July 16, 1935. W. S. AYRES 2,008,122

PROCESS AND APPARATUS FOR REMOVING IMPURITIES FROM COAL OR OTHER MINERAL PRODUCTS AND THE LIKE

Filed Sept. 9, 1930 2 Sheets-Sheet 1

FIG. 1

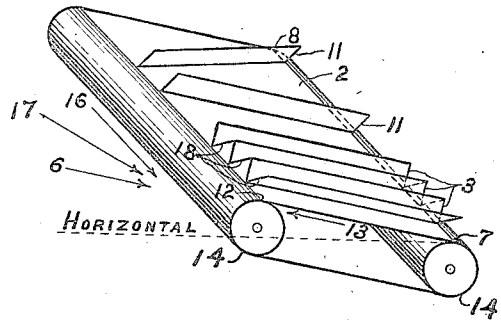
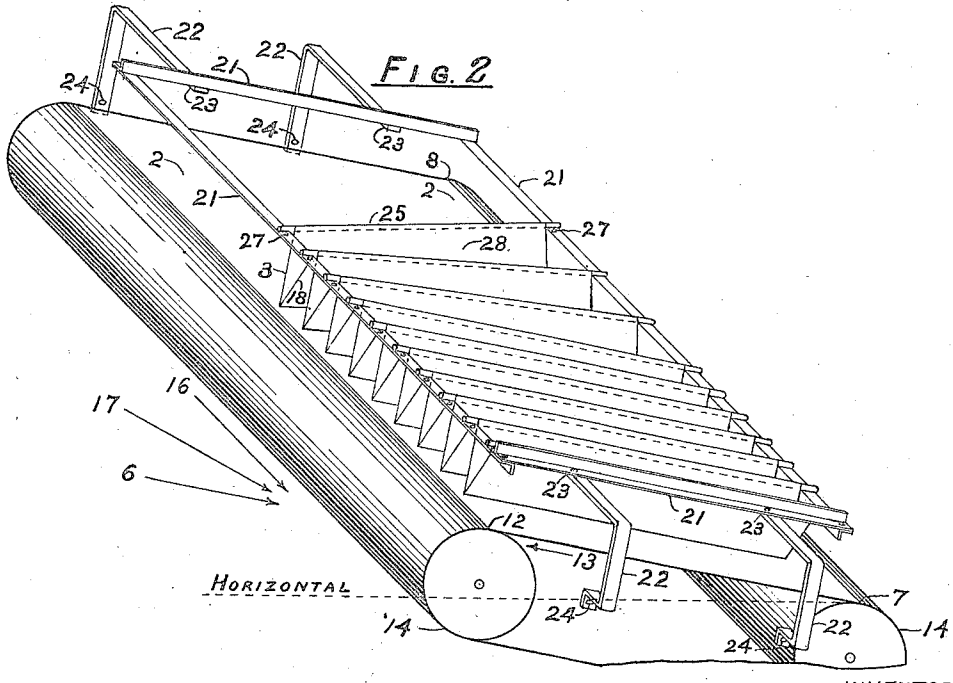


FIG. 2



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FIG. 3

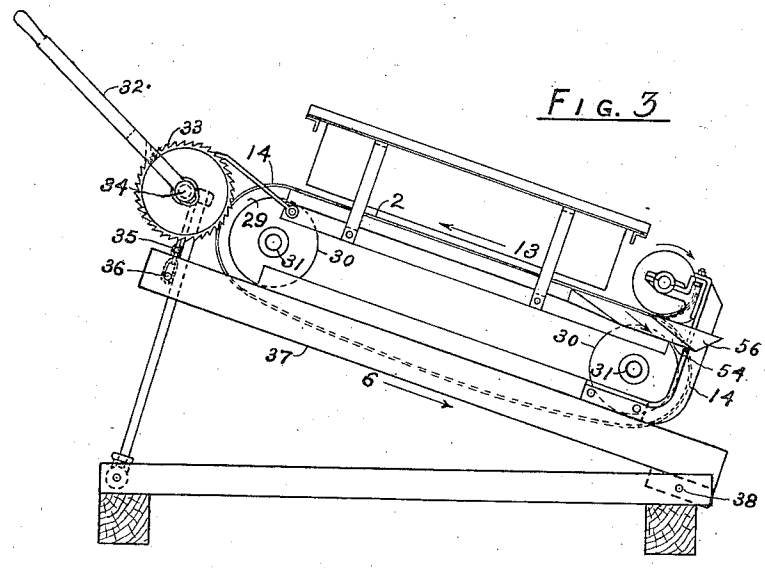


FIG. 4

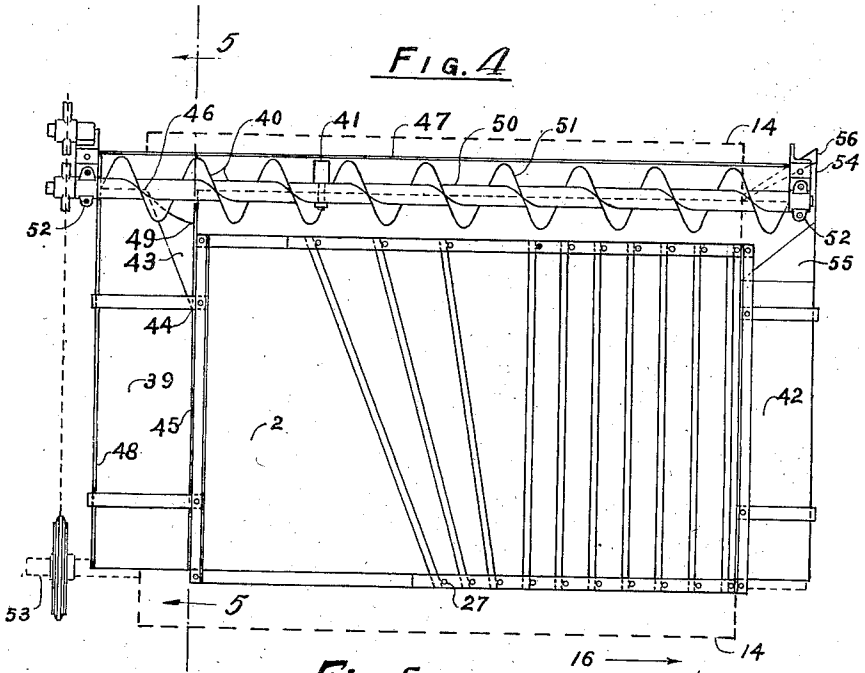
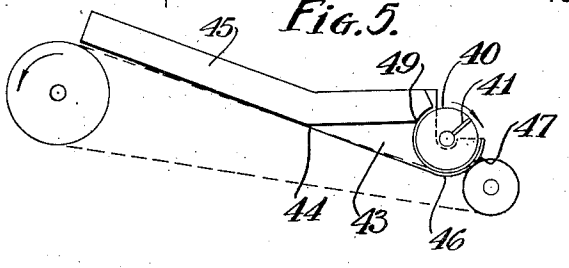
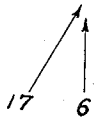


Fig. 5.





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2,008,122

PROCESS AND APPARATUS FOR REMOVING IMPURITIES FROM COAL OR OTHER MINERAL PRODUCTS AND THE LIKE

Wallace Shaw Ayres, Hazleton, Pa.

Application September 9, 1930, Serial No. 480,768

6 Claims. (Cl. 209—112)

This invention has reference to the several processes for classifying coal and other mineral products and similar materials, and has special reference to those processes known as frictional processes, water-impulse or water-current processes, and water-and-sand flotation processes. In the frictional processes the difference in the angle of repose is taken advantage of, while in all water-operated processes the difference in specific gravity furnishes the classifying influence effecting the separation.

The object of this invention is to remove the various types of impurities that are refused or not removed by the other processes, by the introduction and combination of new and heretofore unused forces, and at the same time to remove the same impurities heretofore removed.

Most of the different kinds of coal—and rock—products and similar materials, have associated with them impurities that are very difficult and very necessary to remove. They are of various kinds and shapes and of widely different natures, such as: chips of wood and bark; pieces of slate or rock that are flat and thin, presenting a large surface in comparison with their weight; and rounded or any shaped pieces of ash-cinders of light specific gravity; all of which float over with the cleaned product in all water-impulse or water-current, and water-and-sand flotation processes; and also rounded pieces of different materials such as pebbles of rock or slate, balls of clay and rounded pieces of ash-cinders, or any kind of impurities rounded in form, a large part of which, in frictional machines, roll back into the cleaned product irrespective of their specific gravity or the angle of repose of the material out of which they have been formed.

It is chiefly the rounded pieces of many kinds of impurities just described which have defied all separation processes now in use, whether water-flow or frictional. In the water-flow processes the flat pieces of impurities and all impurities not rounded, but of a light specific gravity, are also only partially removed. This new process has for its object the entire removal of all of these impurities heretofore refused by other processes, or only partially removed by them.

It is common practice to size these crushed products of coal, rock, or other materials, by screening either before or after being treated by any separating process. And it is the screened material, all of one size, that lends itself best to the new process herein described. The behavior of the rounded pieces of impurities as observed in the processes now in use has made clear the necessity of this new process, and it has been made possible only by discovering a method of controlling the direction of travel of the rounded pieces.

In its elemental form the process contemplates the engaging of the rounded surface of the piece of objectionable material at more than one point, preferably by employing two or more plain surfaces of suitable material, brought in contact with the rounded piece at two or more points on its surface, and either simultaneously, continuously or intermittently. These surfaces may be parallel to each other, or disposed at any desired angle. Motion may be imparted to one or all of these surfaces, and the motion may be rectilinear or curvilinear, and the direction of one motion may be parallel to or at any desired angle to the others. In every application of the principle, however, it is imperative that the engaging of the rounded piece at more than one point of contact must be established to make it operative.

Referring to the accompanying drawings forming a part of this application,—

Fig. 1 is a perspective view illustrating diagrammatically the principle of the invention and showing a movable belt used with a plurality of stationary plane surfaces;

Fig. 2 is a perspective view, showing more completely the arrangement of Fig. 1;

Fig. 3 is an end elevation of the apparatus of Fig. 2, but omitting distant parts and showing the mechanism more completely;

Fig. 4 is a plan view of the apparatus of Fig. 3; and

Fig. 5 is a diagrammatic sectional view taken on the line 5—5 of Fig. 4.

In its simplest form the elemental principle of the process may be best contemplated by placing a rounded body between two parallel surfaces. It is self evident that if a motion be given to either of these surfaces, with the motion in any desired direction, and either rectilinear or curvilinear, the piece of rounded material can be led by these two points of contact in any direction desired. And it is also plain that these two parallel surfaces can together be inclined at any angle to the horizontal, without in any way destroying the controlling action of the two surfaces on the rounded piece. In the process of leading the rounded impurities in the direction desired, it is also important to allow the valued material to freely pass on to the storage place provided for it. This automatically takes place in the process from the self evident fact that the maximum height of the irregularly fractured pieces passing through a round mesh screen, as compared with the diameter of the spherical pieces passing through the same mesh, is always less than the diameter of the rounded piece. Therefore when the material thus sized by the screen comes upon the lower surface, in a single layer, the rounded pieces of impurities will be taller, and will engage with the upper surface which has been properly adjusted to their height,

while all other pieces can pass under the upper surface without coming in contact with it, and without obstruction.

Fig. 1 represents an effective arrangement of surfaces. In this arrangement the surface 2 is inclined to the horizontal in two directions as indicated by the arrows 6 and 16, thus giving a resultant inclination indicated by the arrow 17, or in other words the surface 2 is inclined toward the corner 7. The surface 11 is shown in two longitudinal positions with reference to the side 7—8 of the surface 2 and these positions can be varied at any angle provided the angle is not less than the resultant angle 17. This surface 11 can also be inclined transversely to the surface 2 as shown by the surface 3, or in the opposite direction as shown by surface 18. It is also plain that the inclined surface 3 may be placed adjacent the oppositely inclined surface 18, and a series of such oppositely inclined surfaces may be formed as shown.

It is contemplated as a part of this invention that any desired number of points of contact, two, three, four, or more, may be employed. Whatever number is employed, however, the principle remains the same. The preferred arrangement has the surface 2 moving upwardly along the plane of its inclination and in the direction of its side 7—12 as shown by the arrow 13, while the other surfaces remain at rest with reference to the surface 2.

It is therefore plain that any rounded piece fed to the upwardly moving surface 2 at or near its corner 8, would, because of the double inclination of the surface 2, roll against the surface 11 in any of its possible positions. Consequently two points of contact would be established and maintained, and the rounded piece would be led up along the surface 11 in any of its positions, to any desired point of discharge. It is also plain that if the series of adjacent and oppositely inclined surfaces 3 and 18, forming triangular passageways with the surface 2, are adjusted to the surface 2 so that their lower ends are situated at a suitable distance above its lower edge 7—8, and if the material containing the rounded impurities is fed to the upwardly moving surface 2 at or near its corner 8 and is caused to flow along its lower edge 7—8, and also if this series of surfaces 3 and 18 are properly proportioned to the particular size of rounded pieces being removed, then as each rounded piece is drawn out of the stream of material by the upwardly moving surface 2 it will enter one of the triangular passageways, and consequently three points of contact will be established, either continuously or intermittently, depending on how closely the rounded piece approximates a perfect sphere.

It will also be plain that two, three, four or more points of contact can be established, and that the same elemental principle in the process of removing rounded pieces is in all cases maintained, namely, to engage the rounded piece at more than one point on its surface.

The several variations in applying this new process of removing rounded pieces of impurities are easily adapted to coal operating devices such as shown and described in Letters Patent No. 798,385, granted to me on Aug. 29, 1905, also in Letters Patent No. 1,069,517 granted Aug. 5, 1913, No. 1,136,578 granted Apr. 20, 1915, No. 1,139,250 granted May 11, 1915 and No. 1,140,236 granted May 18, 1915. This new process can also be applied to other separating devices, but for the purposes of illustrating its complete operation the description given in this application will be confined to its adaptation to the separator described in the patents just named.

Fig. 2 of the drawings forming a part of this application represents the mechanical embodiment of the fundamental principles of this new process as adapted to the coal separating device described in the patents just enumerated. It consists of a suitable frame 21 made of structural steel, or other material mounted upon carrying brackets 22 and attached to them at 23, which brackets in turn are attached to the frame of the separator at 24. Upon this frame is placed a series of bars 25, preferably made of pipe, of any desired number, and disposed in any position best adapted to the material being treated. The ends of these bars are secured in position by being gripped between a flat bar placed over each series of ends of the pipe bars, and the frame 21, by means of the bolts 27. See also Fig. 4. Over the central portion of these bars is placed a continuous strip of canvas 28 or other flexible material of any desired width, and so festooned between them that the lowest part of each deflexed loop hangs at the required distance above the surface 2 of the separating belt 14—14, which distance as previously pointed out must be a little less than the mesh of the screen through which the material has passed. Or, the canvas may be cut into narrow strips and each strip attached by one edge to a single bar, and each strip may be of a single thickness or any number of thicknesses. When these strips, either single or multiple in thickness, are individually attached to the bars the height of the lower edge of the strip above the surface 2 can be adjusted by merely revolving each bar separately. The strips of flexible material or the festoons are attached to the bars 25 by suitable clamps. These strips or festoons of flexible material form the surfaces 3, 18, or 11 of Fig. 1.

Fig. 3 of the drawings forming a part of this application represents a tail-end view of the separator described in the foregoing patents issued to this applicant. The separator consists, in its chief parts, of an endless belt 14—14, the upper run of which corresponds to the surface 2 in Fig. 1 of this application. The belt is composed of narrow plates of shaped steel attached to several strands of parallel endless chains 29, traveling around sprocket wheels 30 keyed on two parallel shafts 31. The upper surface 2 of this belt is held to a true plane by parallel surfacing bars over which the parallel strands of chain slide between the two sets of sprocket wheels. The motion given to this surface is upward in the direction of the arrow 13. This surface 2 is inclined in two directions as shown in Fig. 1, forwardly in the direction of the arrow 16, and transversely in the direction of the arrow 6, thus giving a resultant inclination in the direction of the arrow 17. This surface of the belt 14—14 is capable of adjustment in its transverse pitch, to the angle of repose of any material such as coal and to the point where the coal freely slides down its inclination while the slate and other impurities, because of their greater angle of repose, cling to the upwardly moving surface 2 of the endless belt 14—14 and are consequently carried out and away from the coal. The adjustment is accomplished by means of the lever 32 operating the ratchet-wheel 33, shaft 34, and winding chains 35 which are attached at 36 to the free ends of the bed pieces 37. The opposite ends of these bed pieces are hinged at 38.

In Fig. 4 are shown the several devices which are added to the separator just described to cooperate with the device set forth in Fig. 2, and to most efficiently carry out this new process. They are, the specially designed feed-pan 39; the screw conveyor 40, provided with one or more mixers or spreaders 41; and the specially formed tail-apron 42, over which the cleaned coal is quickly discharged. These new devices as shown in Fig. 4 are assembled upon the upper surface 2 of the separating belt 14—14, just as they are positioned when in operation, but the frame of the separator is omitted for the purpose of clearer illustration.

The feed-pan 39 is preferably composed of sheet metal of any kind, cut and bent to the form shown in Fig. 4 and Fig. 5. The plane of the main portion of its bottom is tangential to the bottom of the cylindrical segment of the conveyor trough as shown in Fig. 5. The lower edge of the sloping part 43 of the bottom runs diagonally across the main portion from a point 44 at the inner vertical side 45 of the feed-pan to the point 46 situated in the junction line of the main portion of the bottom and the cylindrical segment of the conveyor trough 47, and distant from the outer vertical side 48 of the feed-pan, any desired amount. This sloping part 43 intersects the cylindrical segment of the conveyor trough in an elliptical curve which begins at the point 46, just described, and, continuing upwardly from this beginning point, terminates against the inner vertical side 45 of the feed-pan at the point 49. This elliptically curved junction line of the sloping part of the bottom and the cylindrical segment of the conveyor trough is held in place either by welding, bolting, or riveting, as desired.

The screw-conveyor 40 is made up of a shaft 50 and a continuous conveyor-flight 51 and it revolves in suitable bearings at 52 and 52, and is driven from the main drive shaft 53 of the separator by any suitable drive, preferably a chain and sprocket drive, outlined in Fig. 5. The direction of revolution of the conveyor is shown by the arrow in Fig. 5 which represents the direction of motion of the top of the conveyor-flight. The bottom of the flight, consequently, is moving in the opposite direction or in the same direction as the surface 2 shown by the arrow 13 in Fig. 3. The number of feet per minute traveled by the outside circumference of the conveyor-flight can be made equal to, or greater, or less than the number of feet per minute traveled by the surface 2, to which surface the conveyor is adjusted in close proximity, and the required rate of travel of the outside circumference of the conveyor-flight is determined by the behavior of the particular material under treatment. Usually it should be a little faster than the separating surface 2. The screw-conveyor, in addition to the continuous conveyor-flight 51, has mixers or spreaders 41 attached to either the flight or to the shaft, preferably to the shaft as shown. These spreaders can be made to stand at any desired angle to the axis of the shaft. They can begin immediately below the feed-pan and continue about half way across the surface 2. They can be placed as frequently as desired, one at every quarter turn of the flight, at every third of a turn, every half turn, every two-thirds of a turn, every three-fourths of a turn, every turn, or at any other spacing which the nature of the material may require.

The tail-apron 42 (Fig. 4) is composed, like the feed-pan, of sheet metal or other metal, and is bent to the form shown. The sloping section 54 (see also Fig. 3) is, at its outer edge, depressed considerably below the plane of the main portion 42. The triangular portion 55 merely connects the main portion 42 with the sloping portion 54, and is integral with the metal sheet out of which the whole tail-apron is composed. The bent-up section 56 at the lower end is merely a stoppage to the flow of material in that direction. The cleaned coal, consequently, flows off of the separating surface 2 and across the tail-apron in the direction of the arrow in Fig. 3, with a quick run-off.

The object of this arrangement of feed-chute, screw-conveyor and tail-apron, is to deliver and distribute the material to the separating surface 2 so that the impurities mentioned in a foregoing paragraph of this specification, particularly the rounded pieces of impure material, will enter the triangular passage ways shown in Fig. 2 in the most favorable manner for their removal by this new process, and at the same time to provide a means for a quick run-off of the cleaned material from the separating surface 2. The perfected manner of delivery of the material by the feed-pan to the separating surface 2, the uniform distribution and speed of travel of the material by the screw-conveyor and the quick run-off, provided by the tail-apron, together form means for carrying out this new process in actual practice and make it possible to remove a class of refuse material which it has heretofore been impossible to remove by any of the processes known to the art of coal cleaning. They are described as follows:

The material fed into the feed-pan 39, Fig. 4, slides down toward the screw-conveyor where the stream of material is forced over against the outer vertical side 48 of the pan by the sloping part 43 of the bottom, and, consequently, is thereby contracted into a narrow stream. At each revolution of the conveyor the flight cuts off a limited portion of this narrowed stream, thus insuring an approximately uniform rate of feed. The form of this feed-pan and the manner of its joining the screw-conveyor trough make this uniform rate of feed possible which is an important factor in securing the greatest capacity and the greatest efficiency.

The screw-conveyor then transports the limited portion of material so cut off at each revolution along the conveyor-trough, and at the same time the mixing paddles attached to the conveyor are, intermittently, forcing the material out of the conveyor-trough and spreading it thinly over that portion of the separating surface 2 adjacent the conveyor-trough. This spreading out of the material is an efficient means for bringing each piece of impure material in perfect contact with the upwardly moving separating surface 2 of the belt 14—14, and also for giving the impure piece an opening between the pieces of coal so that it can, under the continuous urge of its frictional adherence to the moving surface 2, freely move out and away from the stream of coal. This is particularly efficient with the rounded pieces of ashes or of other impure material.

Heretofore these rounded pieces, just after they have been drawn out of the stream of coal by the upwardly moving surface 2 of the belt 14—14, and, after they have traveled up the incline a short distance, have rolled back into the stream of coal, out of which they again, repeatedly, have been drawn only to roll back again. To prevent this rolling back has been the great problem. It

has been solved, however, by placing above the upwardly moving surface 2 of the belt 14—14 a series of the surfaces previously described and set forth in Figs. 1 and 2 as surfaces 3, 11, and 18. Fig. 2 shows the arrangement of these surfaces adapted to the separator herein described, and applied in Figs. 3, 4 and 5. These superimposed surfaces are adjusted to the separator surface 2 so that their lower ends are at the desired distance—determinable only by experiment—from the conveyor, and also at a distance above the upwardly moving surface 2 just a little less than the diameter of the screen mesh through which the material being treated has passed. From this arrangement and adjustment of the surfaces it is plain that any round piece of impure material which has been carried up the incline a short distance, will enter some one of the several open spaces between pairs of surfaces 3 and 18, and when it begins to roll back it will roll against the surface 3 of that particular triangular opening because of the longitudinal inclination of the surface 2 in the direction of the arrow 16 of Figs. 1 and 2. The arrow 17 represents the direction of the path of the piece as it rolls back. As soon as the piece rolls against the surface 3 a second point of contact with its rounded surface has been established, and consequently it is under complete control, is quickly and surely carried on up the incline by the moving surface 2 of the belt 14—14, and discharged into the refuse chute.

It is also clearly conceivable that a series of brushes superimposed above the surface 2 with their brushing surfaces, composed of bristles or the like, adjusted to a distance above it just a little less than the diameter of the screen mesh through which the material has passed, or with their brushing surfaces set at any angle to the surface 2, similar to the inclination of the surfaces 3, 11 and 18 in Figs. 1 and 2, will function in the same way and will provide the second point of contact with the rounded piece.

At the same time that the rounded pieces of ashes and other impurities are being removed, the flat pieces of the same impurities which do not roll, and as well the flat pieces of slate, pieces of bark, chips, etc., are quickly and positively removed and without any interference with the removal of the rounded pieces.

This process, while in operation, is open to view at all times; it does not chip or break the coal; it is capable of adjustment while in operation; it requires but little height; and after it has been adjusted to the material being treated it does not require an attendant. It removes a class of impurities not heretofore removed by any other process.

Obviously the present invention is not restricted to the particular embodiments thereof herein shown and described. Moreover, it is not indispensable that all the features of the invention be used conjointly, since they may be employed advantageously in various combinations and subcombinations.

What I claim is:

1. The process of removing rounded pieces of impurities from any solid lumpy material which is characterized by altering the direction of travel of the rounded pieces, when in motion and mixed in with the lumpy material, by subjecting the surfaces of the rounded pieces to contact simultaneously at at least two spaced points with frictional surfaces so placed as not to engage the pure lump material; and conducting away the rounded pieces so diverted.

2. A process of removing rounded impurities from screened coal and the like which comprises the step of causing coal containing said impurities to move by gravity down a surface inclined in two directions at right angles, and changing the direction of travel of the rounded impurities by effecting contact of each rounded impurity simultaneously with two plane surfaces each at an angle to the inclined surface and to each other extending in the general direction in which the coal travels.

3. Apparatus for effecting the removal of rounded impurities from screened coal and the like comprising, in combination, means providing a sliding surface down which the impure coal may move, said surface being inclined in two directions relative to the horizontal; and means providing a series of fixed surfaces arranged above said inclined surface and providing a plurality of passageways through which the coal and its impurities travel; said fixed surfaces being arranged in upwardly converging pairs so relative to each other and to the inclined surface that the impurities contact with one or both fixed surfaces bounding each passageway while moving down said inclined surface.

4. Apparatus for effecting the removal of rounded impurities from screened coal and the like comprising, in combination, a belt wrapped around two spaced rollers, one of which is power-driven; said belt being inclined downwardly in two directions so that material placed on said belt tends to move toward the lower end of the lower roller; a frame above the upper surface of the belt; and means supported on said frame to provide a series of passageways substantially triangular in cross-section extending between said rollers and above said belt, said means being spaced above the belt a distance less than the mesh of the screen through which the coal has been passed.

5. Apparatus for effecting the removal of rounded impurities from screened coal and the like comprising, in combination, an endless belt; a feed pan at one side of the belt; a screw conveyor receiving coal from the feed pan and extending for the width of the belt from the higher end thereof; a separator consisting of a plurality of fixed plane members extending substantially longitudinally of the belt and providing a series of passageways above the belt, said passageways converging upwardly and being spaced from the upper surface of the belt; and a tail apron at the side of the belt opposite to the one at which the feed pan is arranged.

6. Apparatus for effecting the removal of rounded impurities from screened coal and the like comprising, in combination, an endless belt; a feed pan at one side of the belt; a screw conveyor receiving coal from the feed pan and extending for the width of the belt from the higher end thereof; a mixer secured to the screw conveyor; a separator consisting of a plurality of fixed plane members extending substantially longitudinally of the belt and being spaced from the upper surface of the belt; and a tail apron at the side of the belt opposite to the one at which the feed pan is arranged.

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