Nov. 16, 1954 E. HARVENGT 2,694,490

METHOD AND APPARATUS FOR HYDRAULICALLY CLASSIFYING COAL OF VERY SMALL SIZES

Filed Nov. 7, 1950 10 Sheets-Sheet 1

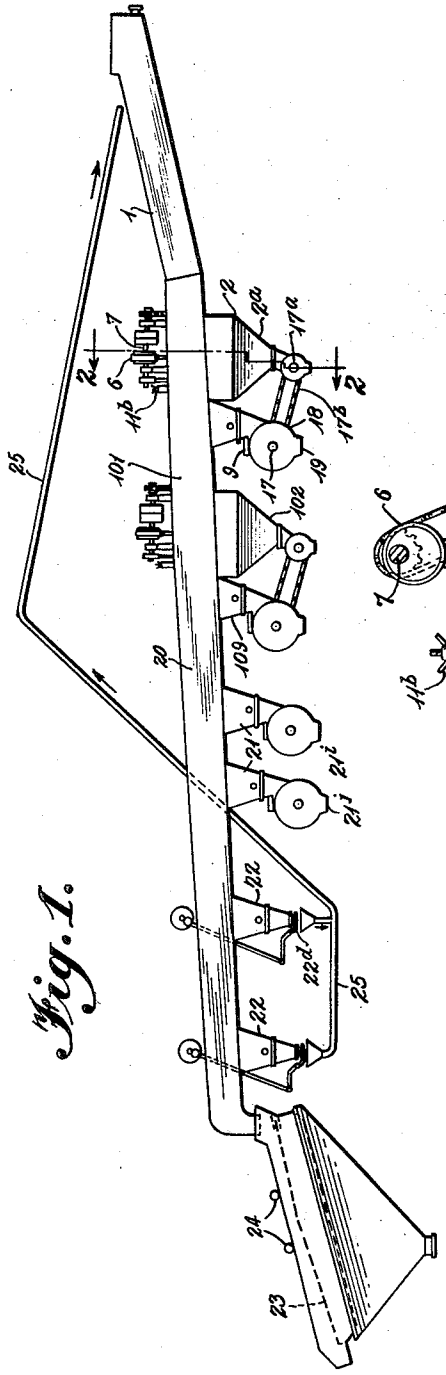


Fig. 1.

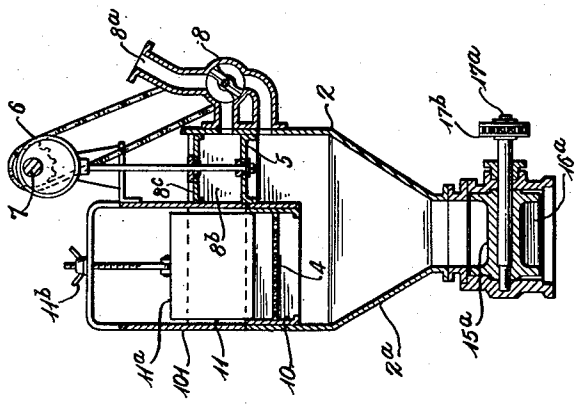


Fig. 2.

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Nov. 16, 1954 E. HARVENGT 2,694,490

METHOD AND APPARATUS FOR HYDRAULICALLY CLASSIFYING COAL OF VERY SMALL SIZES

Filed Nov. 7, 1950 10 Sheets-Sheet 2

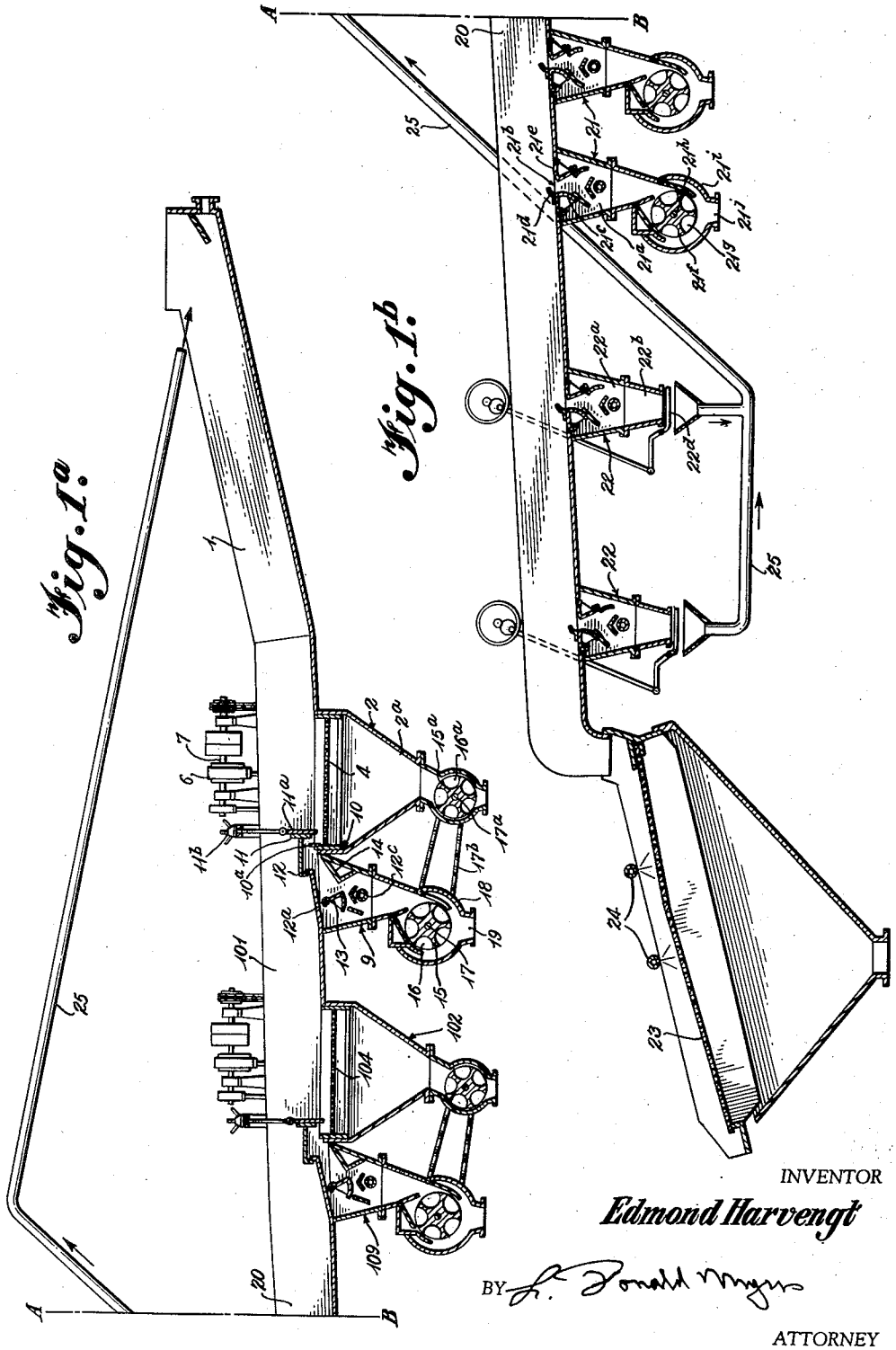


Fig. 1a

Fig. 1b

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Nov. 16, 1954 E. HARVENGT 2,694,490

METHOD AND APPARATUS FOR HYDRAULICALLY CLASSIFYING COAL OF VERY SMALL SIZES

Filed Nov. 7, 1950 10 Sheets-Sheet 3

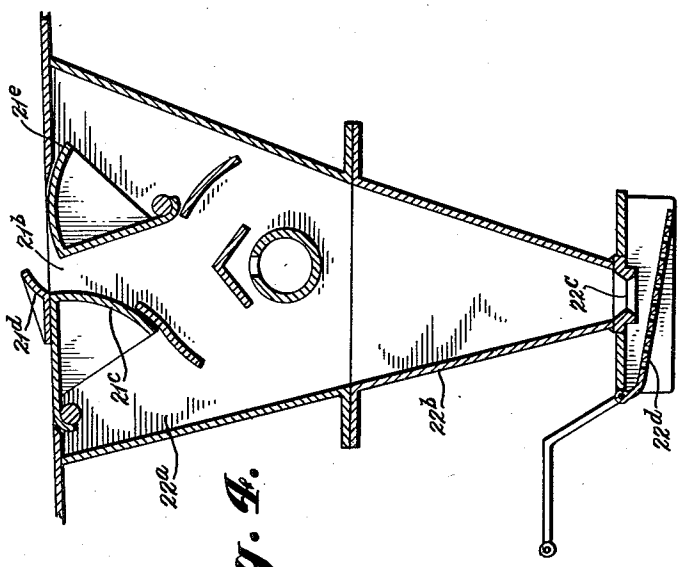


Fig. 4.

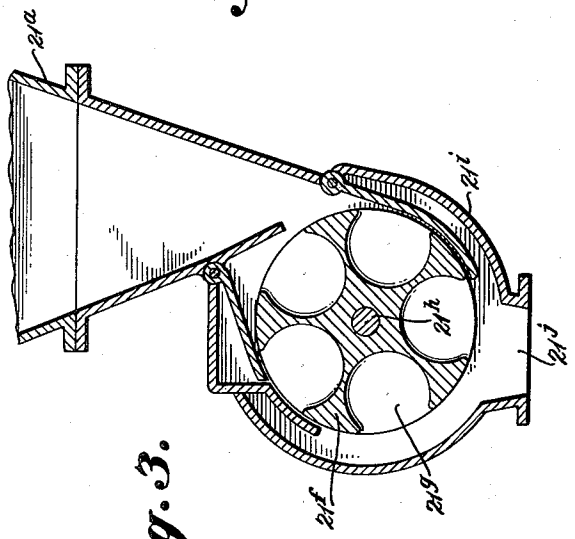


Fig. 3.

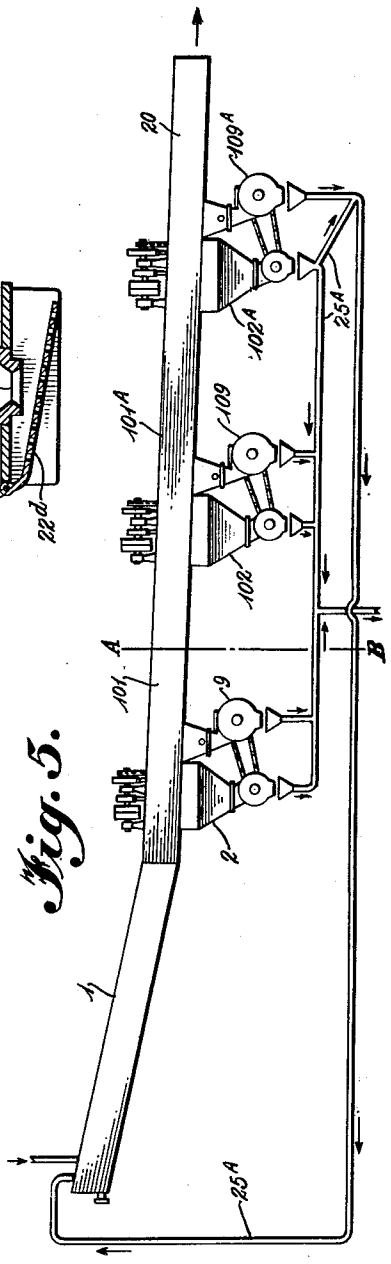


Fig. 5.

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Nov. 16, 1954 E. HARVENGT 2,694,490

METHOD AND APPARATUS FOR HYDRAULICALLY CLASSIFYING COAL OF VERY SMALL SIZES

Filed Nov. 7, 1950 10 Sheets-Sheet 4

Fig. 5a.

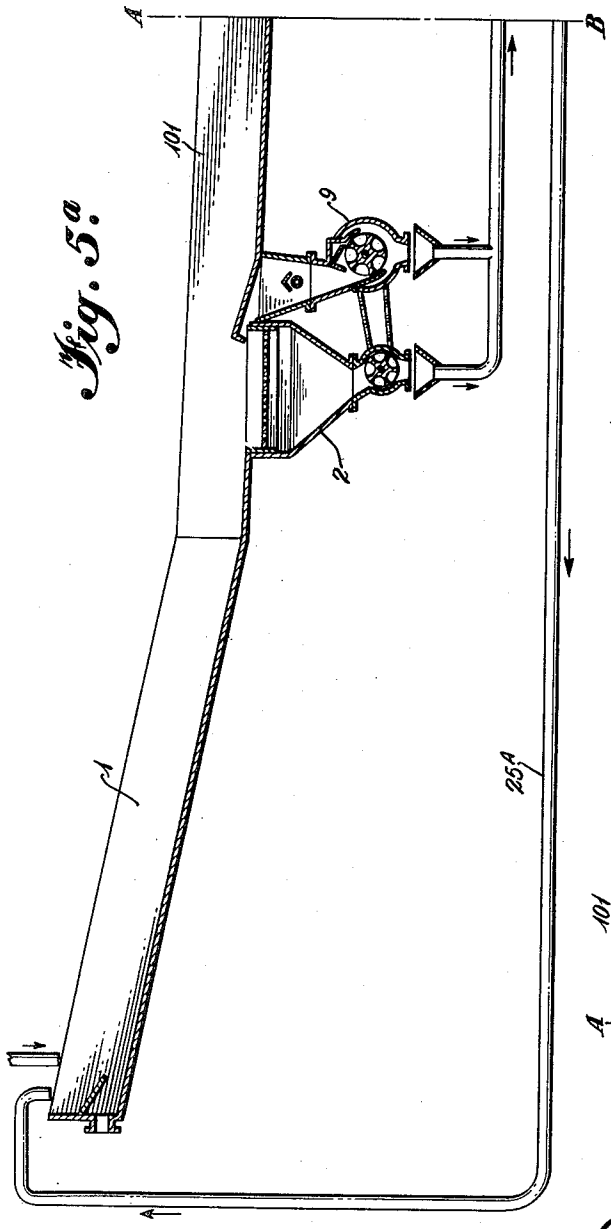
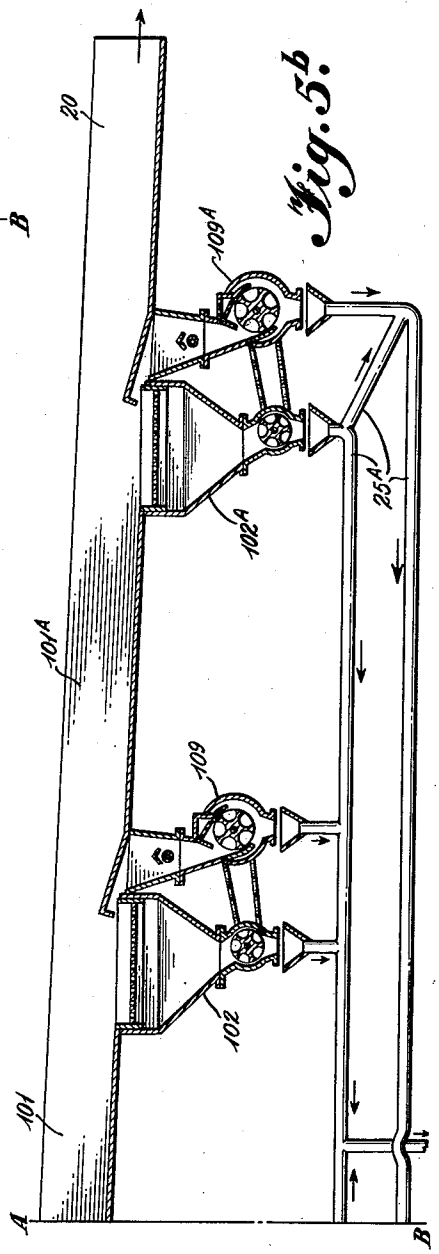


Fig. 5b.



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Nov. 16, 1954 E. HARVENGT 2,694,490

METHOD AND APPARATUS FOR HYDRAULICALLY CLASSIFYING COAL OF VERY SMALL SIZES

Filed Nov. 7, 1950 10 Sheets-Sheet 5

Fig. 6.

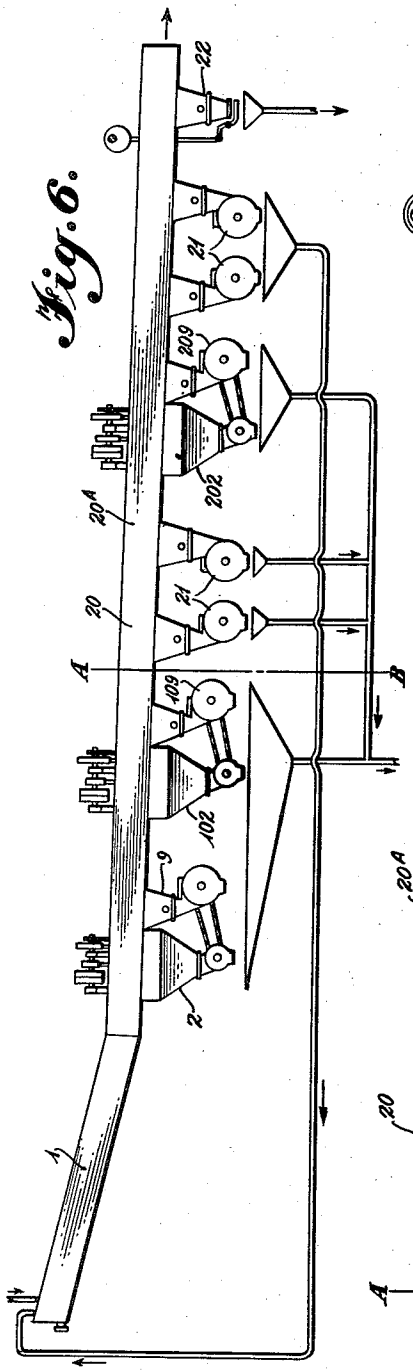
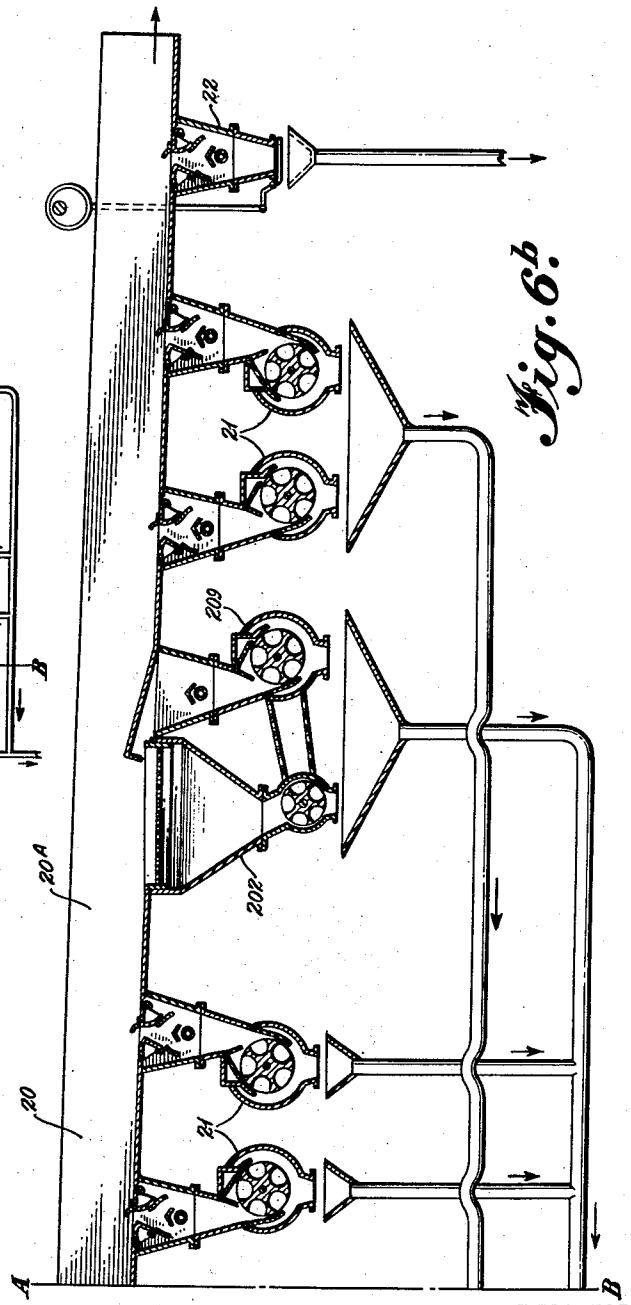


Fig. 6b.



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Nov. 16, 1954 E. HARVENGT 2,694,490

METHOD AND APPARATUS FOR HYDRAULICALLY CLASSIFYING COAL OF VERY SMALL SIZES

Filed Nov. 7, 1950 10 Sheets-Sheet 6

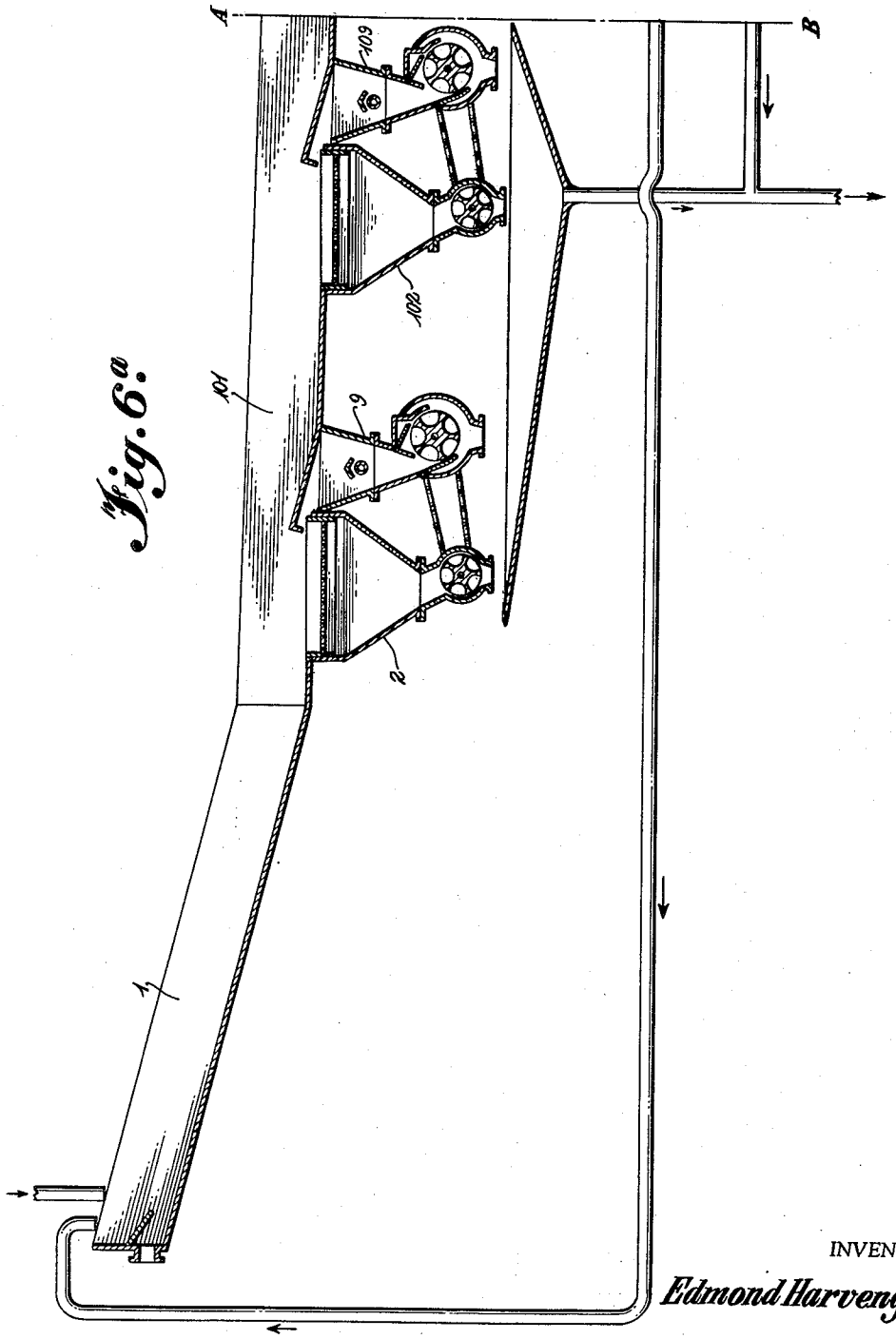


Fig. 6a

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Nov. 16, 1954 E. HARVENGT 2,694,490

METHOD AND APPARATUS FOR HYDRAULICALLY CLASSIFYING COAL OF VERY SMALL SIZES

Filed Nov. 7, 1950 10 Sheets-Sheet 7

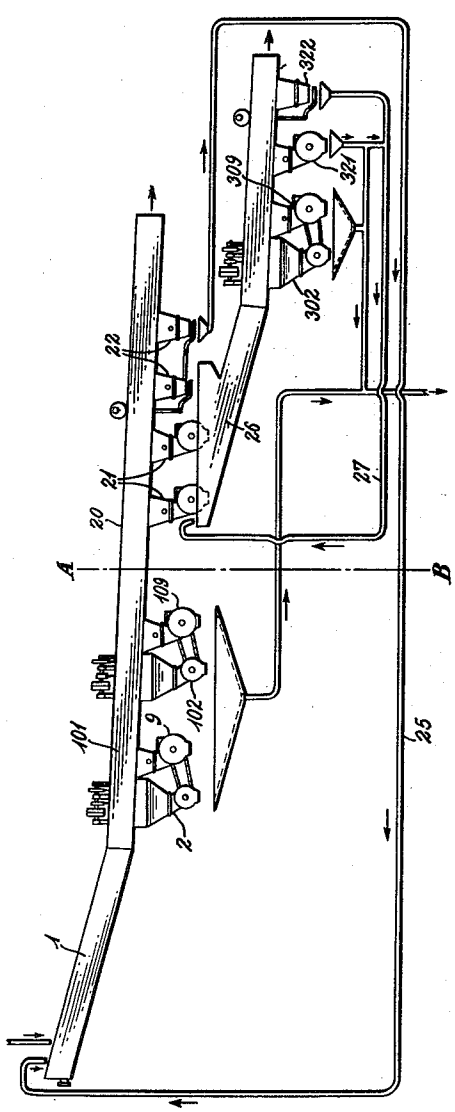


Fig. 7.

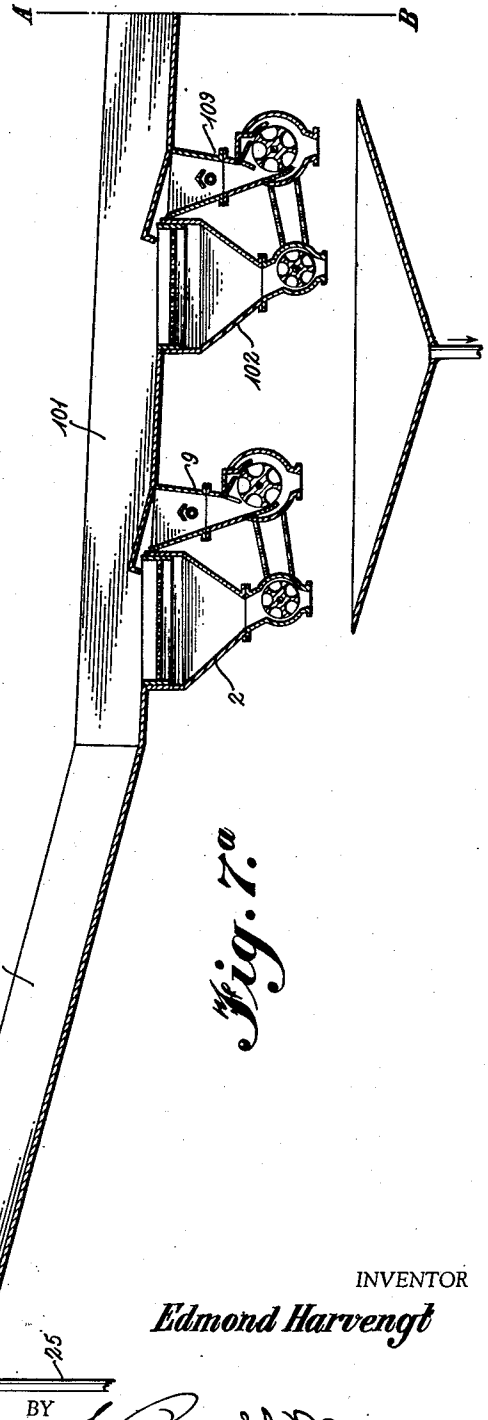


Fig. 7a.

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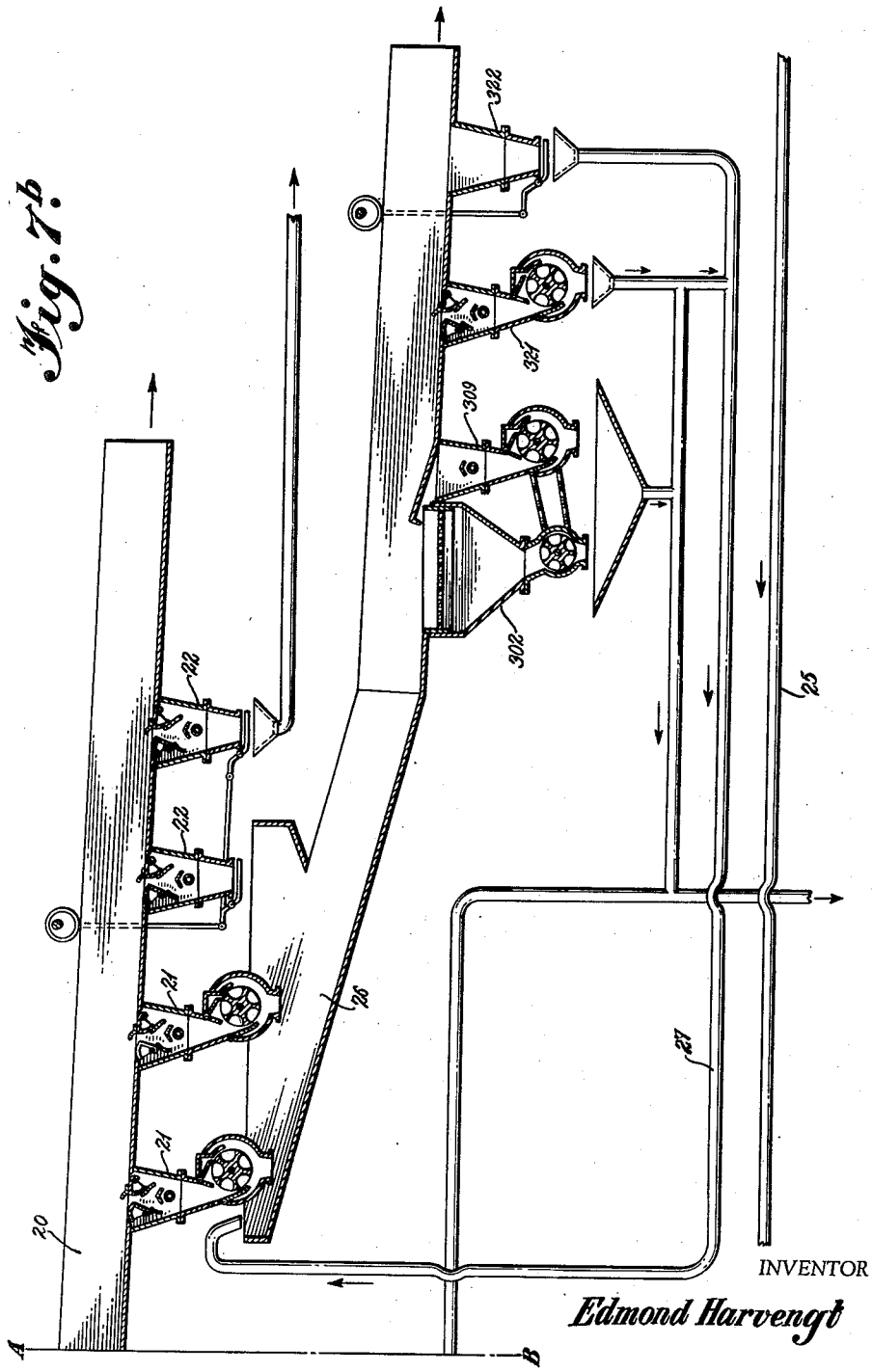
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Nov. 16, 1954 E. HARVENGT 2,694,490

METHOD AND APPARATUS FOR HYDRAULICALLY CLASSIFYING COAL OF VERY SMALL SIZES

Filed Nov. 7, 1950 10 Sheets-Sheet 8

Fig. 7b.



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Nov. 16, 1954 E. HARVENGT 2,694,490

METHOD AND APPARATUS FOR HYDRAULICALLY CLASSIFYING COAL OF VERY SMALL SIZES

Filed Nov. 7, 1950 10 Sheets-Sheet 9

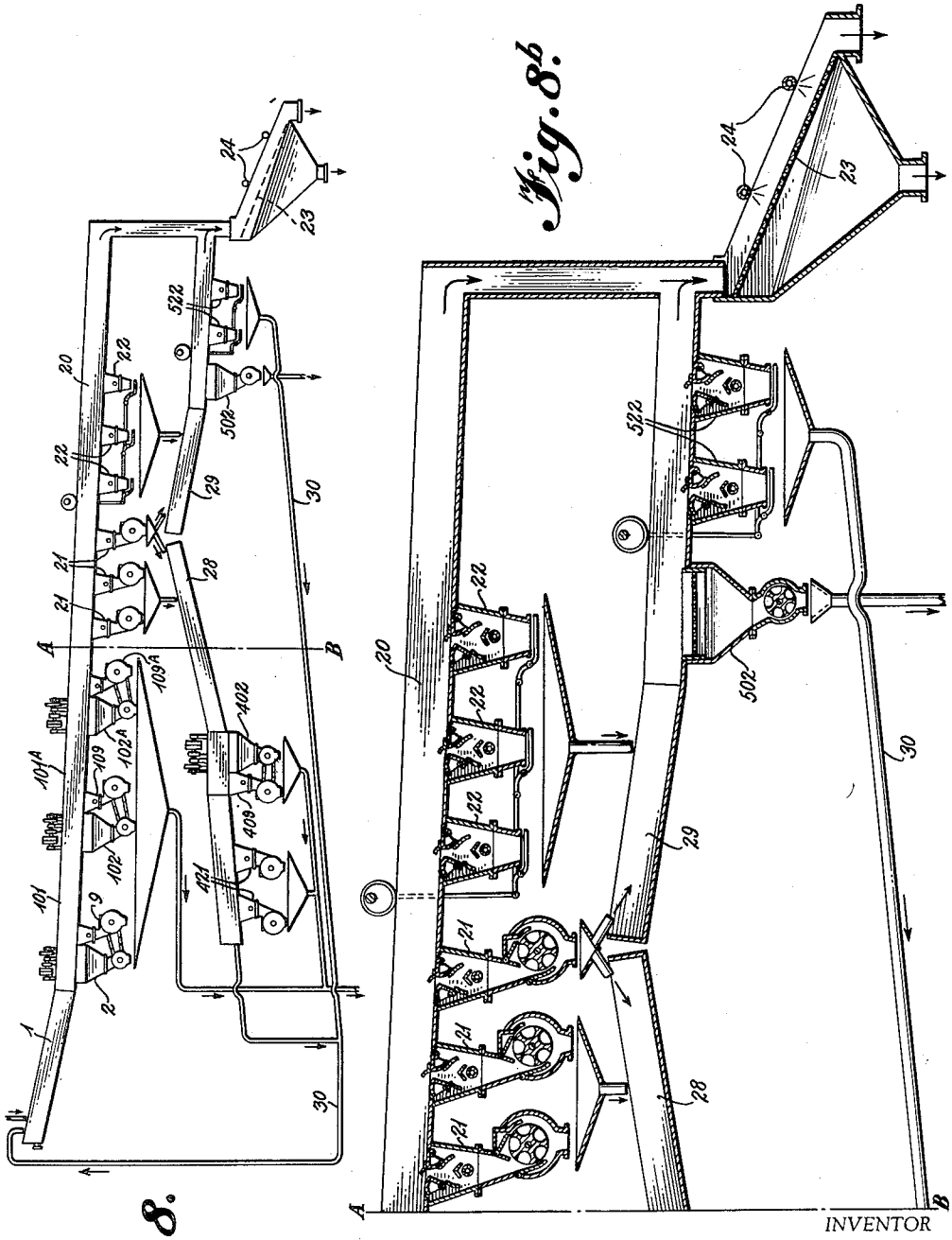


Fig. 8b.

Fig. 8.

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Nov. 16, 1954 E. HARVENGT 2,694,490

METHOD AND APPARATUS FOR HYDRAULICALLY CLASSIFYING COAL OF VERY SMALL SIZES

Filed Nov. 7, 1950 10 Sheets-Sheet 10

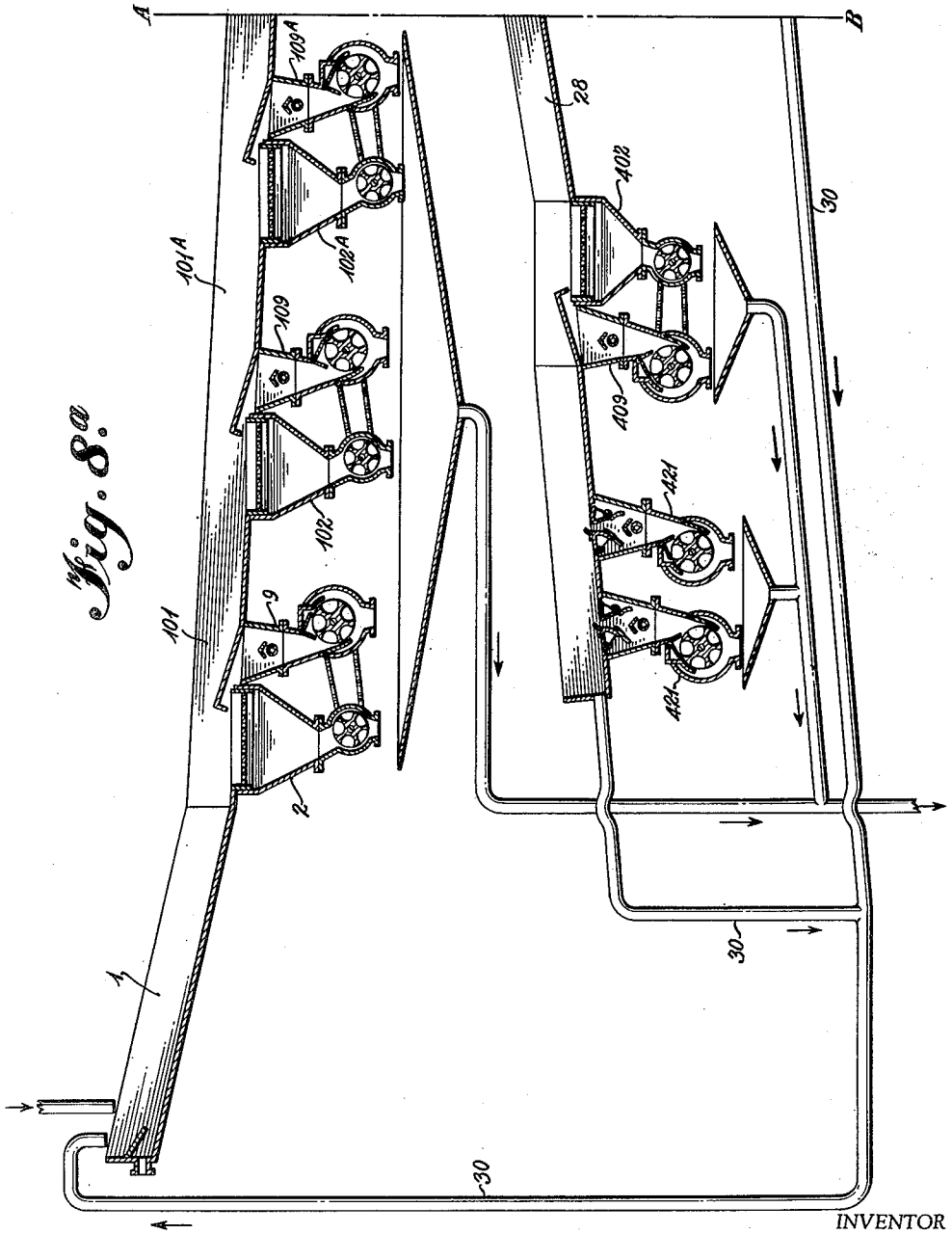


Fig. 8a

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United States Patent Office 2,694,490 Patented Nov. 16, 1954

2,694,490

METHOD AND APPARATUS FOR HYDRAULICALLY CLASSIFYING COAL OF VERY SMALL SIZES

Edmond Harvengt, Moustier-sur-Sambre, Belgium, assignor to Link-Belt Company, Chicago, Ill., a corporation of Illinois

Application November 7, 1950, Serial No. 194,449

12 Claims. (Cl. 209—18)

The invention relates to the treatment of coals of very small sizes, and particularly concerns the treatment of such coals which are not, or are imperfectly, dustfreed only when they contain considerable quantities of fine heavy particles. A known economical method of treatment of such coals comprises subjecting the same to a dry dust freeing operation wherein, in order to separate most of the fine heavy particles, the major portion of the fine particles is extracted from the coals, and the remainder is subjected to a complementary, preferably wet, treatment in order to separate out the remaining heavy particles and to divide the other particles into categories of products.

The present tendency in mining results in coals having a substantial moisture content such that the dry dust freeing operation cannot longer be directly applied or will lose its efficiency to such an extent that the subsequent treatment leads to commercially nonusable products.

The problem is thus to treat directly, and in a simple and economical manner, the coals of very small sizes in a more or less wet state, and usually in considerable quantities, having regard to the fact that in the usual washing processes in troughs, fine heavy particles are found in substantially all of the portions of the washing bed and cannot be removed therefrom except with difficulty.

The purpose of the invention is mainly to resolve the aforesaid problem.

According to the invention, the coals of very small sizes which are not, or are imperfectly, freed from dust, which have a high content in fine heavy particles, and which additionally may be comparatively wet, are subjected in troughs provided with a liquid current first to a grading by density and thereafter to the action of liquid pulses without noticeable suction effect, together with a removal of the fine heavy particles which have reached the bottom of the bed, so that the bed remaining after this removal may be divided into its various categories of products.

In accordance with another feature of the invention, especially when considerable quantities of materials are to be treated and/or the content in fine heavy particles of these materials is comparatively high, subsequent to the grading by density and the removal of the fine heavy particles which have reached the bottom of the bed as specified above, there is separated from the residual bed a fraction thereof comprising the lower component layers. This fraction is carried away or preferably subjected again to a grading by density followed by the removal of fine heavy particles as hereabove outlined. The upper remaining layers of the said residual bed are divided into categories, or subjected to a grading operation that is followed by the removal of fine heavy particles. The ultimate residual bed is finally divided into categories of products.

In accordance with an alternate to the above outlined method, following the first grading by density and the first removal of heavy fine particles, there are separated in succession from the residual bed several fractions of the said bed, each being formed of the lower component layers, and each such fraction is subjected to a grading by density followed by the removal of fine heavy particles. The residual beds of these various treatments are then divided into categories of products.

In each of the above cases, the middlings may be rewashed if desired and to accomplish this, they are reintroduced in to the process, preferably by being returned to the head thereof.

For carrying the invention into practice use is made of plants comprising washing troughs, and jigs working in direct combination, with the jigs being provided with means for balancing entirely or to any desired extent the suction effect therein order to enable the fine heavy particles to percolate through the bed to the lower portion thereof, as well as extracting apparatus operating at full level and adapted to separate fractions formed of the lower layers of the bed without noticeable disturbance of the said bed.

In order that the invention may be well understood, certain preferred embodiments thereof will now be described jointly with certain plants adapted for carrying the invention into practice, which plants are illustrated, by way of example only, in the accompanying drawings, in which:

Figure 1 is a side elevational view of one plant embodying the invention,

Figure 2 is a vertical sectional view taken on line 2—2 of Fig. 1,

Figures 1*a* and 1*b* collectively provided a longitudinal, vertical sectional view, on an enlarged scale, of the plant of Fig. 1,

Figures 3 and 4 are detail, vertical sectional views of extractors that are included in the plant of Fig. 1,

Figure 5 is a side elevational view of a modified form of plant embodying the invention,

Figures 5*a* and 5*b* collectively provide a longitudinal, vertical sectional view, on an enlarged scale, of the plant of Fig. 5,

Figure 6 is a side elevational view of a further modified form of plant embodying the invention,

Figures 6*a* and 6*b* collectively provide a longitudinal, vertical sectional view, on an enlarged scale, of the plant of Fig. 6.

Figure 7 is a side elevational view of a still further modified form of plant embodying the invention,

Figures 7*a* and 7*b* collectively provide a longitudinal, vertical sectional view, on an enlarged scale, of the plant of Fig. 7,

Figure 8 is a side elevational view of another modified form of plant embodying the invention, and

Figures 8*a* and 8*b* collectively provide a longitudinal, vertical sectional view, on an enlarged scale, of the plant of Fig. 8.

Referring to the drawings, and first to Figs. 1 to 4, **1** designates a washing, or alluviation trough, of appropriate slope and provided with a liquid current, and **2***a* designates the bin of the jg **2**, provided with a sieve **4** and liquid impulses, for example, generated by a piston **5** reciprocated by means of an eccentric gear **6** mounted on a rotating shaft **7** actuated by a power system not illustrated.

Means are provided for balancing to any desired extent the suction effect resulting from the nonworking strokes of the piston **5**, fo r example, a rotary valve liquid feeding mechanism **8** actuated by the drive for the piston **5**, the arrangement being such that the liquid from a pipe **8***a* is introduced into the chamber **8***b* above the piston **5** during the working or descending strokes of said piston, and forced into the bin **2***a* below the piston **5** during the ascending or non-working strokes of the piston. An auxiliary piston **8***c* may be provided for controlling the capactiy of the chamber **8***b* and thus adjusting the amount of balance of the suction effect. Although the described apparatus is preferred, other balancing arrangements could be adopted.

At the outlet end **10** of the sieve **4** there is provided an adjustable weir **10***a* and above the sieve is arranged a cross partition **11** having an external extension **12** arranged as an overhanging shelf.

Associated with the partition **11** is a slide valve **11***a* provided with a device for adjusting the depth thereof, for example a screw drive generally indicated **11***b*. With the outlet end **10** is preferably combined a full level operated extractor **9** including a chamber **12***a* provided towards the end thereof with a balanced shutter **13** so arranged that the chamber **12***a* is normally closed and is opened only when the shutter yields under the pressure of the materials that have accumulated therein. The yieldable shutter provides an open slot for the materials between its

own edge and the wall **14** of the chamber **12***a*, said slot being automatically closed when the pressure of the materials on the shutter decreases.

An adjustable liquid supply adapted to form an ascending current through the discharge slot may be provided as at **12***c*.

Continuous discharge means arranged at the bottom of the extractor **9** comprises a drum **15** having pockets **16** and mounted on a shaft **17** rotating within a casing **18** provided with a discharge opening **19**, the shaft **17** being moved by a suitable drive, not shown.

The materials discharged from the chamber **12***a* are received within the pockets **16** of the drum **15** and in turn are discharged through the opening **19** as the drum rotates.

On the other hand, in the lower part of the bin **2***a* is arranged a discharge device, preferably operating in a continuous manner, and which may be formed with advantage of a rotating drum **15***a* having pockets **16***a* and mounted on a shaft **17***a* rotated in any convenient manner as by means of a transmission gear **17***b* from the driven shaft **17** of the drum **15**.

The described arrangements are not limitative and apparatus of different kinds could be used provided they operate at full level, that is without causing substantial disturbance of the bed in the trough.

Following the jig **2** and extractor **9** there is provided a washing trough section **101**, and with this section is preferably associated a jig **102**, which is constructed similarly to the described apparatus **2**, and an extractor **109** constructed in a manner generally similar to the apparatus **9** already described.

Following the apparatus **102** and **109** there is a trough section **20** and at a suitable location in this section there are arranged one and preferably two extractors **21** working at full level and which, with advantage, are of the pocket type.

Such an extracting apparatus comprises, as illustrated in part in Fig. 3, a hopper **21***a* in communication with the trough through a transverse slot **21***b*, this slot being provided with two movable and adjustable shutters of which the one **21***c* is provided with a nose **21***d* forming a protrusion above the bottom of the trough while the other **21***e* is adapted to move in the plane of the slot in order to increase or decrease the width thereof. Within the hopper **21***a* is arranged an adjustable liquid supply producing through the slot **21***b* an adjustable ascending current in the direction of the trough. At the bottom of the hopper is connected an evacuating apparatus comprising a drum **21***f* having pockets **21***g* and mounted on the shaft **21***h* supported for rotation in a casing **21***i* surrounding the drum and provided with a discharge opening **21***j*.

The shaft **21***h* is actuated at a suitable speed by means of a drive, not shown, so as to evacuate through the discharge **21***j* the materials passing through the adjusted slot **21***b* and filling the pockets **21***g*. Moreover, following the extractor or extractors **21**, there is mounted in the trough section **20** one or two extractors or evacuating apparatus **22** working at full level and which may be extractors of the pocket type such as the extractors **21**, but which, owing to the usually reduced quantities of materials yet to be evacuated at this stage of the treatment, may be evacuators of the flap type, preferably as described in the Belgian Patent No. 455,896, dated May 26, 1944. One embodiment of such an apparatus is illustrated in Fig. 4 and comprises a hopper **22***a* communicating with the trough through a transverse slot **21***b* provided with two movable and adjustable shutters **21***c* and **21***e*, the hopper being provided with an adjustable liquid supply forming an adjustable ascending current through the slot. The hopper is extended downwardly by a chamber **22***b* preferably of conical or pyramidal shape provided with a lower opening **22***c* the size of which is in any case sufficient to enable the unrestricted passage therethrough of the largest particles to be evacuated, while it is provided at its bottom end with a supporting member or plate **22***d* which may be perforated and which is adjustable relative to the opening.

If desired, at the end of the trough section **20** may be mounted a sloping sieve **23** equipped with spraying means **24** and adapted to receive the discharge of the trough.

Finally, known means indicated at **25** may be provided for periodically returning, particular to the head of the trough section **1**, the products collected at the discharges of the extractors **22**.

In a plant arranged as just described, the treatment of the wet small sized coals not, or imperfectly only, freed from dust and of high content in fine heavy particles, is performed as follows.

The coals supplied at the head of the trough section **1** grade themselves by density therein, the fine heavy particles tending to reach the bottom of the bed together with the heavy coarse or schist particles, and the thus graded bed reaches the first group of jig and extracting apparatus **2** and **9**, respectively. The mesh size of the sieve **4** is chosen to enable the fine heavy particles to pass therethrough. Owing to the liquid impulses with no suction effect that are communicated to the materials on the sieve, the washing bed is opened up without being materially disturbed, thus permitting the fine heavy particles already occupying the bottom of the bed to pass through the sieve while those yet retained in the higher layers of the bed may be accelerated in their descending movement so as to finally reach the sieve and pass therethrough. These fine heavy particles are connected in the bin **2***a* and are discharged by the pocketed drum **15***a*. The heavy coarse or schist particles are retained on the sieve and pass at the outlet end thereof into the chamber **12***a* where they accumulate until the quantity thereof is sufficient to cause the yielding of the shutter **13**. The heavy coarse particles then pass into the pockets of the drum **15** which carry them towards the discharge **19**.

The remainder of the bed passes over the weir formed by the partition **11** and the adjusted sliding valve **11***a* and reaches the section of the alluviation trough **101** where a regrading takes place with passage of the residual heavy particles as well as the residual heavy coarse particles to the bottom of the bed. When this regraded bed reaches the jig **102** and the extractor **109**, the heavy fine particles are eliminated through the sieve **104** and the pocketed drum of the apparatus **102**, and the coarse particles retained on the sieve are evacuated by the pocketed drum of the apparatus **109** in accordance with the process above outlined.

The bed of materials that reaches the trough section **20** contains substantially no heavy fine particles. It can then be divided into categories of products, with the small quantity of schists yet contained therein being caught and eliminated at the extractor or extractors **21** together with such portion of the mixed schists that it may be desirable to eliminate. The middlings are collected at the extractor or extractors **22** and the clean coals are collected either at the end of the section **20** or at the end of the sloping sieve **23** after being subjected to a sprinkling operation which is intended to free the clean coals of any adhering minute particles, such as argillaceous particles.

According to the intended use for the middlings they are collected at the extractor or extractors **22**, or are cyclically returned to the process, as along the path **25**, to the head of the trough section **1**.

Experiments have shown that while treating a raw coal 0–6 mm. not freed from dust and showing an ash content of 38.88%, while containing 38.4% of particles smaller than 1 mm., with sieves of 2 mm. mesh size, subsequently to the elimination of the fine heavy particles, coals are obtained showing 12.58% of ash content while the products discharged at the apparatus **2** and **102** showed 82.40% and 74.50% of ash content respectively, and the products discharged at the apparatus **9** and **109** showed 76.05 and 79.50% of ash content, respectively.

The exemplative plant described with reference to Figs. 1 to 4 is related with applications wherein, owing to the composition of the starting materials, and after removal of the fine heavy particles, it may be desirable to divide the residual bed into various categories of products. One such case, for example, will be that of the treatment of a raw coal. However, the division of the residual bed will not always be necessary and in certain cases, as when the starting materials are formed of a mixture of fine particles, it may be sufficient to eliminate the fine heavy particles from said starting materials to form therewith a valuable or at least saleable product.

Figs. 5, 5*a* and 5*b* show a plant which may be used for this purpose. In this plant may be found the trough **1** and the jig **2** and extractor **9**, as well as the trough section **101** and the jig **102** and extractor **109** of Fig. 1, the discharges of the apparatus **2**, **9**, and **102**, **109** being considered as true schists. The materials remaining in the trough beyond the extractor **109** may form the final

cleaned or improved product, but to secure a more perfect cleaning or a materially enhanced improvement of this product, the apparatus 109 is followed by a trough section 101A in which is arranged a jig 102A and an extractor 109A both similar to the apparatus 2 and 9, or 102 and 109 respectively. Then according to whether the starting materials do or do not include a large proportion of fine heavy particles, the discharge of the jig 102A will contain only a small proportion of these fine heavy particles together with middlings from which it may be desirable to extract the values, or such a proportion of fine heavy particles that it must be considered as a residue. In the former case said discharge is subjected to a so called rewashing, for example by returning same to the head of the trough 1 as indicated at 25A; while in the second case said discharge is mixed with those of the apparatus 2 and 9, and 102 and 109, that is with the true schists.

In both cases, the discharge of the apparatus 109A will usually form a product having a substantial proportion of valuable particles which is preferably rewashed, for example by returning it to the head of the trough 1 as indicated at 25A. The cleaned and improved product is collected at the end of the section 20 of the washing trough.

When for a given trough section the quantities to be treated increase, the depth of the bed increases and the fine heavy particles contained in the central and upper layers of the washing bed normally tend to remain therein. Owing to the pulsations without suction effect imparted to the bed while it is passed over the sieves of the jigs such as 2 and 102, the composition of these central and upper layers is very materially improved at the expense of that of the lower layers, without however, all of the fine heavy particles having reached the bottom of the bed so that they should be eliminated while the materials pass over the aforesaid sieves.

In such a case, in accordance with the invention, a more or less considerable part of the lower portion of the bed is then separated, the separated fraction being, as the case may be, considered as a residue or retreated for the extraction of the values therein. Owing to this separation a double result is immediately secured, i. e.: first, of considerably reducing the volume of the bed containing the valuable products so that its subsequent cleaning treatment and its separation into categories of products is greatly facilitated and, second, to enable the fine heavy particles yet contained in the central and upper layers of the bed to be freed therefrom in an easier manner and to reach the bottom of the bed in order to be eliminated.

Figs. 6, 6*a* and 6*b* show a plant generally similar to that of Fig. 1, but completed so as to enable the process just described to be performed. In this figure, and within the section 20 of the washing trough, and following the two extractors 21 and a regrading section trough 20A, there is arranged a jig 202 and an extractor 209 similar to the apparatus 2 and 9, or 102 and 109, respectively, of the plant illustrated in Fig. 1. At the said extractors 21, following a first separation of the fine heavy particles and coarse schists at the apparatus 2 and 9, and 102 and 109, there is separated from the residual bed, as a residue, a fraction formed substantially by the major portion of the residual tailings. The depth of the remaining bed thus is materially reduced, with the central and upper layers correspondingly positioned nearer the bottom of the trough. When the materials pass over the sieve of the jig 202, the liquid impulses without appreciable suction effect to which the remaining bed is subjected have the result of permitting the fine heavy particles which have reached the bottom of the bed, and the major portion of those yet contained in the said central and upper layers, to be eliminated at the said apparatus, while the residual coarse schists are eliminated at the extractor 209. The remainder of the treatment, that is the separation into categories of the final residual bed, may be similar to that of Fig. 1, and may be carried out with similar apparatus, with or without ultimate passage of the coals over an inclined sieve with liquid sprinkling such as 23 and 24, respectively, of Fig. 1, not illustrated. According to the illustration, the two extractors, such as 21, which are located in the end portion of the trough section 20A furnish a product to be rewashed and a further extractor 22 furnishes a usable middling product.

It is to be understood that when necessary or desirable, the discharges from the extractors 21 of the trough section 20A will be retreated for the extraction therefrom of the valuable products yet contained therein.

In principle the plant of Figs. 7, 7*a* and 7*b* is intended to answer this requirement. In these figures, the discharges from the extractors 21 and from one or several apparatus such as 22 of Fig. 1, are retreated in a trough 26 equipped with a jig 302 and a conjugated extractor 309 as well as, for example, an extractor 321 of the pocket type, and an extractor 322 of the flap valve type, similar to the apparatus 21 and 22, respectively, of Fig. 1, and as hereinbefore described.

In fact, following a first separation of fine heavy and coarse schist particles effected at the apparatus 2 and 9, and 102 and 109, there is separated a portion of the bed comprising the lower layers and a fraction of the central layers, the portion thus separated being regarded in the head section of the trough 26 in order to be freed from the fine heavy and coarse schist particles therein at the apparatus 302 and 309. The remainder of the bed is subjected to a final cleaning and separation in the downstream section of the trough 26 and at the apparatus 321 and 322.

The following categories of products are collected from the plant of Fig. 7. Clean coals, which may or may not be caused to pass over a sloping sieve with sprinkling means, at the end of the trough section 20. At the apparatus 22 of this trough section 20, and at the end of the trough 26, a product which may be used as a middling product but which may be also cyclically returned to the process, such as along the path 25 to the head of the trough section 1. Fine heavy and coarse schist particles may be eliminated at the discharges of the apparatus 2 and 9, 102 and 109, and 302 and 309. At the extractor 322 a more or less schistous product which is conveniently returned in cycle to the process such as along 27 to the head of the trough 26. Finally, at the discharge of the apparatus 321 a product near the pure schists which may be eliminated either together with the schists or united with the product to be rewashed which is collected at the discharge of the apparatus 322.

Finally, where the quantities of materials to be treated are considerable or when the content in fine heavy particles of these materials is particularly high, the plant may be arranged as illustrated in Figs. 8, 8*a* and 8*b* in accordance to which, following a first removal of heavy fine and coarse schist particles, there is effected several successive separations of the lower portions of the residual bed, each fraction thus separated being preferably subjected to a complementary treatment including the removal of fine heavy particles.

In these figures may be found again the trough sections 1, 101 and 20 with the same equipment in Fig. 1, together with the additional trough section 101A equipped with apparatus 102A and 109A. The extractors 21 and 22 of the trough section 20, however, are three in number in each case. The sieve 23 with its liquid sprinkling means 24 is associated with the general coal discharge.

The extractors 21 are arranged and adjusted to separate from the bed, downstream of the apparatus 102A and 109A, a part of the lower portion of the bed. The discharge of the apparatus 21 is carried to the head of a trough 28 equipped with the apparatus 402 and 409, similar to the apparatus 2 and 9, or 102 and 109, as well as with two extractors 421 of the pocket type similar to the extractors 21 already described.

With this arrangement there is eliminated from the bed the fine heavy particles at the apparatus 402 and the coarse schist particles at the apparatus 409. The discharge of the apparatus 421 is formed of a product of high content in schists which should be eliminated with the residues. At the end of the trough is collected a product which in most cases is to be rewashed and for this reason is returned to the head of the trough section 1 along the path 30.

At the apparatus of the trough section 20, there is extracted from the residual bed another portion of its lower layers, which portion is carried to the head of a trough 29 which is preferably equipped as illustrated with a single jig 502 followed with one or two extractors 522 similar to the apparatus 22 already described.

The apparatus 502 eliminates from the formed bed the fine heavy particles that may be present in the fraction extracted by the apparatus 22 of the trough section 20, while the extractor or extractors 522 separate from

the bed a mixed product which may be used as such or, as indicated in the figure, may be united with the product collected at the end of the trough **28** to be returned in cycle to the process, for example along the path **30** to the head of the section **1** of the upper trough. At the end of the trough **29** there is collected coals which are to be united to those collected at the end of the section **20** of the upper trough, these coals being preferably washed on a sieve **23** provided with a liquid sprinkler **24**.

As will be understood, should the content in fine heavy particles so require, from the residual bed in the trough section **20** there may be separated a third portion of the bed, to which may be applied a treatment similar to that carried out in the trough **29**, or this trough section **20** could be equipped with a jig such as **2**, in order to eliminate the fine heavy particles therein.

I claim:

1. A process for treating coals of very small sizes which are not, or are imperfectly, freed from dust and are of high content in fine heavy particles, comprising partially classifying the starting mixture of materials by density into layers by flowing the said materials down an inclined path in a stream of liquid, further classifying the entire partially classified bed, to permit fine heavy particles still remaining in the upper layers to percolate to the bottom of the bed, by moving the said bed bodily over the screen of a jig while retaining the previously effected classification of the bed and flowing surges of additional liquid in an upward direction through said screen and the bed of materials supported thereon while absorbing any downward flow of liquid through the bed of material, removing the percolated fine heavy particles substantially free from light particles through the bottom of the bed while it is passing over the screen, parting the classified bed as it leaves the jig into upper and lower fractions and removing the lower fraction, and after the upper fraction of the bed has moved beyond the jig separating the same into categories of products.

2. The process of claim 1 characterized by further classifying the upper fraction of the parted bed, to deliver to the bottom thereof any remaining heavy particles, by flowing the bed down an inclined path in a stream of liquid, removing from the bottom of the further classified bed a fraction containing said remaining heavy particles, and separating the remaining upper portion of the bed into categories of products.

3. The process of claim 1 characterized by further classifying the upper fraction of the parted bed, to deliver to the bottom thereof any remaining heavy particles by flowing the bed down an inclined path in a stream of liquid, removing from the portion of the further classified bed a fraction containing said remaining heavy particles, separating the remaining upper portion of the bed into middlings and coal, and returning the separated middlings to the starting mixture of materials to be reprocessed therewith.

4. The process of claim 1 characterized by further classifying the upper fraction of the parted bed, to deliver to the bottom thereof any remaining heavy particles, by flowing the bed down an inclined path in a stream of liquid, removing from the bottom of the further classified bed a fraction containing said remaining heavy particles, separating the remaining upper portion of the bed into categories of products, further classifying the said removed fraction containing the heavy particles by flowing the material down an inclined path in a stream of liquid, removing from the bottom of the flowing bed the said heavy particles, and separating the remaining bed into categories of products.

5. The process of claim 1 characterized by further classifying the upper fraction of the parted bed, to deliver to the bottom thereof any remaining heavy particles, by flowing the bed down an inclined path in a stream of liquid, removing from the bottom of the further classified bed a fraction containing said remaining heavy particles, separating the remaining upper portion of the bed into categories of product, further classifying the said removed fraction containing the heavy particles by flowing the material down an inclined path in a stream of liquid, removing from the bottom of the flowing bed the said heavy particles, separating the remaining bed into categories of products, and returning one of said last mentioned products to the said fraction containing the heavy particles for further classification therewith.

6. The process of claim 1 characterized by further classifying the upper fraction of the parted bed into layers by flowing the bed down an inclined path in a stream of liquid, successively separating from the bottom of the further classified bed a first fraction containing the remaining heavy particles and a second fraction including middlings so as to leave coal in the flowing stream, separately further classifying the said successively separated fractions by flowing the fractions down individual inclined paths in streams of liquid, removing from the bottom of the flowing bed formed of the said first fraction the heavy particles and returning the remainder of the bed to the original starting mixture of materials to be reprocessed therewith, removing from the bottom of the flowing bed formed of the said second fraction the middlings and returning the same to the original starting mixture of materials to be reprocessed therewith, and mixing the remainder of the bed formed of the second fraction with the aforesaid coal.

7. A plant for treating coals of very small sizes which are not, or are imperfectly, freed from dust and are of high content in fine heavy particles, comprising an inclined washing trough, having a smooth bottom surface, along which the starting mixture of materials flows in a stream of liquid so as to be partially classified by density into layers, a jig directly connected to the lower end of the trough to receive the entire bed of materials from the trough in its partially classified condition, said jig having a screen to support the bed of materials while it moves bodily through the jig and the previously effected partial classification of the bed is retained, and means in the jig for flowing surges of additional liquid in an upward direction through the screen and the bed of materials supported thereon while absorbing any downward flow of liquid through the bed of material to further classify the entire bed by permitting fine heavy particles still remaining in the upper layers to percolate to the bottom of the bed and pass through the jig screen, means at the discharge end of the screen for parting the classified bed leaving the jig into upper and lower fractions, an extractor for removing from the bed the parted lower fraction, and means connected to the extractor to receive the parted upper fraction of the bed and separate the same into different categories of products.

8. A plant as in claim 7 further characterized by an inclined washing trough, having a smooth bottom surface, connected to the extractor to receive the parted upper fraction of the bed for movement therealong by liquid discharged from the jig for further classifying the bed into layers, an additional extractor connected in said last mentioned washing trough for removing from the bottom portion of the bed the remaining heavy particles, and means connected in the last mentioned washing trough beyond said additional extractor for separating the remaining bed into different categories of products.

9. A plant as in claim 7 further characterized by an inclined washing trough, having a smooth bottom surface, connected to the extractor to receive the parted upper fraction of the bed for movement therealong by liquid discharged from the jig for further classifying the bed into layers, additional extractors connected in said last mentioned washing trough for successively removing from the bottom portion of the bed a first fraction containing the remaining heavy particles and a second fraction including middlings, and means for returning the said second fraction including the middlings to the upper end portion of the first mentioned washing trough for reprocessing with the starting mixture of materials.

10. A plant as in claim 9 further characterized by the provision of an additional inclined washing trough, having a smooth bottom surface, receiving the said first fraction containing the remaining heavy particles for movement therealong in a stream of liquid for further classification into layers, a jig connected in the intermediate portion of the additional trough and having a screen for supporting the entire bed, means in the jig for generating liquid pulses without noticeable suction effect and passing them only in an upward direction through the screen and the bed supported thereon to further classify the bed and to remove the heavy particles that pass through the screen, means connected in the said additional washing trough beyond the jig for extracting additional categories of products from the bottom of the bed, and means for returning the material discharged from the end of the said additional trough to

the upper end portion of the initial trough for reprocessing with the starting mixture of materials.

11. A plant as in claim 10 further characterized by means for returning to the upper end of the said additional washing trough one of the said products extracted from the bottom of the bed in said trough.

12. A plant as in claim 7 further characterized by an inclined washing trough, having a smooth bottom surface, connected to the extractor to receive the parted upper fraction of the bed for movement therealong by liquid discharged from the jig for further classifying the bed into layers, additional extractors connected in said last mentioned washing trough for successively removing from the bottom portion of the bed a first fraction containing the remaining heavy particles and a second fraction including middlings, two additional inclined washing troughs for separately receiving the said first fraction containing the remaining heavy particles and the said second fraction including middlings, said additional washing troughs further classifying their respective fractions of the parted bed into layers as the fractions flow therealong in streams of liquid, means connected in each one of the two additional washing troughs for separating their classified beds into different categories

of products, and means for combining one product from each one of said additional washing troughs and returning the combined products to the upper end portion of the initial washing trough for reprocessing with the starting mixture of materials.

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