a diagrammatic view of the electrical connections for the discriminating device.

Figure 2 is a diagrammatic side view of the assembly for separating the material into two classes.

Figures 3 and 4 are diagrammatic views of the fingers or combs in contact with pieces of laminated material.

Referring to Figure 1, a pair of comb-like contacting devices **22**, **18** having flexible contacting feelers or fingers **24**, **20** are arranged so that they are fixed with regard to the main frame of the machine and will contact with the sides of any piece of material, such as **21**, which moves past them.

The electrical connections include a thermionic amplifying device employing a valve **26**.

Supply mains **27** feed the solenoid **14** through a switch **28** which latter is closed when a solenoid **29** in the anode circuit of valve **26** carries sufficient current to lift the relay armature **30** from the position shown in the drawing to abut against the upper stop or contact **31**.

A pair of the supply mains **27** feed the primary **32** of a transformer **33**.

One secondary winding **34** of this transformer energizes the cathode **35** of the valve **26**.

The ends of another secondary winding **36** are connected respectively to the anode **37** of the valve **26** through the solenoid coil **29** and to the grid **38** by way of a variable condenser **39**.

The comb **22** is connected together and to a tapping point on the secondary winding **36** whilst the comb **18** is also connected to the grid **38**.

The passage of a piece of material **21** through the contacting fingers will thus vary the voltage of the grid **38** in accordance with its electrical characteristics of conductance. For instance the passage of a piece of electrically non-conductive material past the fingers might have no effect upon the potential of the valve grid and therefore upon the anode current whilst on the other hand the passage of a piece of electrically conductive material past the fingers would raise the potential of the grid and increase the value of the anode current in the anode circuit to such an extent that the solenoid **29** would actuate the contact **31**. This in turn would close the switch **28**, and energize the solenoid **14**.

In Figure 2 feeding devices **42** and **43** supply single pieces of the material to be separated, at substantially equal intervals of time, to an inclined chute **45**.

The chute is furnished near its entrance end with discriminating means comprising contact fingers operating as already described in conjunction with a solenoid device **14** in such a way that the passage of a piece of material having a particular conductive characteristic between the fingers or combs **22** and **18** will cause the solenoid to be energized and to move a hinged flap from its normal position **44** to the position shown as **44a** at the time when the particular piece of material concerned is passing the flap. Such a piece of material therefore will be diverted into the lower chute **16** and the flap will resume its normal position **44**. If the succeeding piece of material has the same particular characteristic as the preceding one the flap will again open and close so as to deposit the second piece with the first.

The passage of a piece of material with suitably different conductivity, for instance having a very much greater electrical resistance, will not suffice to cause energization of the solenoid and will pass unhindered into the chute **15**. Any quantity of material passing the discriminating means as described will thus be divided into two groups according to the particular characteristics of the individual unitary pieces.

It will be realized that in connection with the separation of coal one has to deal with not only pure coal and pure stone but with a certain proportion of laminated material which normally consists of pieces of coal with bands or layers of stone running through them.

In order to separate the banded material from the stone the combined stone and laminated material treated by passing it through a contact device or comb arranged as illustrated in Figures 3 and 4.

According to Figures 3 and 4, assuming the combs are both electrically insulated from the chute **1**, any piece of laminated material whether the laminations be vertical or horizontal will never act as a conductor of the stone class and will consequently be separated from the stone by the mechanical device following the directions of the discriminating device.

In some cases it would be possible to dispense with the upper comb **24** by making the tray **1** of conductive material and using it as one of the electrical connections to the piece of material.

General

It is not necessary that the discriminating gear, for instance, the brush or feeling or contactor gear should be the same in both or all stages. In the two stage process referred to above, a comparatively simple contactor assembly may be used for the first stage.

It is preferred that the discharge, especially for coal and for coal laminated with "stone", should be vertical, and that suitable chutes should be provided to minimize breakage.

Two or more sorting bands may be used side by side in a single apparatus.

Separation by two stages into three groups in the case of coal is particularly useful where a good bright coal product is required for household purposes, substantially free from laminated material, but where this laminated material has too high a coal content for it to be wasted, such material may, if desired, be crushed and re-sorted.

Although the invention is primarily intended to deal with "coal" of the kind usually subjected to hand picking, it is not limited to material of such sizes.

Dampness either on the surface of the material to be sorted or otherwise associated with the material may affect the process, and this must be taken into account. A drying treatment may be used if necessary and desired.

The invention may also be applied to ore dressing.

The discriminating gear may be stationary or may be moving.

The material to be sorted may, as indicated, be fed on to a plate or tray or like belt, and the surfaces on which it is carried may be roughened for contact purposes if desired. In the case of brush gear the pressure of the brush or feeler assembly may be comparatively great to assist in obtaining good contact, or in moving to a certain extent the material under treatment.

Feeding may take place on a plate or the like having a certain amount of inclination, and of sufficient length for the material to become spread out thereon, due to varying coefficients of friction.

Although reference to amplification has been made above, should the effects obtained be sufficiently great, for instance by reason in the electrical conductivity case of the voltage chosen being sufficiently high to enable a sufficient current to pass through the pieces under discrimination to effect separation, an amplifier need not be employed, and the above statements of process and other statements are to be read subject hereto.

The brush gear may be earthed.

Delay actions between the contact and operating apparatus may be employed if desired.

Frictional separation may be used in conjunction with the process referred to above, especially where smaller sized material comes into question.

The discharge appliance for, for instance, the coal and stone, may be of varied kinds and sizes. For instance, they need not be of the same size for the stone and for the coal; they may be of any suitable angle, fixed or variable; and they may be curved, inclined or straight.

The contact brushes or the like may be made of flat wires or of round wires or a combination of both or in any other suitable way.

In place of a single amplifier or single amplifying valve two or more amplifiers or valves in series may be used.

I claim:

Apparatus for the automatic separation into classes of pieces of coal and the like according to their electrical resistance comprising an electrical circuit, a source of energy connected therewith only, two contact members, of which at least one is of a resilient nature, connected to the respective poles of said electrical circuit, means for causing the material to pass in single pieces between and to make electrical contact with said contact members, diverting means for presenting alternative paths to the pieces of material after they have passed said contact members and automatic means controlled by the current in said circuit for operating said diverting means, said two contact members being arranged to contact with each piece of material from directions substantially at right angles to one another.

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