Feb. 16, 1932. L. HOYOIS 1,845,602

METHOD FOR WASHING COAL, ORES, AND OTHER SIMILAR MATERIAL, AND APPARATUS FOR CARRYING OUT SAID METHOD

Filed Oct. 28, 1926 3 Sheets-Sheet 1

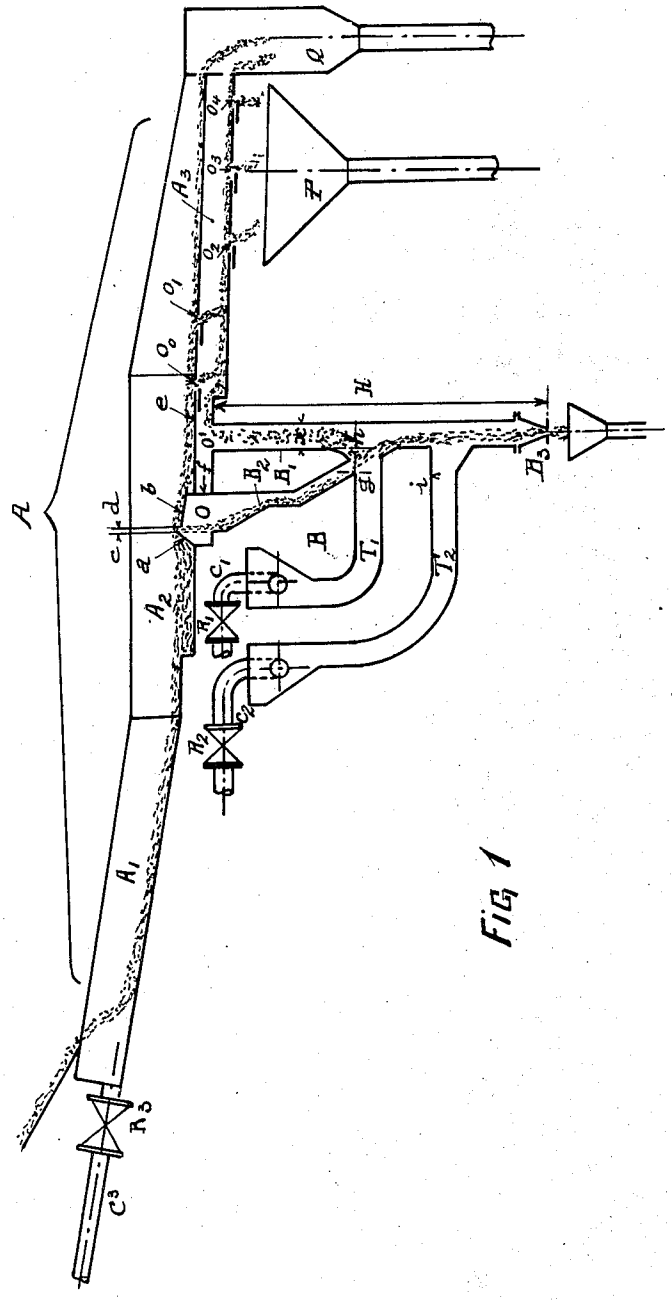


FIG 1

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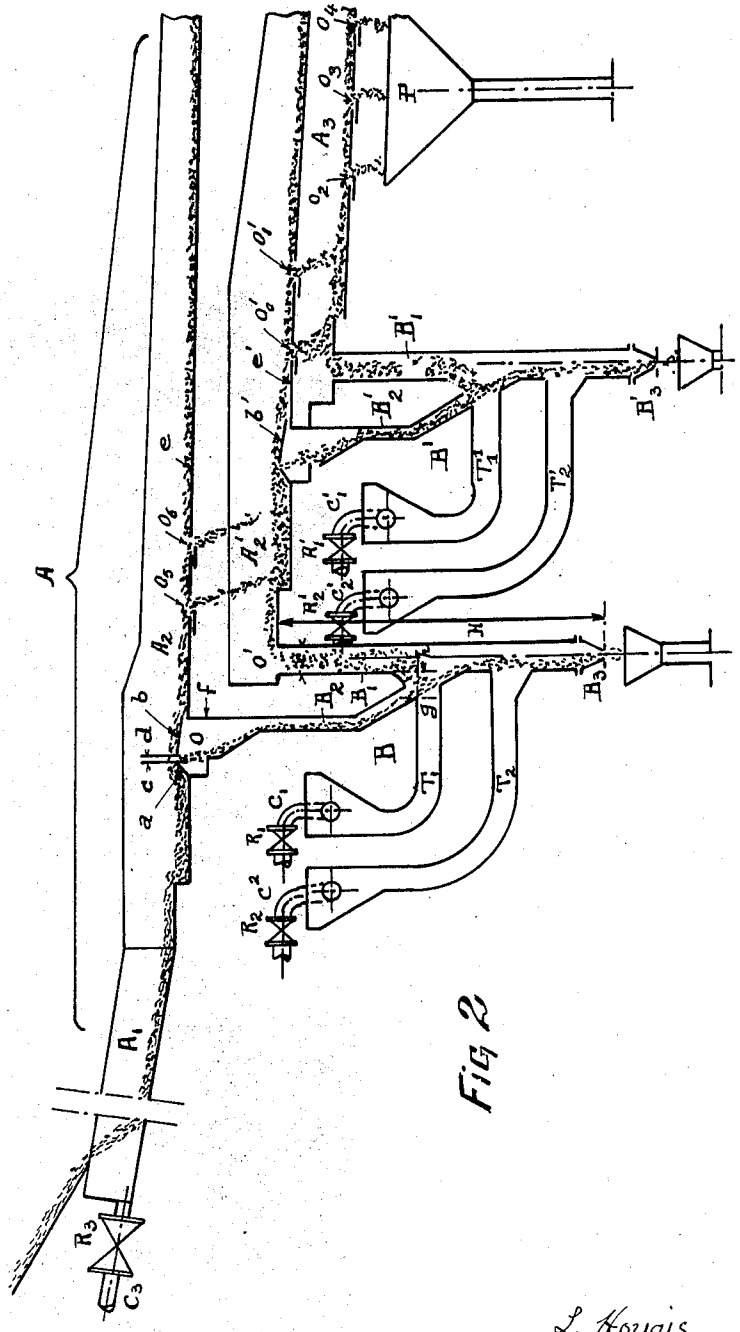


Fig 2

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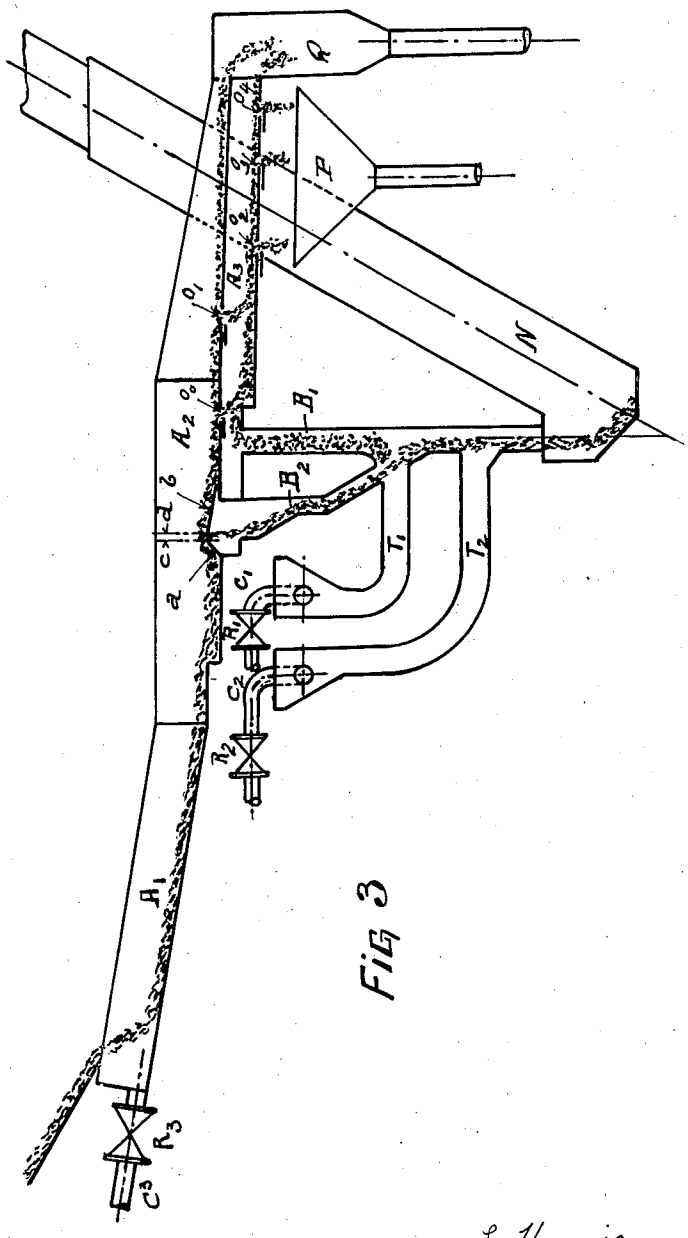


FIG 3

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Patented Feb. 16, 1932 1,845,602

UNITED STATES PATENT OFFICE

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METHOD FOR WASHING COAL, ORES, AND OTHER SIMILAR MATERIAL AND APPARATUS FOR CARRYING OUT SAID METHOD

Application filed October 28, 1926, Serial No. 144,833, and in Belgium November 9, 1925.

The present invention concerns the mechanical preparation of ores, coal and similar material, and has for object an improved method for washing such material as well as suitable apparatus for carrying said method into practice.

It is well known that particles of different densities carried along in a canal by a current of water, rapidly arrange themselves in the order of their densities, the most heavy particles occupying the bottom of the bed.

It is also well known that if the bottom of the canal, instead of being smooth, is rough and for example formed by a stationary bed of dense particles or grains, the velocity of the lower layer of the material carried along by the water will be greatly reduced on account of the obstruction caused by the roughness.

The velocity of the uppermost layers will increase in proportion as the surface is approached, because the elements of the different layers are less and less dense and also because the velocity of the bed upon which each layer moves increases progressively.

If a weir is placed at the end of the stationary bed, the elements composing the various layers will fall through parabolic paths more and more extended as the surface is approached, on account of the progressively increasing velocities of the successive layers and of the progressively decreasing densities of the elements of said layers.

From the above considerations it is obvious that a suitable device, properly located in the current, downstream from the weir, will enable the said current to be divided into parts each of which will mainly carry particles having densities coming within certain limits.

If each of the said parts is again treated by suitable means for eliminating the particles having densities greater or less than the given limits, an exact grading of the material will finally be obtained.

When the treated material is coal, or also ore, or the like, the division on the weir which seems to offer practically the most advantages is that separating the mass into two parts, one comprising most of the particles the densities of which are less than a given value and the other most of the particles the densities of which are greater than said value.

Accordingly, the washing method of the invention comprises the division into two parts, downstream from a weir, of the whole of the particles formed in a washing bed, as well as the subsequent operations of treating each of the two parts, such operations consisting in regrading the lighter part by separating the particles the density of which is greater than the given value, and in causing the heavy part to fall freely through a body of liquid in movement, the said movement being such that the particles the density of which is less than the limit will be carried along by the current, while the particles of greater density will continue their downward movement and finally be discharged.

When, supplementary to the well defined constituents, which in the case of coal are represented by the pure coal and by the shales, the material to be treated includes large quantities of intermediate or mixed products, the above described method may not conduct to sufficiently well sorted divisions and, in such a case, according to the invention, one or several parts formed by the denser portions of the first light part separated, and parts of lesser density separated from the first heavy part, are brought together so as to form a new washing bed which is again divided into two parts, light and heavy, and the latter are in turn treated in the same way as the fractions resulting from the initial division in the above explained method.

If the material to be treated is formed of particles which on account of their nature or for other reasons are very difficult to separate, it can conveniently be caused to pass through several successive series of operations such as those mentioned.

In addition to the described methods, the invention also comprises the appropriate apparatus hereafter more fully described with reference to the accompanying drawings, in which:

Fig. 1 is a general diagram of a plant or equipment suitable for carrying out the treatment of rough coal of average composition.

Fig. 2 is a general diagram of a plan or

equipment suitable for carrying out the treatment of coal containing a large proportion of intermediate products.

Fig. 3 is an alternative form of the arrangement shown in Fig. 1.

Referring first to Fig. 1 and to the first described method or process, in the part A of the arrangement, A_1 designates a suitably inclined trough used to bring the material to be treated into a trough A_2.

The trough A_2 which is horizontal and the width of which is proportioned to the quantity of material to be treated per hour, has two rectangular openings O, O′ extending the full width across its bottom. The dimension x of the opening O′ can be varied according to the size of the particles to be treated.

Two partitions a and b are placed above the opening O. The partition a is inclined and of fixed position, and acts as a weir for the current flowing into the trough A_1 and also as a dam so as to form, on the upstream side, a stationary bed of the material to be treated, over which the current flows. The partition b, which is also inclined, is movable and can be displaced horizontally and vertically so as to change as desired the opening $c\ d$ between the partition a and b, as well as the position of the movable crest d relative to the fixed crest c. This movable partition b is provided for dividing the stream flowing over the crest c of the weir a into two parts, which can be regulated as desired, namely, a lower part flowing towards the opening O, and an upper part which, caught on the partition b, is diverted onto a partition e extending over the full length of a trough A_3 so as to conduct the products to the end of said trough. The partition e is provided with a number of adjustable openings o_0, o_1, in order to enable a part of the diverted material to pass into the trough A_3. The latter is slightly inclined and provided with two or three openings o_2, o_3, o_4, which can be adjusted as desired.

The openings O and O′ are separated by a partition f and receiving hoppers P and Q complete this part of the arrangement.

The part designated by the letter B comprises two columns marked B_1 and B_2. The column B_1 which is vertical is connected to the trough A_2 at the opening O′, having the same cross section as the latter.

The column B_2 makes an angle of 30° with the column B_1. It is connected to the trough A_2 at the opening O and has a rectangular section, the width of which is approximately half that of the column B_1.

Two pipes T_1 and T_2 are connected to the columns B_1 and B_2, both of the said pipes being horizontal and having the same cross section as the column B_1. The pipe T_1 is connected to the column B_2 at such a point that the distance gh is equal to the dimensions x.

The pipe T_2 is connected to the column B_1 at such a point that the distance gi is equal to three times the dimension x.

The column B_1 terminates at the lower end in a nozzle B_3 the outlet opening of which is circular and closed according to the discharge per hour required from the apparatus and the dimensions of the particles of the material to be treated.

The pipes T_1 and T_2 are connected by separate pipes C_1, C_2, to a water tank kept at a constant level and fed by a pump, said tank and pump being not represented.

The said tank also communicates with the upper end of the trough A_1 through a third pipe C_3.

Valves R_1, R_2 and R_3 are provided for regulating the flow of water through each of the three pipes.

By means of the valve R_2 the flow into the pipe T_2 is adjusted so as to give in the column apparatus a water outflow of predetermined value through the nozzle B_3 while at the same time the columns B_1 and B_2 are kept full of liquid.

The flow into the pipe T_1 is adjusted at the valve R_1 so as to obtain an ascending current in the column B_1. The velocity of this ascending current is made such that from the products sloping down in the column B_2, only those the density of which is higher than the predetermined limit will fall towards the nozzle B_3, the products of which the densities are less than such limit being carried upward by the current towards the top of the column B_1.

The trough A_1 is applied through the valve R_3 with the water necessary for carrying the material to be treated which is delivered in any suitable way at the upper end of the said trough.

The column B_1 discharges at the top into the trough A_3 as above mentioned.

The various parts of the apparatus being constructed and combined as described, if the position of the diverting partition b is properly adjusted, the latter will separate out the products which are mostly composed of particles having a density less than a chosen density δ, whereas the products composed mostly of particles having a density greater than δ will fall through the opening c—d into the column B_2.

The light portion separated out by the diverting partition is received on the partition e where it forms a second washing bed, the most heavy particles of this portion—those having a density greater than a predetermined value δ^1—falling into the trough A_3 through the adjustable openings o_0 and o_1.

The material forming the dense portion separated out at the diverting partition and which falls freely through the body of liquid in the column B_2, spreads out in a layer on the inclined bottom of this column. As they leave the bottom of the column, the different

elements of the said layer encounter the current flowing from the conduit T_1 and are thus subjected to the physical laws affecting the motion of bodies falling freely through a current of water. By suitably regulating the velocity of the said current, the particles having a density greater than the predetermined value δ will continue to fall in a path deviated towards the column B_1, into which they will pass so as to be discharged through the nozzle B_3, whereas the elements the density of which is less than δ will be carried along by the current which curves progressively upward after passing the edge g so as to move vertically when entering the column B_1. These lighter products are discharged into the trough A_3.

In the trough A_3, the said products, together with those falling through the openings o_0, o_1, form a new washing bed. By suitably adjusting the openings o_2, o_3, o_4 the most heavy products can be removed from the said bed so that only those having a density less than a predetermined value δ^1 will be discharged at the ends of the trough.

It follows that the body of material delivered at the upper end of the trough A_1 will finally have been divided into different grades, namely: the products having a density greater than δ which are discharged through the nozzle B_3; the products having densities included between δ and δ^1 which are taken out at the openings o_2, o_3, o_4, and light products the densities of which are equal to or less than δ^1 and which are caught at the ends of the partition e and of the trough A_3.

In the case considered, in which coal of average composition is treated, the ash-forming shales are discharged at B_3, the pure coal caught in the hopper Q and the mixed products are taken out at the openings o_2, o_3, o_4.

If, in addition to the well defined products, the material to be treated includes a large proportion of intermediate products, for example if the material is coal which includes large quantities of mixed products in addition to the particles of pure coal and of ash-forming shales a modified method may be conveniently applied and carried out in an equipment such as that shown diagrammatically in Fig. 2.

In this case the arrangement comprises two equipments such as that shown in Fig. 1, disposed in series, that is to say, the products brought back to the top of the column B_1, as well as those falling through the openings o_5 and o_6, formed in the bottom of the trough A_2 beyond the diverting partition b, are reformed into a new washing bed in the trough A^1_2.

This second washing bed is in turn divided into two portions by means of a diverting partition b^1. The light portion, caught on a partition e^1, is composed of the particles denser than a given value, and the dense portion falls freely into a column B^1_2 so as to be subjected therein to the action of a current of water flowing from the conduit T^1_1. The separation is effected in the column B^1_1, the dense particles continuing to fall until discharged through the nozzle B^1_3, whereas the particles capable of being carried along by the said current are brought up to the top of the column so as to be caught in a trough A_3.

In the trough A_3 the said particles are added to those separated out, through the openings o_0 and o_1, from the current flowing on the partition e^1, and the whole forms a new washing bed from which the pieces of coal containing shale are separated through the adjustable openings o_2, o_3, o_4, while the particles of pure coal are discharged into the hopper Q at the end of the trough.

The columns B^1_1 and B^1_2 are supplied with water through the pipes T^1_1 and T^1_2 and C^1_1 and C^1_2, the flow being regulated by means of the valves R^1_1 and R^1_2 in a way similar to that herein before indicated.

If the material to be treated is composed of particles which are very difficult to separate on account of their nature or of their unlike shapes, three or more equipments such as A_2—B can be used in series. In this case, the nozzles B_3, B^1_3, B''_3 etc. will discharge the ash-forming products, the opening o_2, o_3, o_4, in the lower trough give the mixed products, and the pure coal leaves in $n+1$ separate layers, n being the number of equipments A_2—B put in series.

In the foregoing it has been assumed that the material treated was composed of particles of average size, which would enable the nozzles such as B_3 to be given dimensions which do not cause an excessive consumption of water.

If the treated particles are very large, a slightly modified arrangement such as that shown in Fig. 3 may conveniently be used, in order to reduce the water consumption. In this arrangement, the equipment shown in Fig. 1 is unchanged except for the nozzle B_3 which is replaced by a bucket elevator enclosed in a water tight casing N, or by an equivalent apparatus.

As already inferred, it is to be understood that the invention is not restricted to the methods and apparatus specially described and illustrated, but that it also covers their alternative forms and modifications.

I claim:

1. A method of washing coal, ores, and other similar materials, which method consists in causing the body or mass of raw material to flow as a movable washing bed upon a stationary washing bed whereby the grading of said body or mass in a set of superimposed layers is obtained; mechanically dividing and removing as a whole from the movable bed a set of the upper layers forming the light portion, allowing said portion to regrade itself while the dense particles

therefrom are mechanically separated and the remainder is directly eliminated; allowing, simultaneously to the removal of the upper layers, the whole of the lower layers forming the dense portion to freely fall into a liquid body; diverting into a separate ascending current the lighter particles from said dense portion while the remainder of said portion is directly eliminated, and causing said lighter particles of the dense portion to mix directly with the dense particles of the light portion, and to form therewith a distinct residual mass.

2. A method of washing coal and other similar materials, which method consists in causing the body or mass of raw material to flow as a movable washing bed upon a stationary washing bed formed upstream a weir whereby the grading of said body or mass in a set of superimposed layers is obtained, cutting on a plane the said set of superimposed layers so that the upper layers comprising all the coal particles and a part of the mixed particles are collected on and pass above the plane; allowing the collected portion to regrade itself while the dense particles therefrom are separated by gravity and the remainder is directly eliminated; allowing simultaneously to the removal of the upper layers, the whole of the lower layers forming the dense portion and comprising substantially all the shales and the remainder of the mixed particles to pass below the plane and to freely fall into a liquid body, diverting into a separate ascending current the lighter particles from said dense portion while the remainder of said portion is directly eliminated; and causing said lighter particles of the dense portion to mix directly they are separated with the whole of the dense particles of the light portion.

3. A method of washing coal, ores and other similar materials, which method consists in causing the grading of the body or mass of the raw material into a set of superimposed layers of decreasing densities; removing by a diverting partition the whole of the upper layers forming a light portion; allowing for the regrading of said portion while the densest particles therefrom are separated and the remainder is directly eliminated; causing the remainder lower layers to freely fall as a whole into a liquid body in motion to submit same to the action of a horizontal liquid current; separating out the lighter particles and directing said lighter particles into a separate ascending current meeting subsequently the dense particles separated from the lighter portion.

4. A method of washing coal, ores and other similar materials, which method consists in causing the grading of the body or mass of the raw material into superimposed layers of decreasing densities; removing by a diverting partition the set of the upper layers forming the light portion; allowing for the regrading in a trough of the said portion while the densest particles therefrom are separated out and the remainder is eliminated; separating by said diverting partition the remaining lower layers and causing same to freely fall into a liquid body in motion; submitting the descending body of said lower layers to the action of a horizontal liquid current adapted to separate the lighter particles while the remaining particles are directly eliminated; leading the said lighter particles into a separate ascending current, and mixing directly the densest particles of the light portion and the lighter particles from the dense portion into a new washing bed.

5. A method of washing coal, ores, and other similar materials, which consists in causing the grading of the body or mass of the raw material into superimposed layers of decreasing densities; removing by a diverting partition the set of the upper layers forming the light portion; allowing for the regrading in a trough of the said portion while the densest particles therefrom are separated out and the remainder is eliminated; separating by said diverting partition the remaining lower layers and causing same to freely fall into a liquid body in motion; submitting the descending body of said lower layers to the action of a horizontal liquid current adapted to separate the lighter particles while the remaining particles are directly eliminated; leading said separated lighter particles into a separate ascending current; mixing directly said current and the densest particles of the light portion to form a new washing bed; regrading the particles of said bed and separating out successively the different grades of particles of said bed.

6. A method of washing coal, ores and other similar materials, which method consists in causing the grading of a body or mass composed of particles of different grades into superimposed layers of decreasing densities; removing by a diverting partition the set of the upper layers forming the light portion; allowing for the regrading of the said portion while the densest particles therefrom are caused to separate and the remaining particles are directly eliminated; causing, simultaneously to the separation of the upper layers, the lower layers to freely fall into a liquid body in motion; submitting the descending body of said lower layers to the action of a horizontal liquid current adapted to separate the lighter particles while the remaining particles are directly eliminated; leading said separated lighter particles into a separate ascending current; mixing directly said current and the densest particles of the light portion to form a new washing bed; regrading the particles of said bed and successively separating out therefrom the different densest grades of par-

ticles while the remainder is mixed with the lighter products.

7. Apparatus for carrying out the method of washing coal, ores or similar material, comprising a trough allowing for the formation of a washing bed of superimposed layers of the material to be treated, a weir and a diverting partition at the end of this trough, an inclined chute beneath the diverting partition, said chute communicating at its base with a substantially vertical and distinct column provided with an adjustable discharge opening and enclosing an ascending current of liquid; a substantially horizontal conduit enclosing a liquid current entering the chute near the meeting point with the vertical column; a substantially horizontal conduit enclosing a liquid current meeting the vertical column below the first named horizontal conduit; a substantially horizontal trough following the diverting partition and adjustable openings in the bottom of said trough; a trough disposed at the top of the vertical column and adapted to receive the products discharged therefrom; means in said latter trough allowing for the formation of a washing bed; means in said latter trough to allow for the separation of predetermined grades of products; means for supplying liquid to the troughs and the conduits and means to collect the separated products.

8. In an apparatus according to claim 7, means adapted to keep the inclined chute and the vertical column statically full of liquid.

9. In an apparatus according to claim 7, means adapted to maintain in the vertical column an ascending liquid current of a predetermined velocity.

In testimony whereof I affix my signature.

LÉON HOYOIS.