H. R. WAHL.

HYDRAULIC SEPARATOR FOR CRUSHED ORES.

APPLICATION FILED NOV. 6, 1915.

1,306,361.

Patented June 10, 1919.

20 SHEETS—SHEET 1.

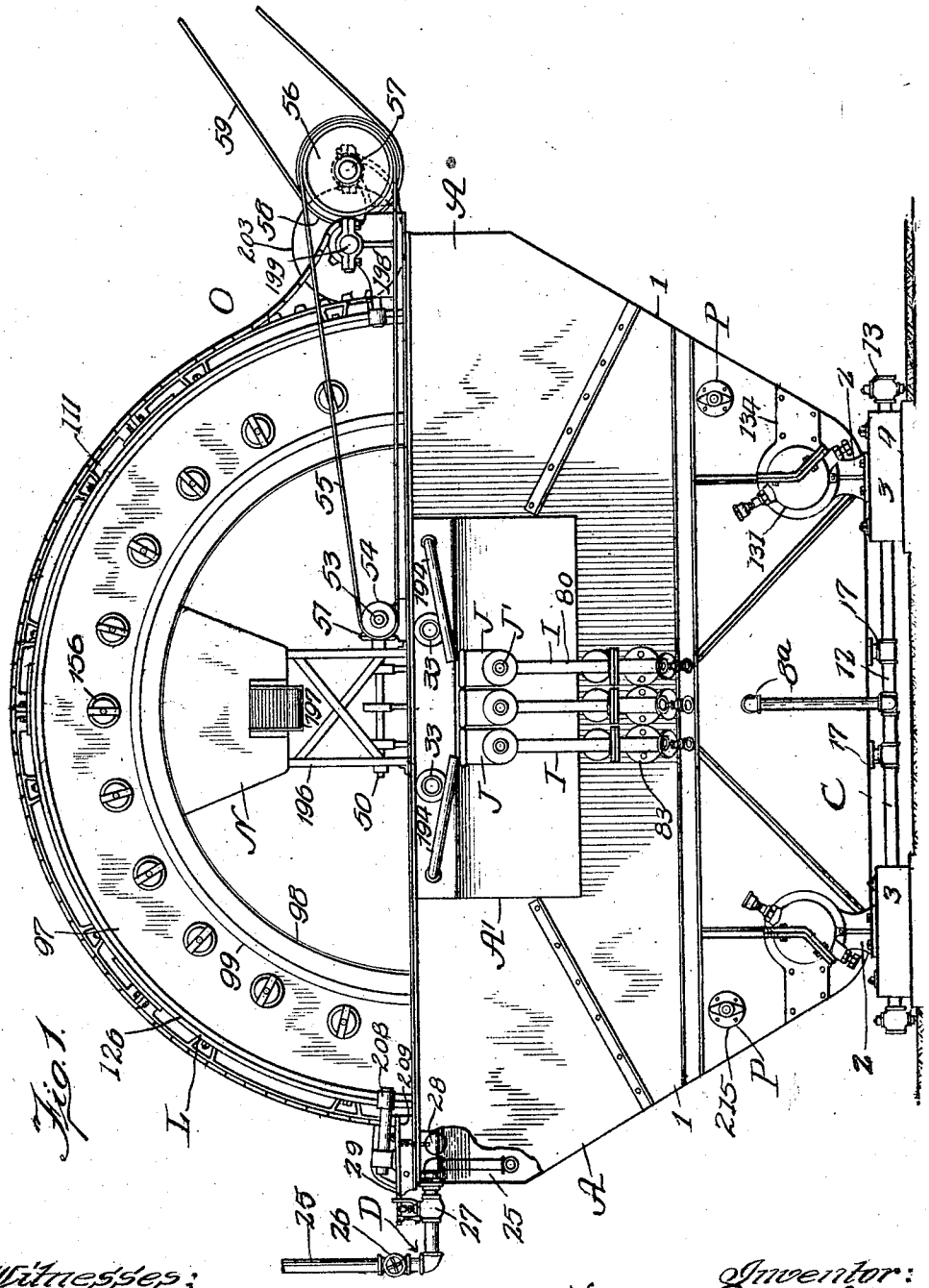


Fig. 1.

Witnesses:
Ed. D. Terry
Chas. Kourek

Inventor:
Henry R. Wahl
By Jno. G. Elliott
Atty.

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H. R. WAHL.

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20 SHEETS—SHEET 2.

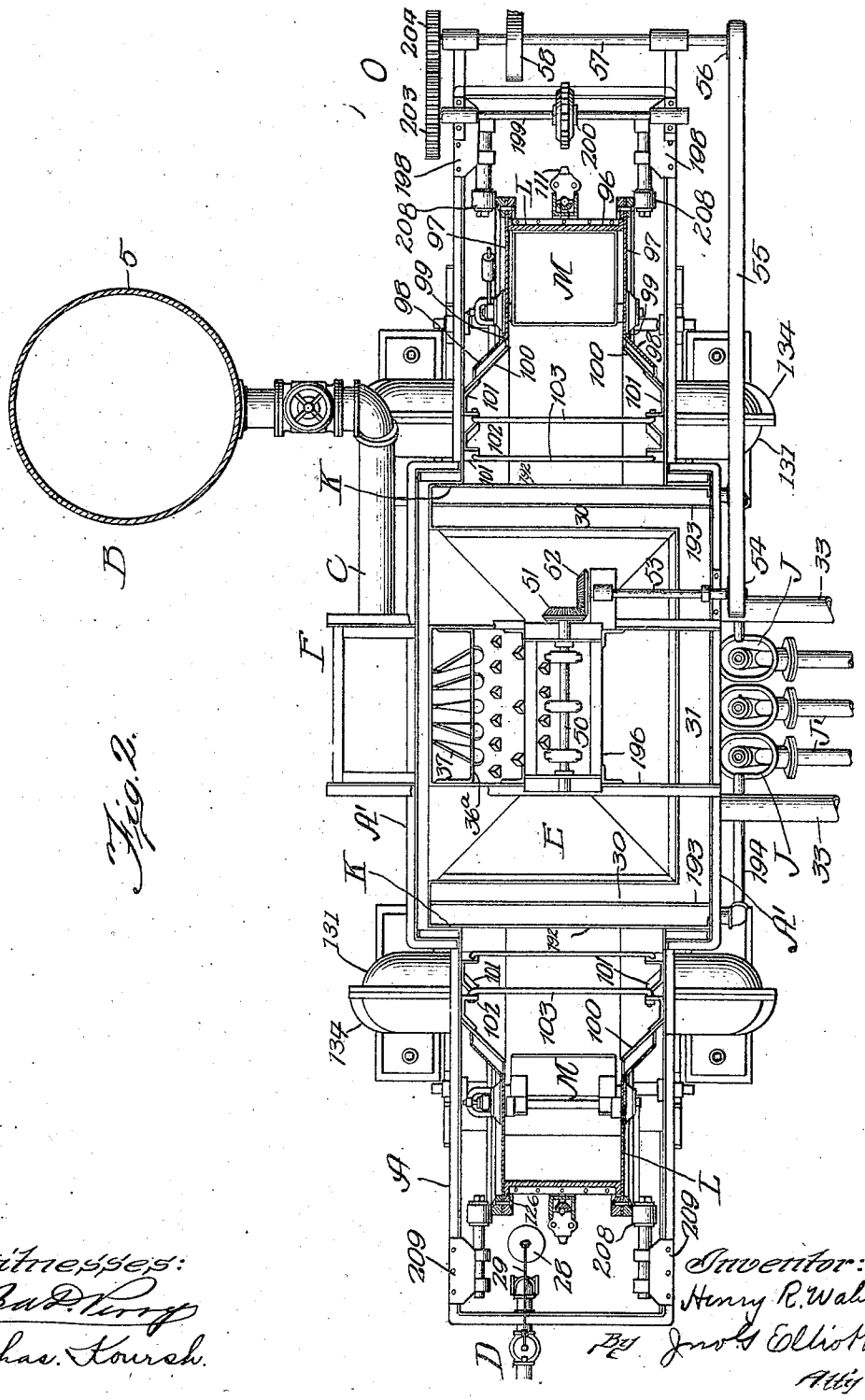


Fig. 2.

Witnesses:
Chas. Lourse.

Inventor:
Henry R. Wahl
By Jno. S. Elliott
Atty

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H. R. WAHL.

HYDRAULIC SEPARATOR FOR CRUSHED ORES.

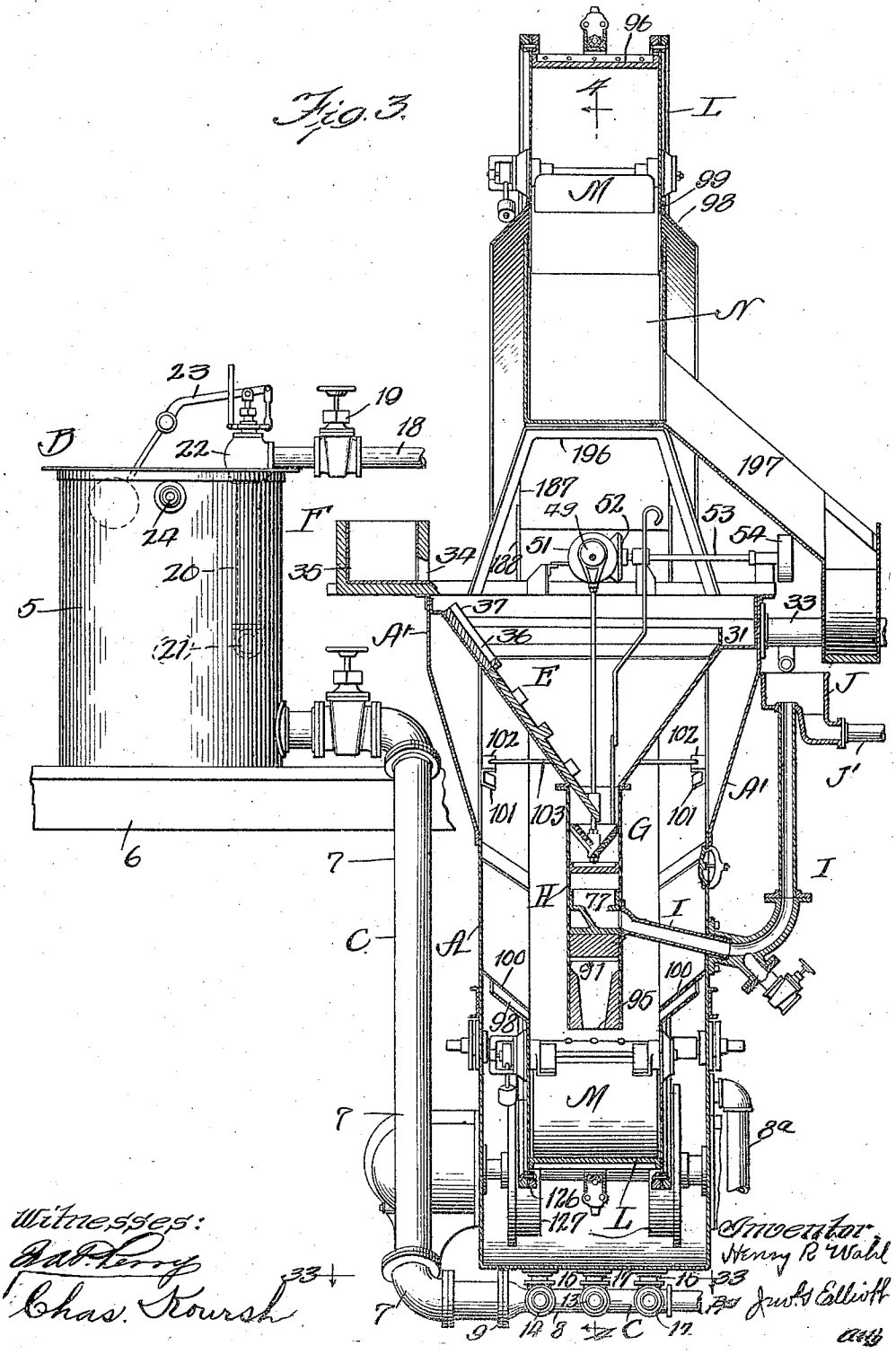
APPLICATION FILED NOV. 6, 1915.

1,306,361.

Patented June 10, 1919.

20 SHEETS—SHEET 3.

Fig. 3.



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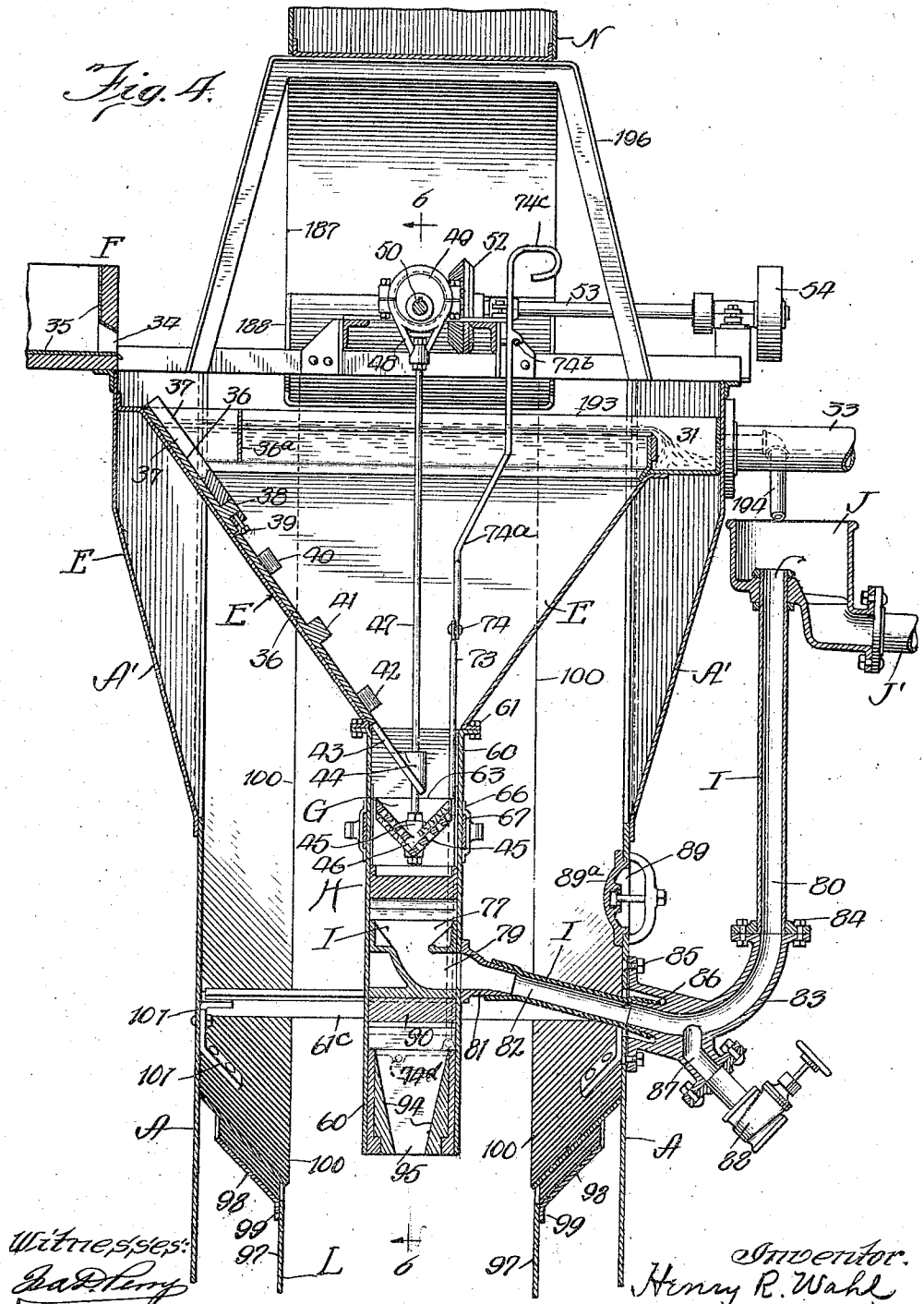
APPLICATION FILED NOV. 6, 1915.

1,306,361.

Patented June 10, 1919.

20 SHEETS—SHEET 4.

Fig. 4.



Witnesses:

Ed. Perry

Chas. Kursh

Inventor.

Henry R. Wahl

By Jno. S. Elliott

Atty.

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20 SHEETS—SHEET 5.

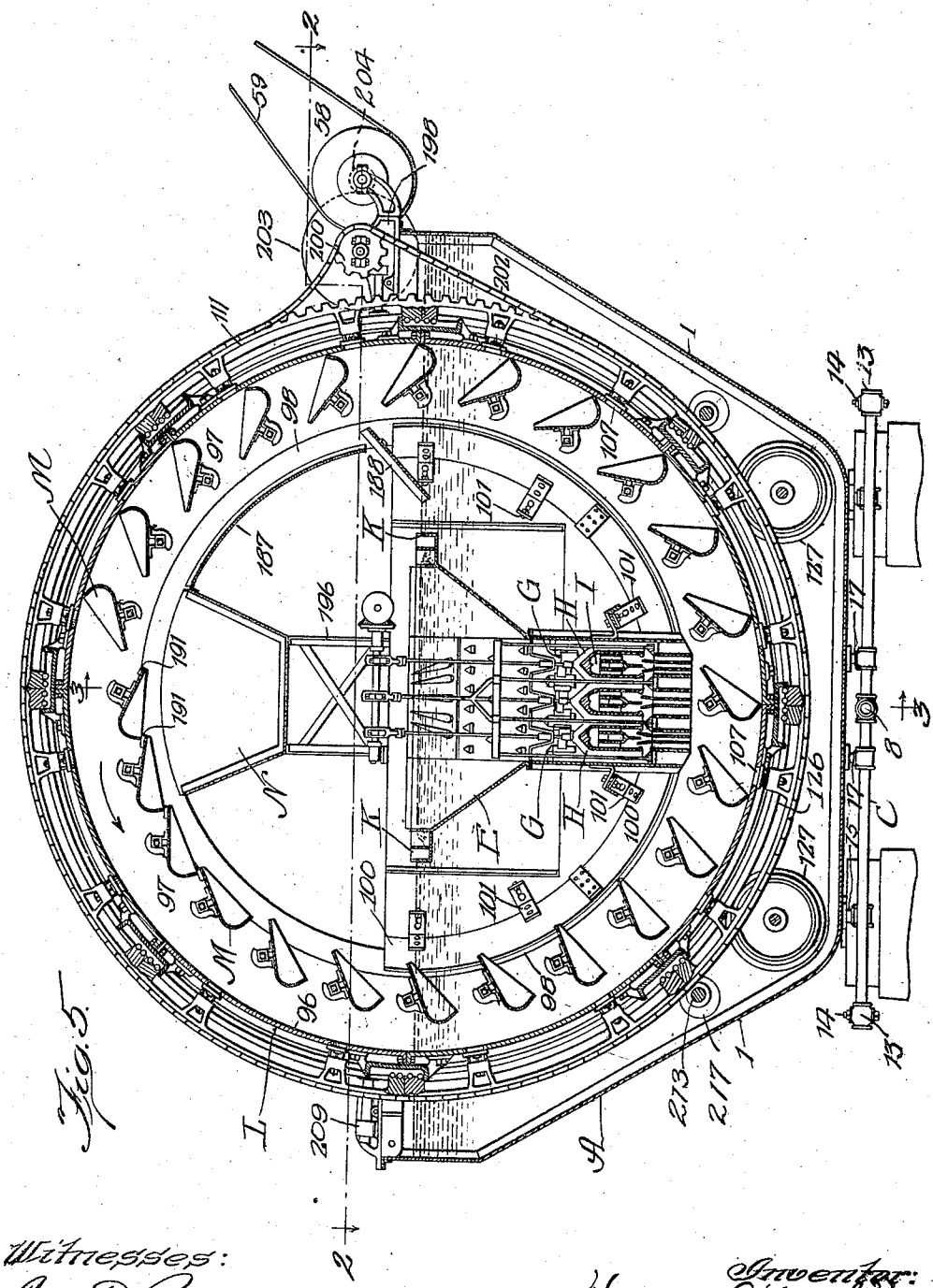


Fig. 5.

Witnesses:
Geo. Lang
Chas. Kursch

Inventor:
Henry R. Wahl
By Jno. S. Elliott
Atty.

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H. R. WAHL.

HYDRAULIC SEPARATOR FOR CRUSHED ORES.

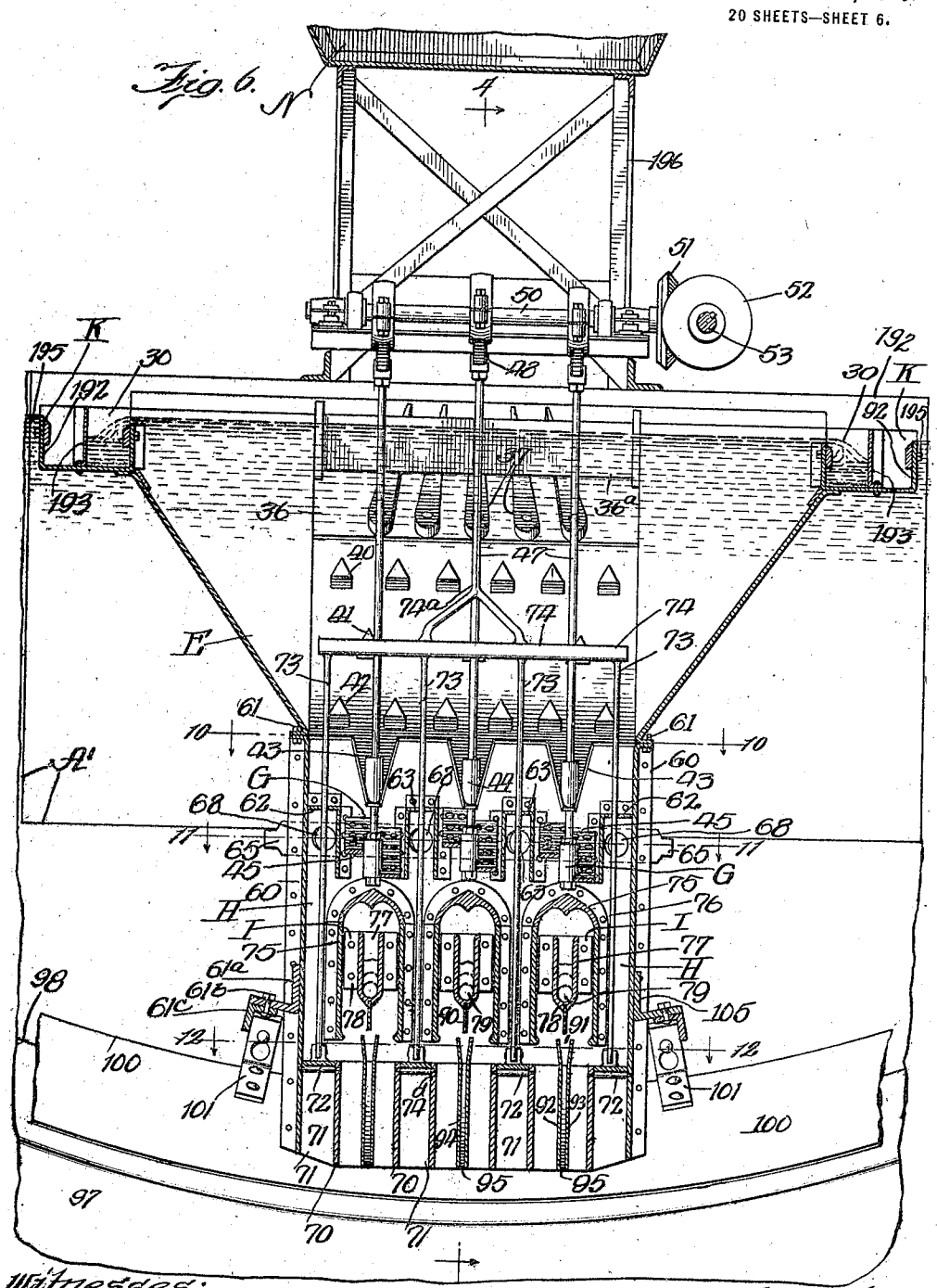
APPLICATION FILED NOV. 6, 1915.

1,306,361.

Patented June 10, 1919.

20 SHEETS—SHEET 6.

Fig. 6.



Witnesses:
Ira D. Sayre
Chas. Kourek

Inventor:
Henry R. Wahl
By Jno. G. Elliott
Atty.

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20 SHEETS—SHEET 7.

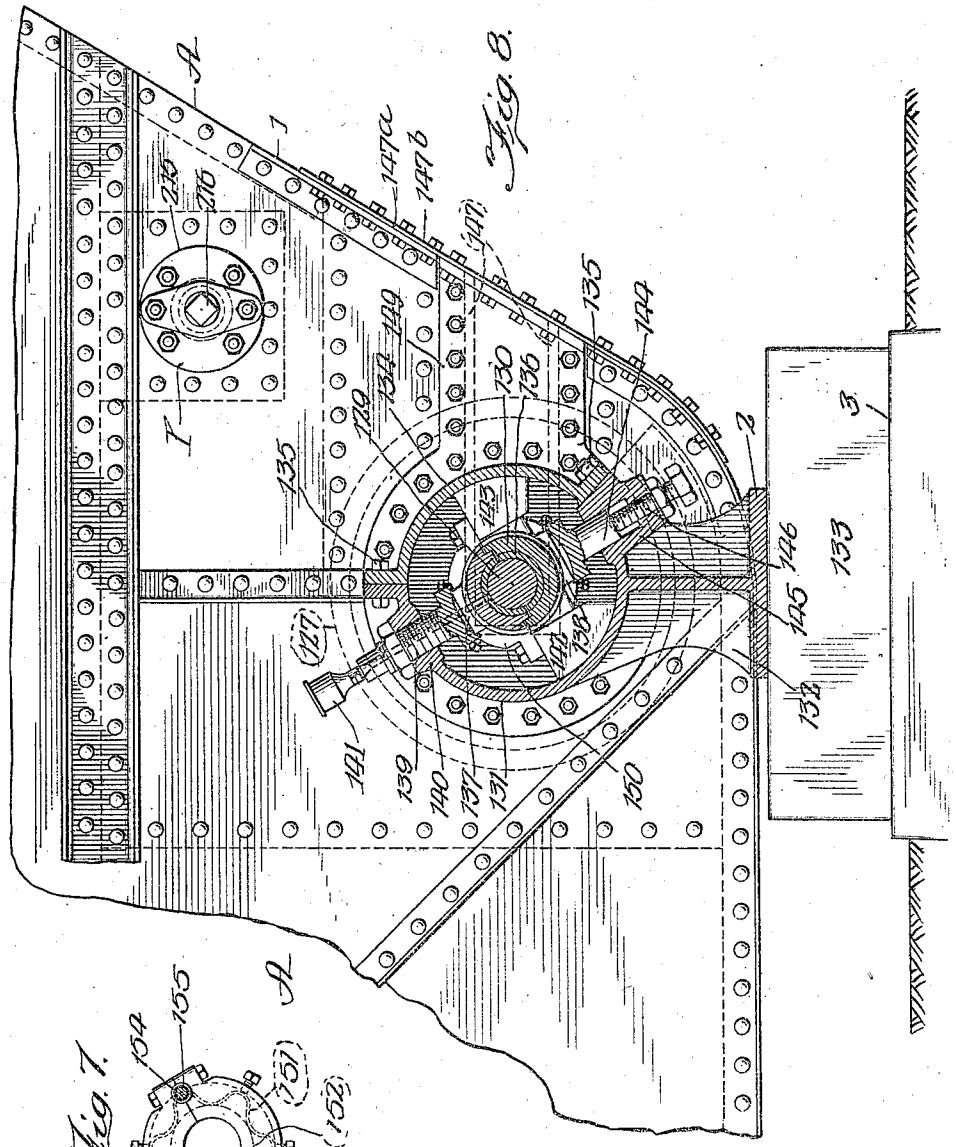


Fig. 8.

Fig. 7.

Witnesses:
Bad. Long
Chas. Kourse.

Inventor:
Henry R. Wahl
By Jno. G. Elliott
Atty.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

H. R. WAHL.

HYDRAULIC SEPARATOR FOR CRUSHED ORES.

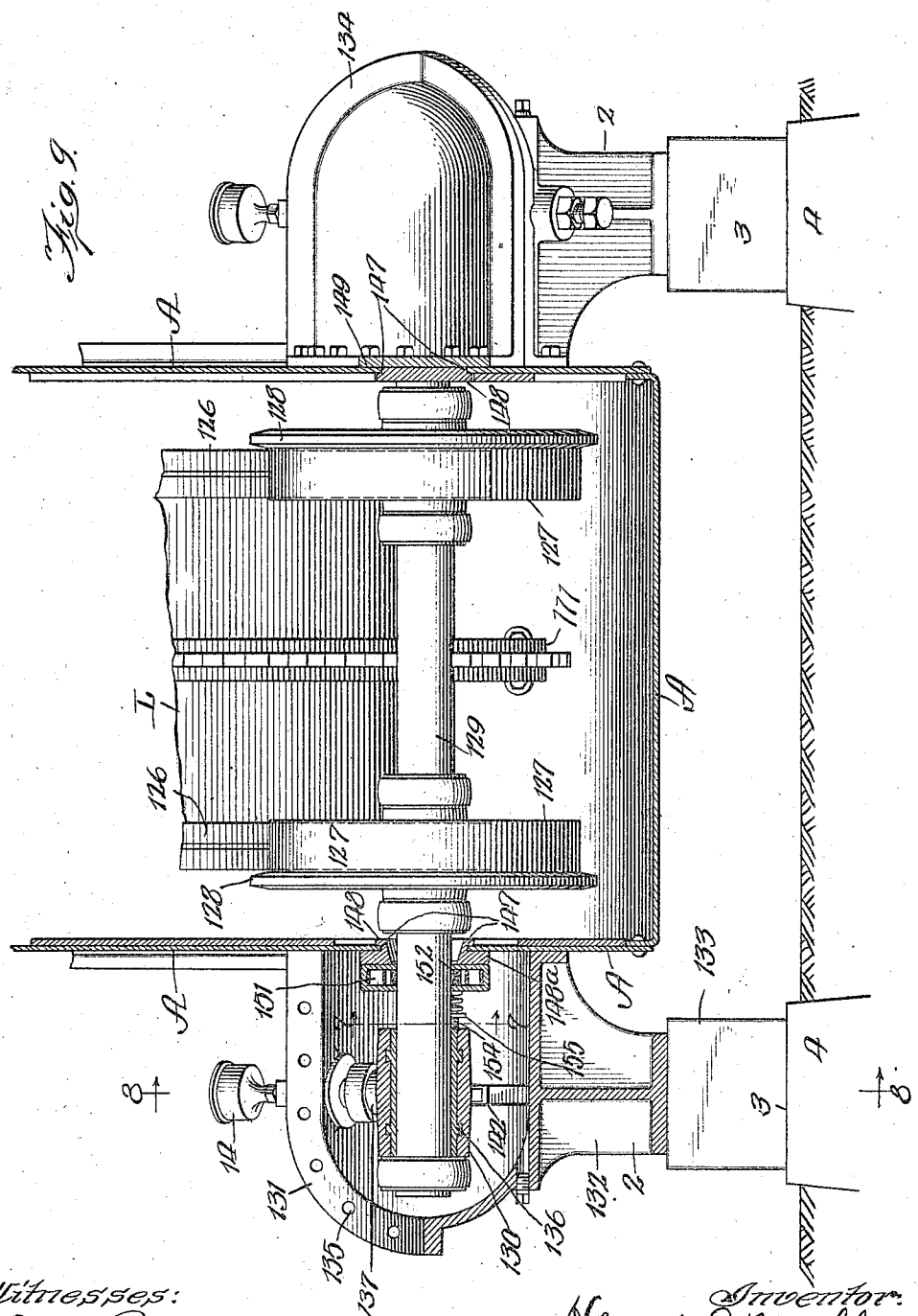
APPLICATION FILED NOV. 6, 1915.

1,306,361.

Patented June 10, 1919.

20 SHEETS—SHEET 8.

Fig. 9.



Witnesses:
Bartleson
Chas Kourek

Inventor:
Henry R Wahl
By Jno G Elliott
Atty.

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H. R. WAHL.

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20 SHEETS—SHEET 9.

Fig. 10.

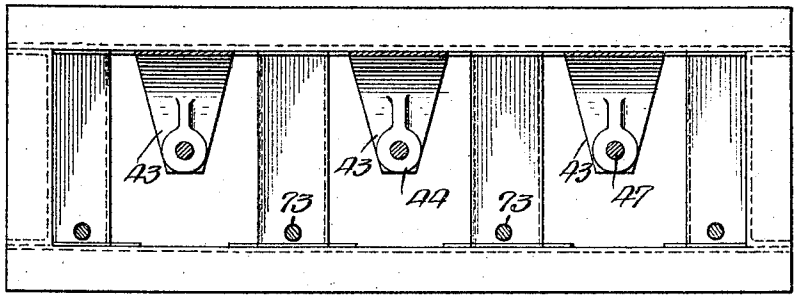


Fig. 11.

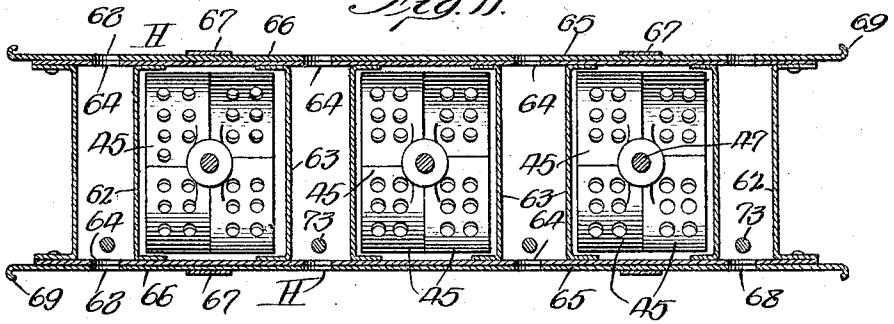
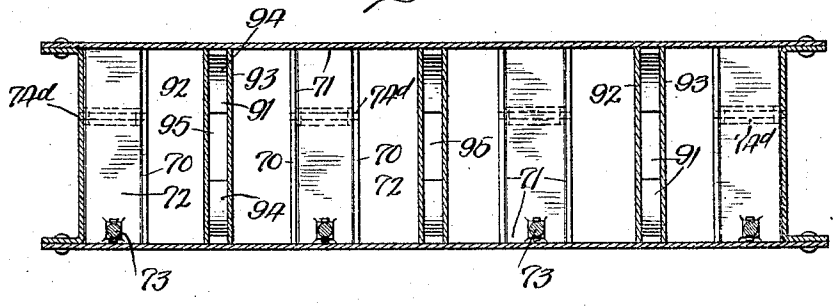


Fig. 12.



Witnesses:
Ba. D. Terry
Chas. Kourse.

Inventor.
Henry R. Wahl
By Jno. S. Elliott
Atty.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

H. R. WAHL.

HYDRAULIC SEPARATOR FOR CRUSHED ORES.

APPLICATION FILED NOV. 6, 1915.

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20 SHEETS—SHEET 10.

Fig. 14.

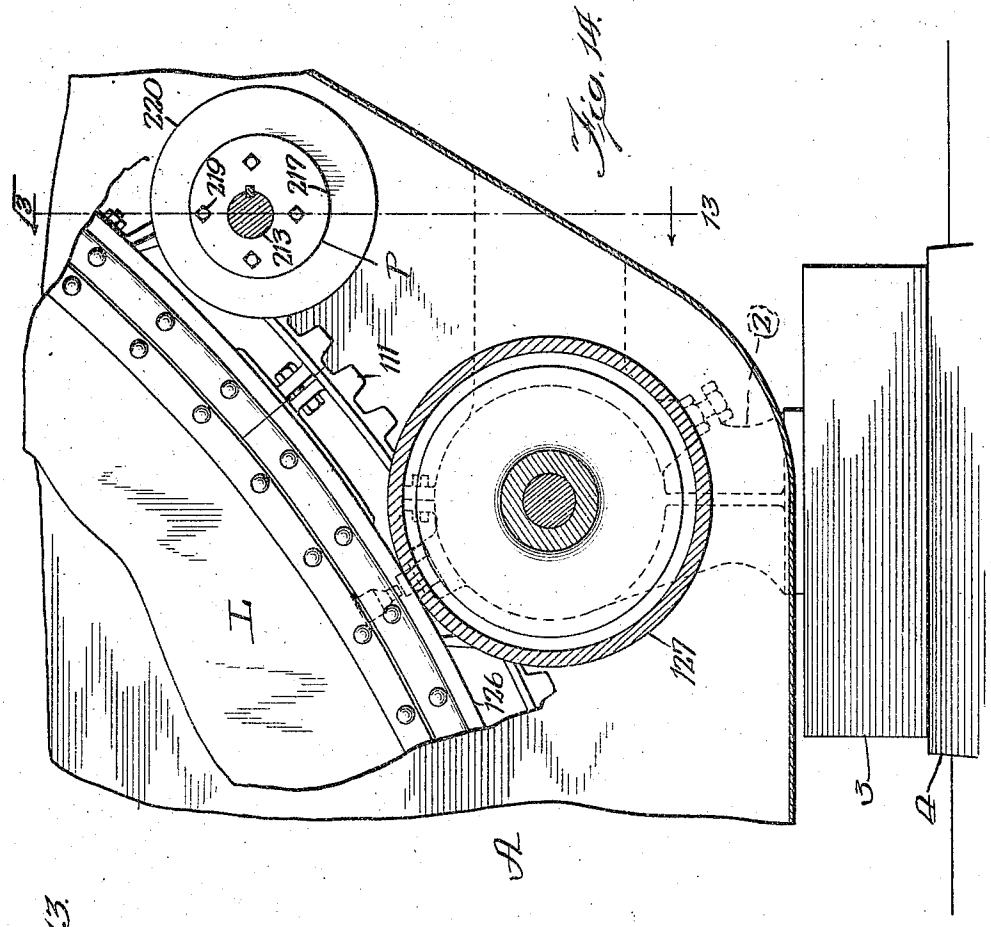
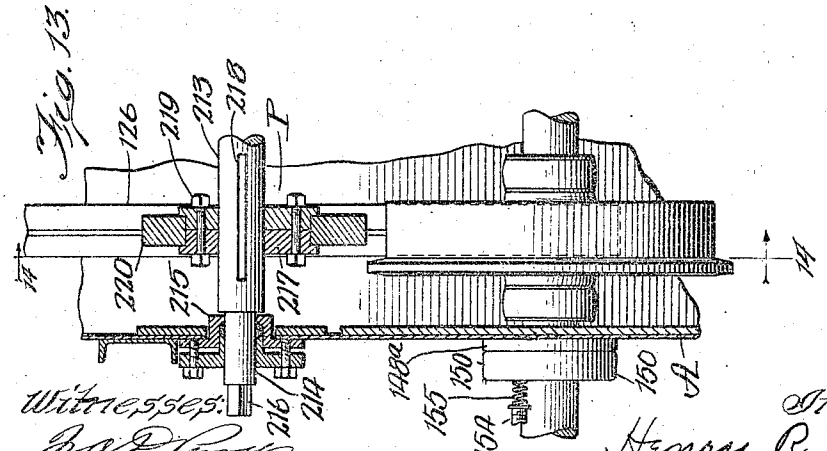


Fig. 13.



Witnesses:

Jas. F. Lang

Chas. Sourish

Inventor:

Henry R Wahl

By Jno G Elliott

Atty.

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H. R. WAHL.

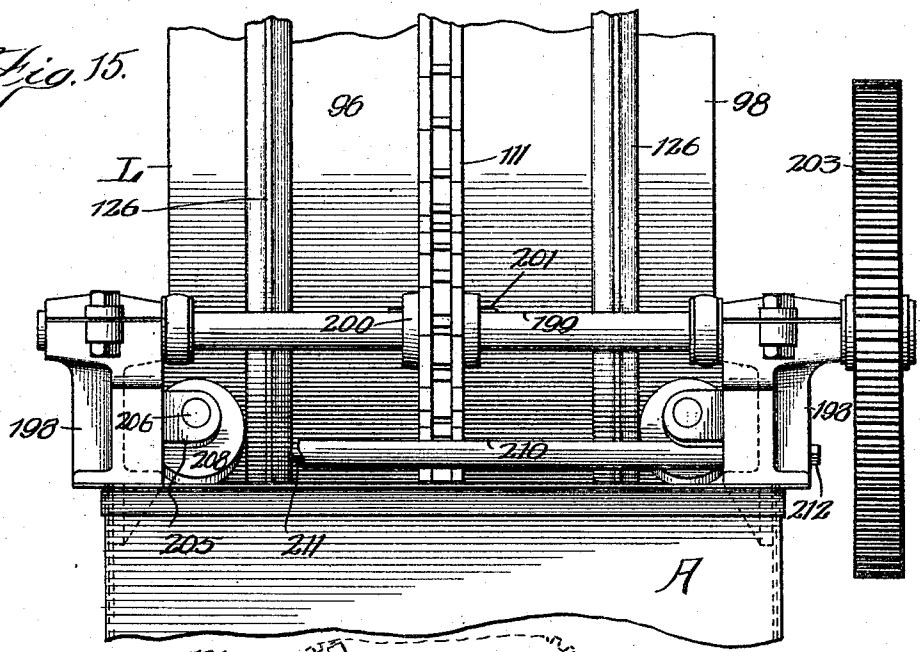
HYDRAULIC SEPARATOR FOR CRUSHED ORES.

APPLICATION FILED NOV. 6, 1915.

1,306,361. Patented June 10, 1919.

20 SHEETS—SHEET 11.

Fig. 15.



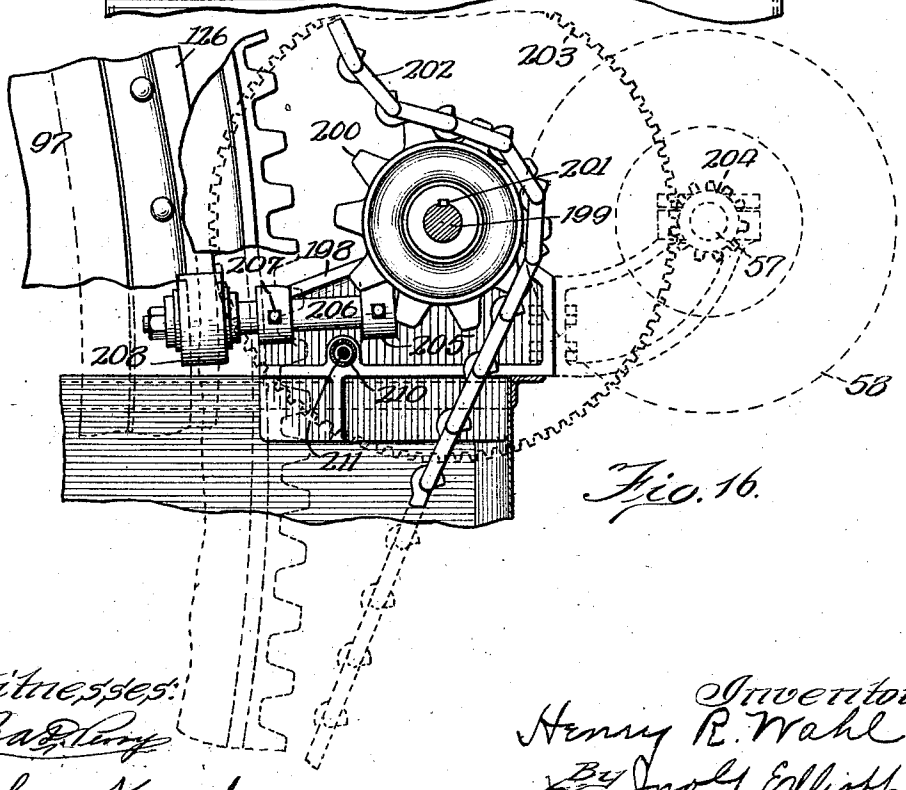


Fig. 16.

Witnesses:
Chas. Kourek.

Inventor:
Henry R. Wahl
By Jno. S. Elliott
Atty.

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H. R. WAHL.

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20 SHEETS—SHEET 12.

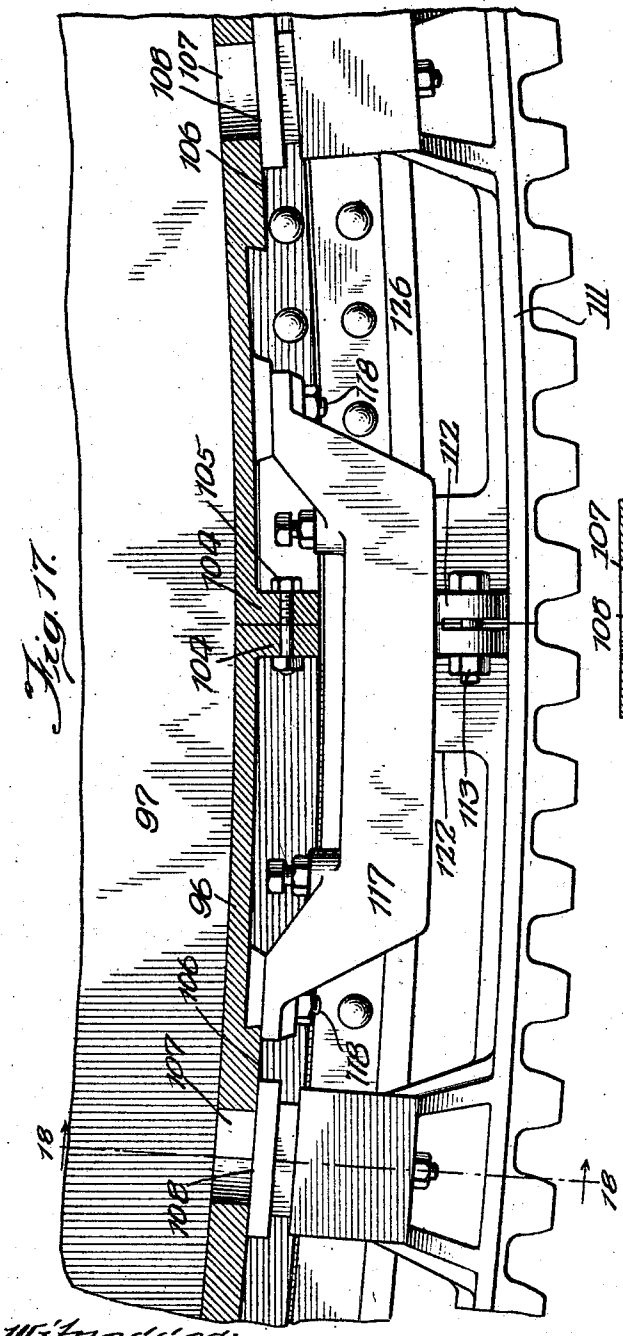


Fig. 17.

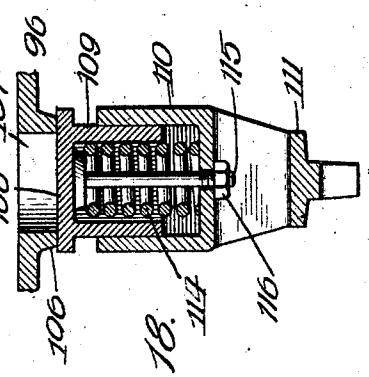


Fig. 18.

Witnesses:
Chas. Kourek.

Inventor:
Henry R. Wahl
By Jno. S. Elliott
Atty.

H. R. WAHL.

HYDRAULIC SEPARATOR FOR CRUSHED ORES.

APPLICATION FILED NOV. 6, 1915.

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20 SHEETS—SHEET 13.

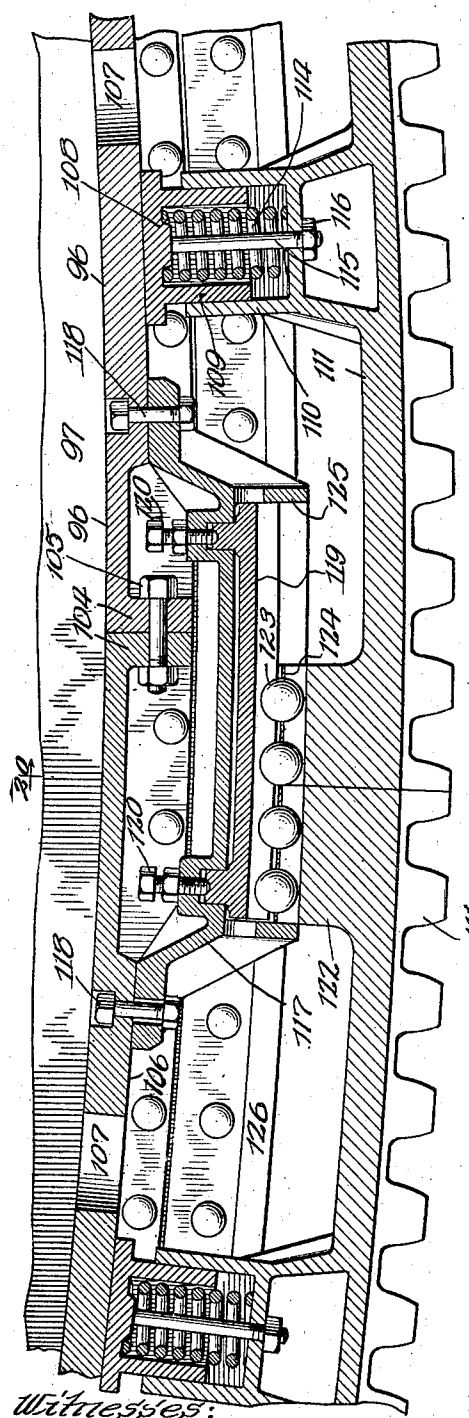


Fig. 19.

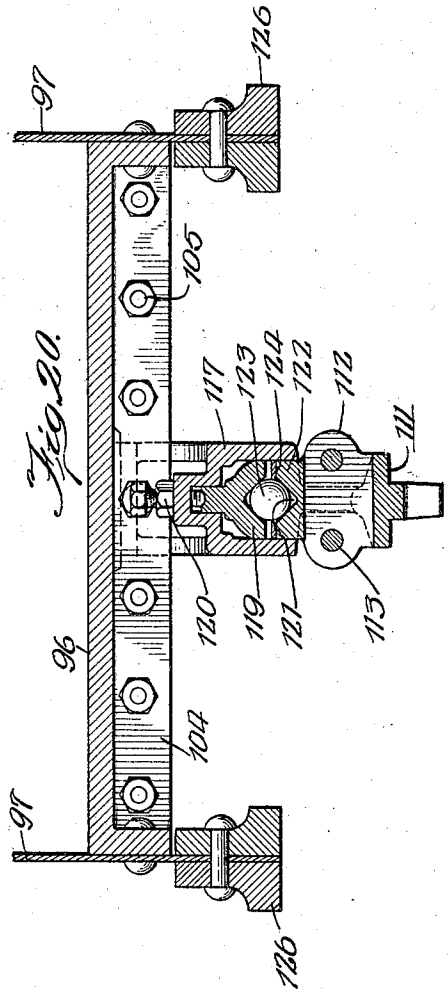


Fig. 20.

Witnesses:
Chas. Kourek

Inventor:
Henry R. Wahl
By Jno. S. Elliott
Atty.

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H. R. WAHL.

HYDRAULIC SEPARATOR FOR CRUSHED ORES.

APPLICATION FILED NOV. 6, 1915.

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Patented June 10, 1919.

20 SHEETS—SHEET 14.

Fig. 21.

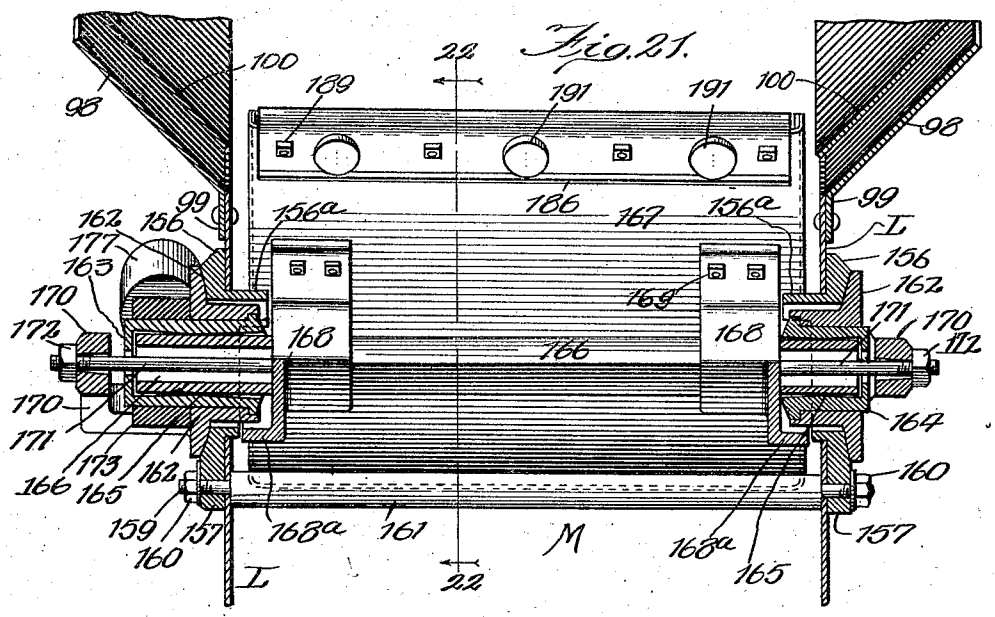
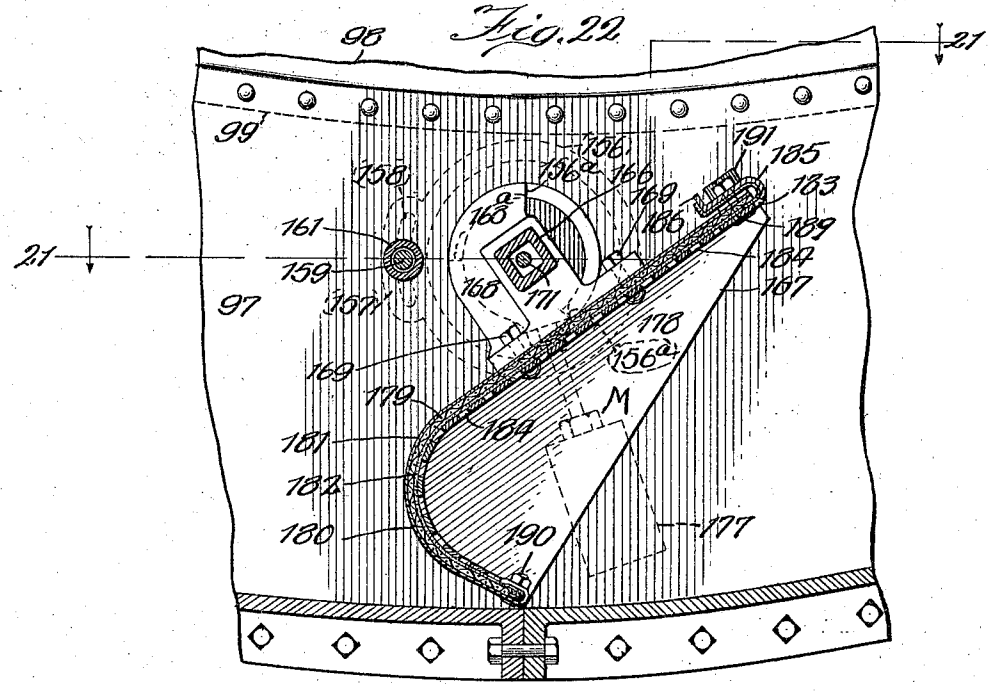


Fig. 22.



Witnesses:
Geo. F. Kenny
Chas. Kourek.

Inventor:
Henry R. Wahl
By Jno. S. Elliott
Atty.

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H. R. WAHL.

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Patented June 10, 1919.

20 SHEETS—SHEET 15.

Fig. 23.

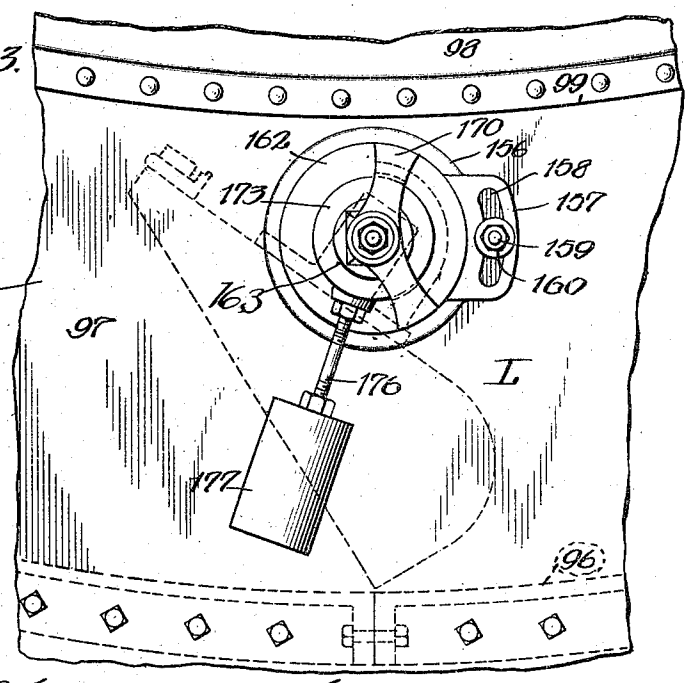


Fig. 24.

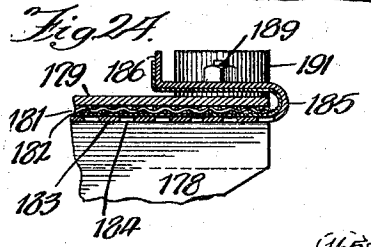


Fig. 25.

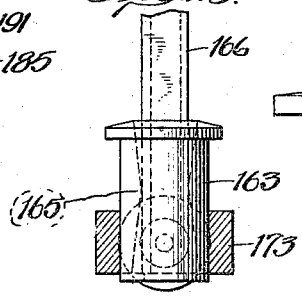


Fig. 26.

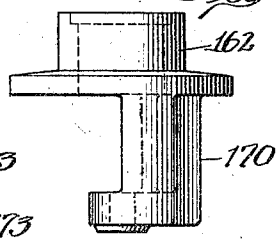


Fig. 27.

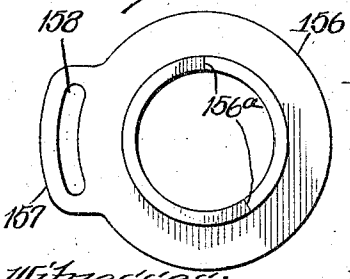


Fig. 28.

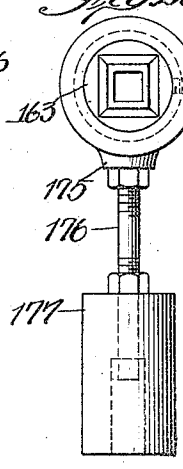
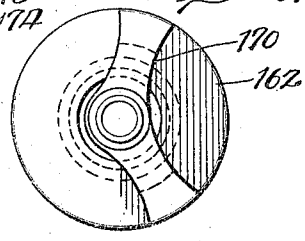


Fig. 29.



Witnesses:

Jas. D. Kemp

Chas. Kourek

Inventor:

Henry R. Wahl

By Jno. G. Elliott

Atty

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H. R. WAHL.

HYDRAULIC SEPARATOR FOR CRUSHED ORES.

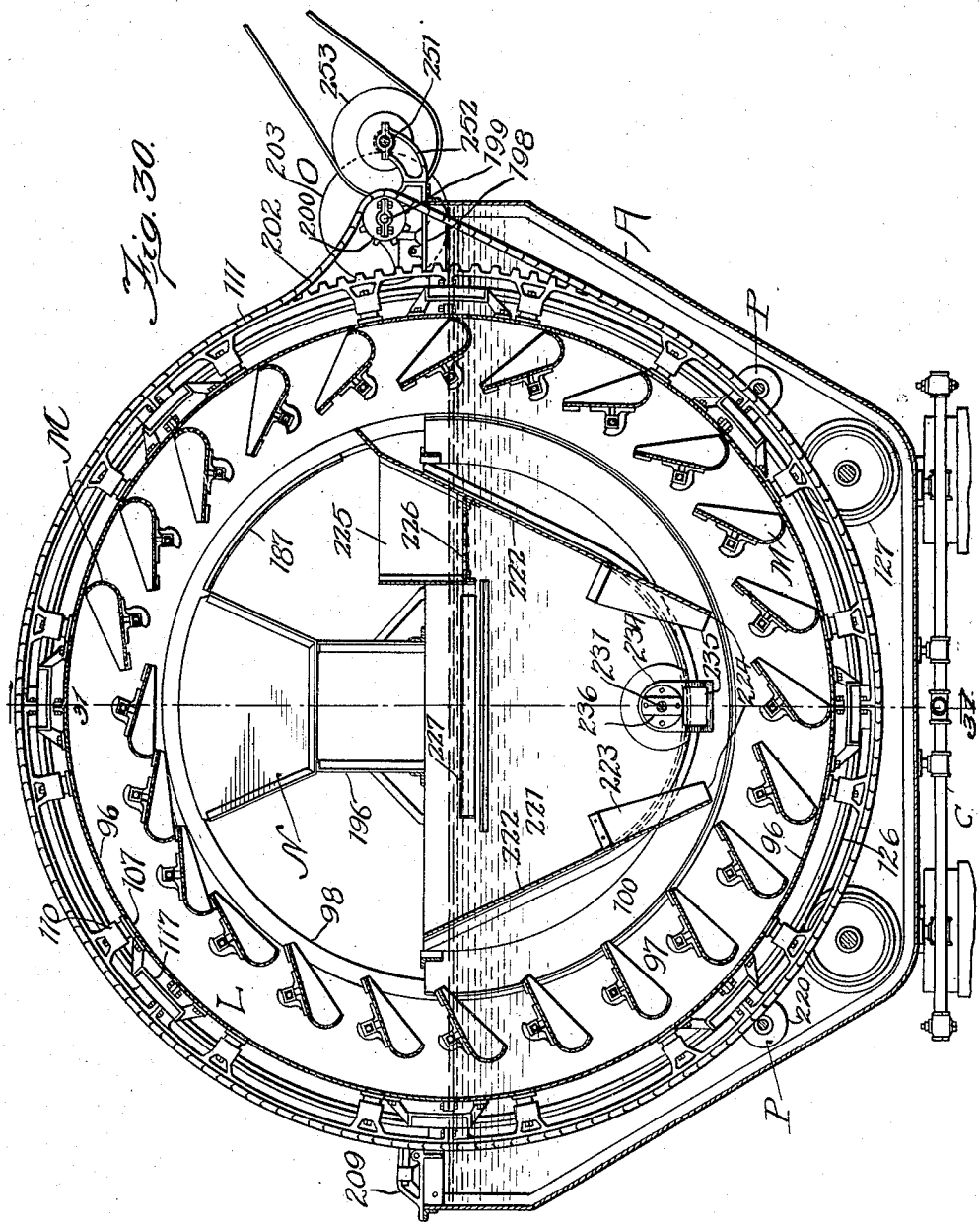
APPLICATION FILED NOV. 6, 1915.

1,306,361.

Patented June 10, 1919.

20 SHEETS—SHEET 16.

Fig. 30.



Witnesses:
Bad. Kemp
Chas. Kourek.

Inventor.
Henry R. Wahl
By Jno. S. Elliott
Atty.

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H. R. WAHL.

HYDRAULIC SEPARATOR FOR CRUSHED ORES.

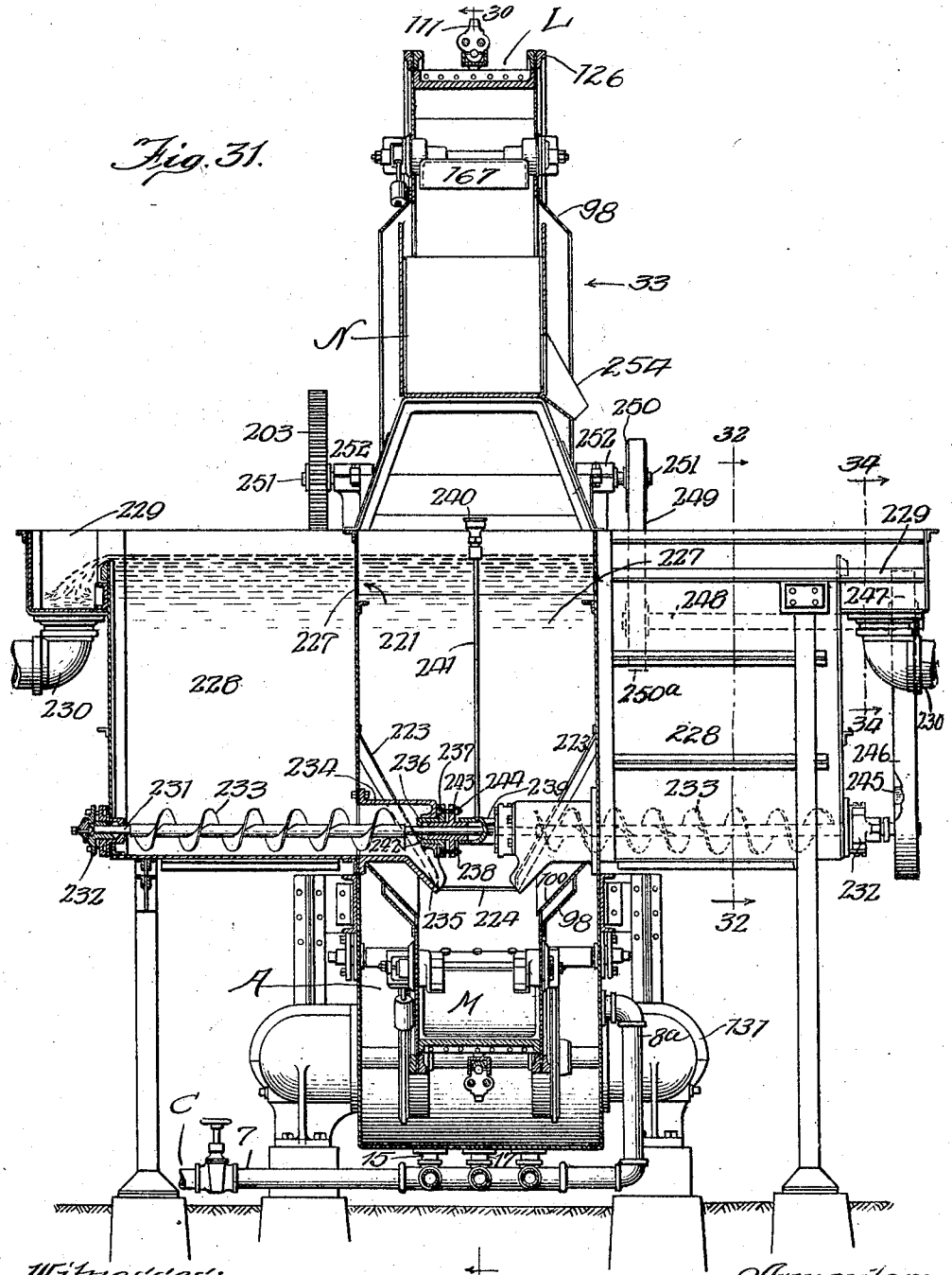
APPLICATION FILED NOV. 6, 1915.

1,306,361.

Patented June 10, 1919.

20 SHEETS—SHEET 17.

Fig. 31.



Witnesses:

Geo. D. Kemp

Chas. Kourse

Inventor:

Henry R. Wahl

By Jno. S. Elliott

Atty.

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H. R. WAHL.

HYDRAULIC SEPARATOR FOR CRUSHED ORES.

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1,306,361.

Patented June 10, 1919.

20 SHEETS—SHEET 18.

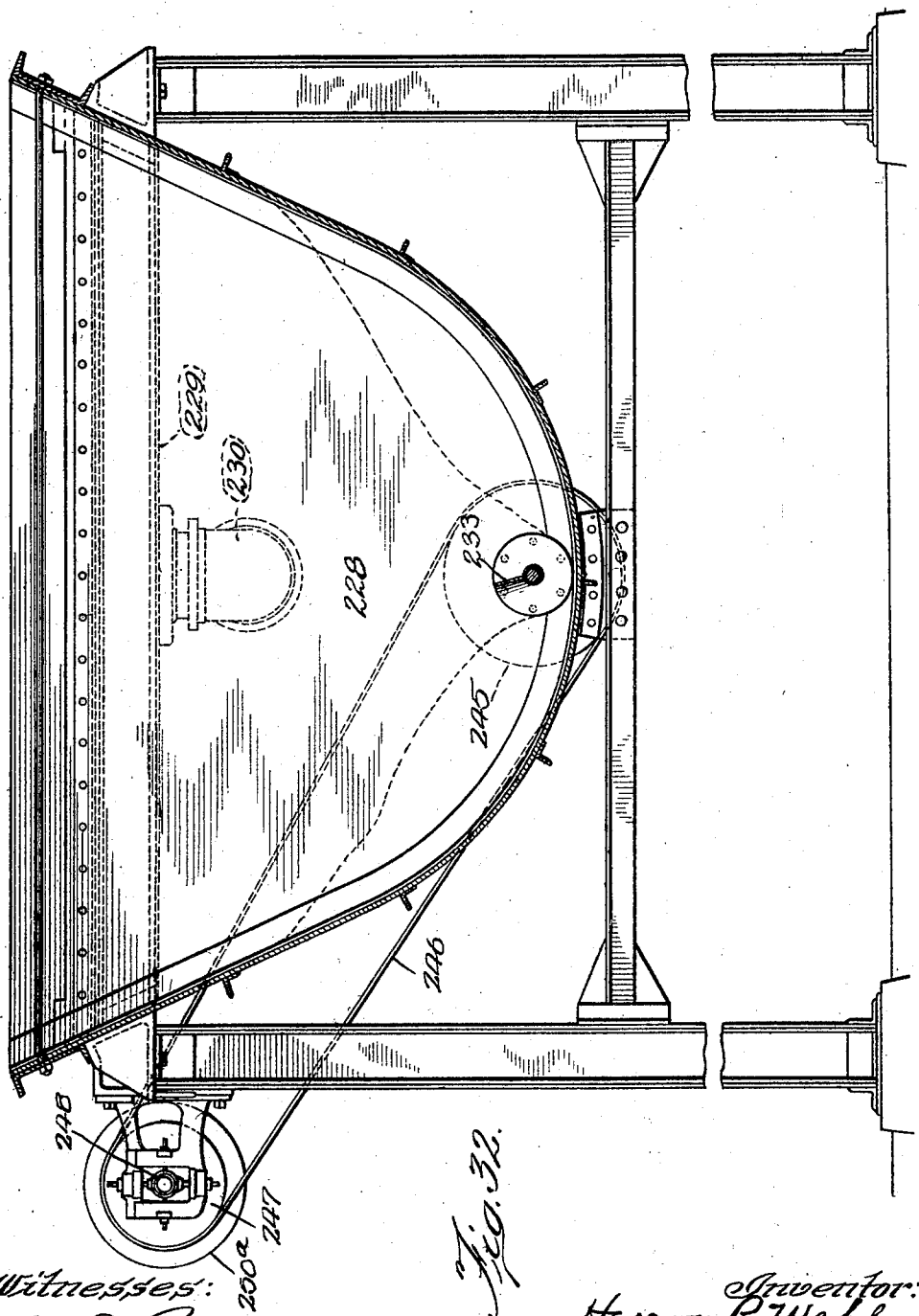


Fig. 32.

Witnesses:
Ba. D. Kerry
Chas. Kourek

Inventor:
Henry R. Wahl
By Jno. S. Elliott
Atty.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

H. R. WAHL.

HYDRAULIC SEPARATOR FOR CRUSHED ORES.

APPLICATION FILED NOV. 6, 1915.

1,306,361.

Patented June 10, 1919.

20 SHEETS—SHEET 19.

Fig. 33.

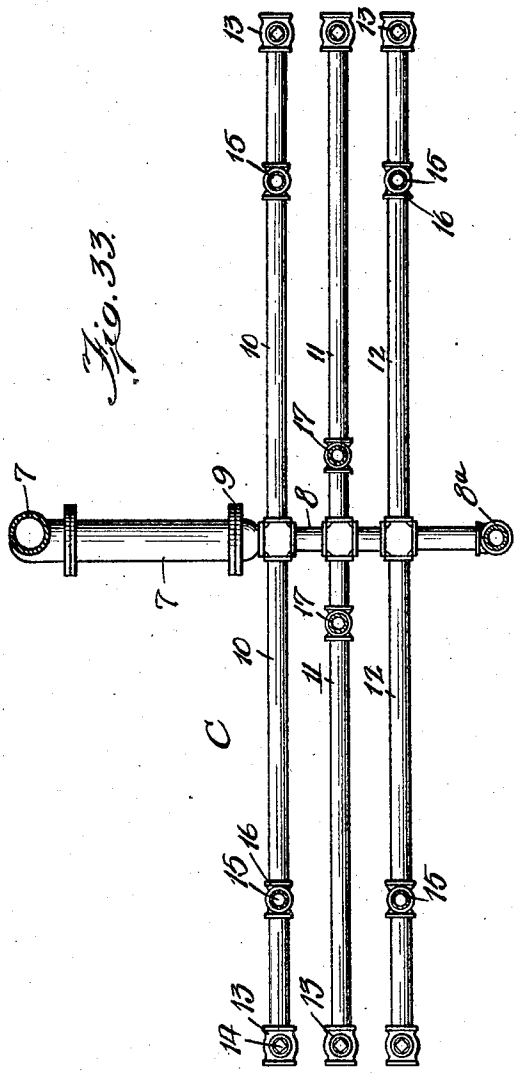
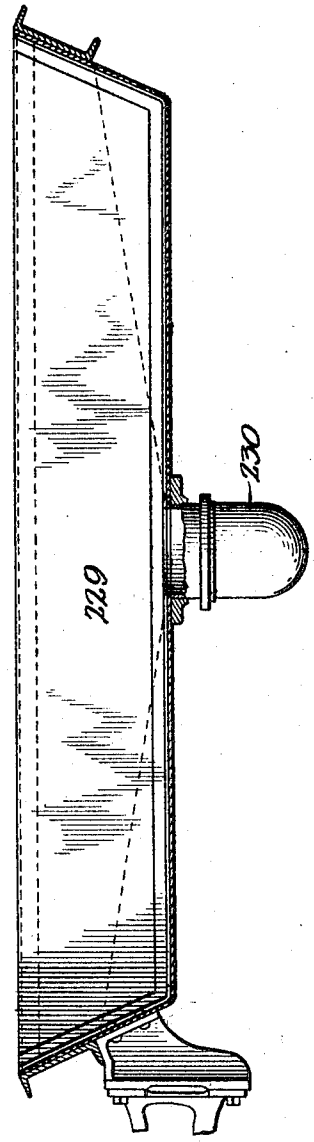


Fig. 34.



Witnesses:
R. A. P. Perry
Chas. Kourek

Inventor:
Henry R. Wahl
By Jno. S. Elliott
Atty.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

H. R. WAHL.

HYDRAULIC SEPARATOR FOR CRUSHED ORES.

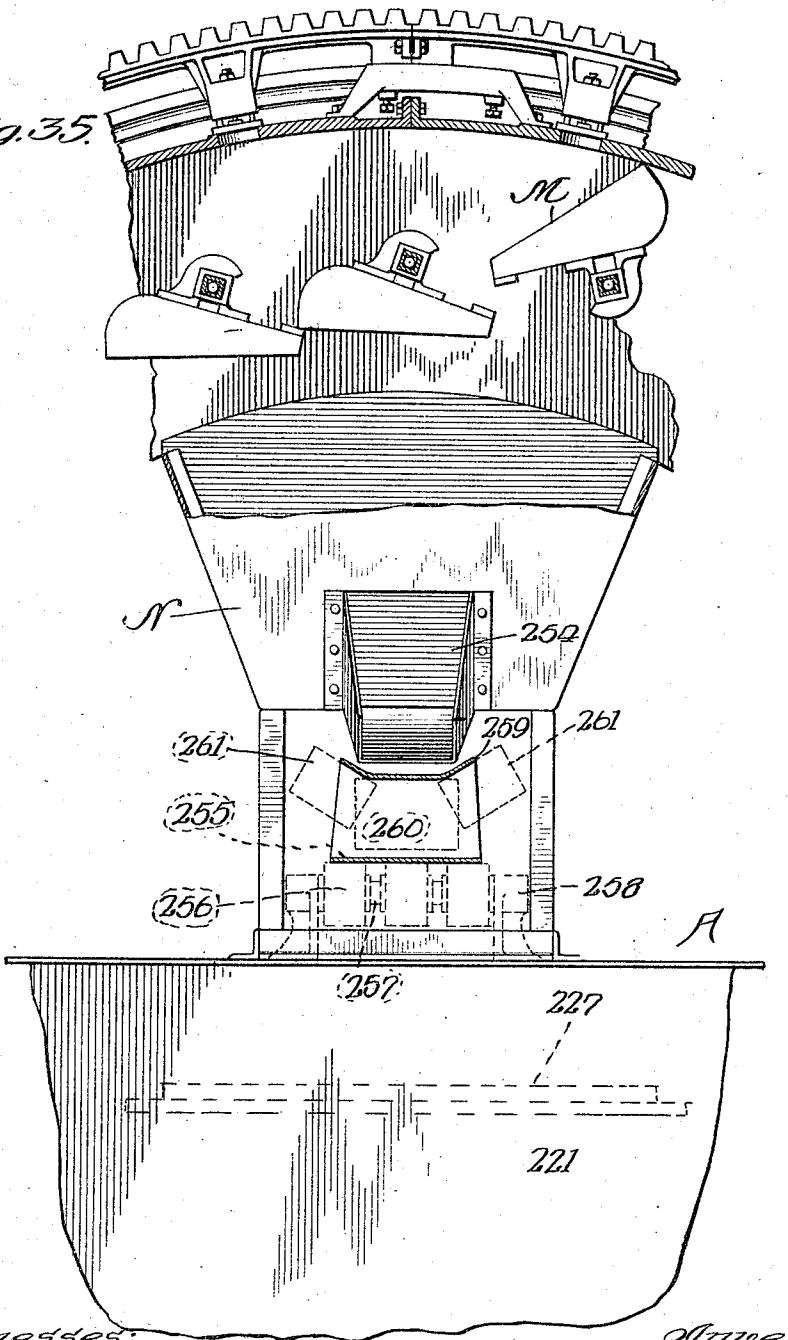
APPLICATION FILED NOV. 6, 1915.

1,306,361.

Patented June 10, 1919.

20 SHEETS—SHEET 20.

Fig. 35.



Witnesses:
R. A. Terry
Chas. Kourek.

Inventor:
Henry R. Wahl
By Jno. S. Elliott
Atty.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

HENRY R. WAHL, OF CHICAGO, ILLINOIS.

HYDRAULIC SEPARATOR FOR CRUSHED ORES.

1,306,361. Specification of Letters Patent. Patented June 10, 1919.

Application filed November 6, 1915. Serial No. 60,019.

To all whom it may concern:

Be it known that I, HENRY R. WAHL, a citizen of the United States, and resident of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Hydraulic Separators for Crushed Ores, of which the following is a full, clear, and exact specification.

This invention relates to improvements in hydraulic separators for crushed ores, in which it has heretofore been sought to separate the slimes from the finer and coarser sands by an ascending current of water under pressure, depositing the sands on the bottom of the water containing tank, and from which the sands are discharged through an opening, with the result that there is an objectionable loss of water; and also to improvements in hydraulic separators and classifiers, heretofore consisting of a number of sorting chambers and individual tanks therefor, supplied from separate sources of water and overflowing from one tank to the other, with the result, however, that the finer pulp, or slimes are diluted to an objectionable degree.

My invention further relates to improvements known as "Sand-slime classifiers" wherein heretofore the sand together with some of the slimes settle on the inclined bottom of a containing tank, from which they are discharged at a point higher than the water level by a mechanical means, such for example, as reciprocating scrapers, or helical conveyers, the agitation of which is intended to prevent to a certain extent the settling of the slimes, further augmented if desired, by water sprays directed against the sand before being discharged, which operation, however, necessitates repetitions detrimental to efficiency and capacity.

My invention also further relates to improvements in "de-watering machines" for crushed ores, or tailings, heretofore discharged from their containing tank by a scraping operation, such as an endless chain with scraper flights, or a revolving wheel with attached scrapers, the use of which is objectionable because of the wear and tear thereto, from their frictional contact with the bottom of the tank, and which for discharging of crushed ore is more seriously objectionable because of pulverizing the ore and thereby producing slimes, difficult of recovery.

For a clearer understanding of my invention, its objects, and the importance of the results attributable and thereby secured, it is to be observed, that in the preliminary preparation of ore for treatment by concentration, it is first crushed by suitable machines, the operation of which reduces some of the particles to powder, others from a number of grains of very fine sand to coarse gravel, which in milling parlance are for convenience grouped and distinguished as "slimes, fine sand, coarse sand, and gravel," the very fine powdered ore of which is designated as "slimes" and the coarse as "gravel."

In ore milling, it is usually necessary for practical and economical reasons to grade the ore into various convenient sizes before treatment on machines adapted thereto, in order to separate the valuable mineral from the inclosing worthless gangue rock, and which is usually accomplished by means of the well known device of revolving or shaking screens, or by the likewise well known various types of hydraulic classifiers, of which the revolving or shaking screens separate the particles contained in crushed ore according to their size, and the hydraulic classifiers according to their specific gravity, or settling ratio in water, modified however, according to the style of the apparatus used.

The recovery of valuable minerals contained in slimes has heretofore been so difficult as to require the use of specially designed apparatus in order to reduce loss; and the presence of slimes among sand or coarser material being treated on machines suitable only to such coarser work, is obviously detrimental to good results.

With a perforated screen, the perforations in which for practical reasons are commonly limited to diameters much greater than the diameter of the ore particles termed slimes, such immediate separation of the slimes is not possible, for the reason that the water sprays used in screening carry the slimes through the perforations along with the finer sand, with the result that they must be subsequently separated either by a hydraulic or mechanical classifier, which entails the use of additional apparatus and a further dilution of the slimes, both of which for reasons before stated are not only undesirable, but objectionable.

Furthermore, in hydraulic classifiers heretofore employing an invented conical or pyramidal hopper in which crushed ore introduced therein, descends through a rising current in a classifying column and overflowing the hopper, and a spigot through which the classified ore is discharged, the separation of slimes from sand and gravel is rendered more or less imperfect and correspondingly objectionable from overcrowding and from eddying currents produced in the classifying chamber, caused by the action of their spigot discharge and other causes as will be pointed out in the following.

In other words, in efforts to classify crushed ores of mixed sizes in a classifier of the above type, it is evident that the direct cause of overcrowding therein is due to the fact that the rising current after leaving the classifying column, has a constantly decreasing velocity in its upward movement before overflowing, because of the increasing area of the inverted pyramidal hopper above same.

The effect of this decreasing velocity is, that ore particles not heavy enough to settle against the rising current in the classifying chamber, are lifted out of same by the current, to a higher level in the hoppers with the result that the reduced velocity of the current is sufficient to equal the settling power of the ore particles.

The particles then settle, until again they meet a current of sufficient velocity to lift them, thus continuing a repeated rising and falling or "teetering" movement, until the space above the classifying chamber has become filled with such moving particles from the stream of ore continuously supplied from the superimposed hopper.

However, when the point of maximum density or "viscosity" is reached, the addition of ore particles thereto from above, causes a corresponding quantity to be forced out, to settle against the current to the bottom of the column and be discharged from the spigot, along with the heavier particles which have easily settled therein.

Under such conditions, it is obvious that an accurate classification is impossible for the reason that ore discharged from the spigot always consists of heavy particles that naturally would settle in a current of a certain velocity, and those that would not, but have been forced down by crowding of the particles immediately above the classifying column.

One of the purposes of my invention is therefore to provide a classifying column with a rising current of differing velocities and an upwardly tapering contraction therein, into the side of which the ore may be introduced and thereby separated first into two groups; the lighter particles being lifted into an upper portion of the column in which a current of sufficient velocity sorts out particles of desired maximum size and at the upper limit of their movement, they are directed into a trap, and their return thereby made impossible, and whereafter they are conducted from the classifier as a classified product.

Concurrently with this trapping of these lighter particles, the teetering particles are separately removed from the path of the rising current and settle in a by-pass, parallel with and adjacent to a lower portion of the classifying column below the contraction in the current, in which the particles too heavy to be lifted then settle out of the current and together with the particles discharged from the by-pass are lifted out of the water by a mechanical means and finally discharged from the classifier in a substantially dehydrated condition.

From the foregoing it will now be apparent that any means for separating the slimes from and dehydrating the coarser material of crushed ores, which provides for the use of additional means, by which it is possible and practical to concurrently therewith separate the finer material, such as sands from the slimes, and substantially promote a better sizing or grading of both the finer and coarser materials, will be a material and substantial improvement in hydraulic separators.

The prime object of my invention broadly stated is to provide a hydraulic separator for crushed ores, wherein the slimes are separated from the ores by a rising column or currents of water, with means for concurrently therewith dehydrating the ores before their discharge therefrom.

A further object of my invention is to provide a hydraulic separator and classifier with means whereby a rising current or column of water may be utilized to separate the slimes from the crushed ores and classify at one operation the slimes, sand, and gravel contained in ore pulp, and whereby they may be separately discharged therefrom for subsequent treatment.

Another object of my invention is to provide a hydraulic separator with means mechanically agitating crushed ores containing slimes constantly ascending to the surface of a rising current or column of water in a containing tank, from which the slimes continuously discharge, and whereby a complete separation of the slimes from the ore particles is made possible and practical.

A further object of my invention is a hydraulic separator and classifier wherein the classifier is contained within a tank filled with clear water, from which the ascending currents used in classifying are taken, for sustaining the steadiness of ascending currents of water for ore separating and

classifying purposes, and as is not practical when the source of the rising column of water is under varying pressure due to external causes.

A further object of my invention is to provide a hydraulic separator and classifier with means for mechanically agitating ore pulp in a column of water at a point between the rising separated slimes and the separating point therefrom of the sands, whereby the slimes are prevented from settling with the sands.

Another object of my invention is to provide a hydraulic separator and classifier with means mechanically agitating crushed ores in a rising current or column of water through which their slimes constantly ascend to the surface of the water and the gravel and sands settle at the bottom of a water containing tank, whereby the ore particles are not only freed from slimes, but may be elevated above the surface of the water, discharged from the machine in the absence of a scraping operation, and in a substantially dehydrated condition.

Another object of my invention is to provide a hydraulic separator and classifier wherein there is a rising current of water with a discharge opening in a plane below the surface of the water, the relative location and size of which opening is such that a velocity of water is provided sufficient to classify sands in sorting chambers adapted therefor.

A further and important object of my invention is to provide a hydraulic separator and classifier with means of trapping classified sands, at the limit of their upward movement in an ascending current or column of water in the several sorting chambers, followed by subsequently conducting them from the machine, and whereby the up and down, that is to say, the "teetering" movement of the sands in a rising current, or column of water and their subsequent crowding is prevented and thereby an accordingly accurate classification of sands is made possible and practical.

Another object of my invention is to provide an ore separator and classifier with mechanical means adapted to lift either slimes, sand or gravel, or all three deposited in the bottom of a water containing tank, in the absence of a substantially wearing frictional contact therefor, the operation and time of which mechanical lifting means is such that the water and slimes are substantially discharged in their entirety prior to the discharge of such sand and gravel from the machine.

With these ends in view, my invention finds embodiment in certain features of novelty in the construction, combination and arrangement of parts by which the said objects and certain other objects are attained, all as hereinafter fully described with reference to the accompanying drawings, and more particularly pointed out in the claims.

In said drawings:—

Figure 1 illustrates a side elevation of a hydraulic separator and classifier in which my invention finds embodiment.

Fig. 2 is a horizontal section taken on the line 2—2 of Fig. 5.

Fig. 3 is a vertical section taken on the line 3—3 of Fig. 5.

Fig. 4 is an enlarged vertical section taken on the line 4—4 of Fig. 3, looking in the direction of the arrows, but terminating on the bottom of the sorting chambers.

Fig. 5 is a vertical longitudinal section taken on a line central through Fig. 1.

Fig. 6 is a vertical section taken on the line 6—6 of Fig. 4, looking in the direction of the arrows, and therefore in the opposite direction of Fig. 3.

Fig. 7 is a detailed end elevation on the line 7—7 of the packing box shown in Fig. 9.

Fig. 8 is a transverse section taken on the line 8—8 of Fig. 9.

Fig. 9 is an enlarged detailed section showing the bucket containing rotor, the roller supports therefor, and one of the end supporting bearings for the shaft of the rollers, in section, and the other with cover in place.

Fig. 10 is a transverse section taken on the line 10—10 of Fig. 6.

Fig. 11 is a similar section taken on the line 11—11 of Fig. 6.

Fig. 12 is a similar section taken on the line 12—12 of Fig. 6.

Fig. 13 is a vertical section taken on the line 13—13 of Fig. 14.

Fig. 14 is a vertical section taken on the line 14—14 of Fig. 13.

Fig. 15 is an enlarged detail end elevation of the rotor showing the driving mechanism therefor.

Fig. 16 is an enlarged front elevation of the driving mechanism.

Fig. 17 is an enlarged transverse section of the rotor showing the circular rack therefor in side elevation.

Fig. 18 is a transverse section taken on the line 18—18 of Fig. 17.

Fig. 19 is a vertical longitudinal section taken through the circular rack.

Fig. 20 is a transverse section taken on the line 20—20 of Fig. 19.

Fig. 21 is a section taken on the line 21—21 of Fig. 22.

Fig. 22 is a section taken on the line 22—22 of Fig 21.

Fig. 23 is a detail front elevation looking from the left of Fig. 21 with one of the buckets shown internally thereof in dotted lines.

Fig. 24 is an enlarged detail sectional view of the upper end of the bucket shown in Fig. 22.

Figs. 25, 26, 27, 28, 29 illustrate in detail the several parts of the bearings for the dehydrating buckets and the support for their counter-balance weight.

Fig. 30 is a vertical section through a modified construction of a hydraulic separator and classifier taken on the line 30, 30 of Fig. 31.

Fig. 31 is a vertical section taken on the line 31—31 of Fig. 30.

Fig. 32 is a vertical section taken on the line 32—32 of Fig. 31.

Fig. 33 is a transverse detail of the water supply pipes taken on the line 33—33 of Fig. 3.

Fig. 34 is a detail vertical section taken on the line 34—34 of Fig. 31, and—

Fig. 35 is an enlarged detail side elevation showing the hopper receiving the dehydrated ore discharged from the buckets and the chute through which such ore is discharged from the machine.

Similar characters of reference indicate the same parts in the several figures of the drawings.

For clearness of description and understanding of the purposes of the structure in which my invention finds embodiment, it may be generally described as consisting of an operating water tank A, Figs. 1, 5, 7, 9, 15 and 22, preferably filled with clear water supplied from water reservoir B, Figs. 2 and 3, by means of pipes or water supply system C, Figs. 1, 2, 3, 5 and 33, and also high pressure water supply D, Figs. 1 and 2.

Detachably secured to and submerged in the contents of the water tank A is a slime separating hopper E, Figs. 2, 3, 4 and 6, supplied with crushed ores from a feed box F, Figs. 2, 3 and 4. Underneath the hopper E and secured thereto is a sorting chamber H, a rectangular structure composed of various passages for the ore and containing in the lower portion of its length, the classifying columns I, wherein sand is separated from gravel by means of a rising current of water derived from water tank A, the velocity of which is controlled by the relative area of the sand discharge outlet within the hoppers J, Figs. 1, 2, 3 and 4, individual to the several classifying columns, and the hydraulic head or depth existing between the said outlets and the surface of the water in water tank A.

Within the upper portion of the sorting chamber H are the agitating and disintegrating chambers G, in which is a perforated plunger actuated by eccentrics and shaft mounted on a suitable support on top of water tank A, the action of which, in a rising current of water therein, caused by a slight difference in the levels of the water in tank A and the slimes in the hopper E, prevents the settling of slimes, and causes their overflow at the upper edges of the slime separating hopper E, from which they are conducted by suitable means for subsequent treatment.

Adjacent to the upper edges of the slime separating hopper E, and parallel thereto, is a water level control K, Figs. 2, 5 and 6, comprising an overflow when so caused, of the water in tank A, by a surplus thereof, which is conducted away by means of troughs and pipes therefor and discharged into the hoppers J for convenience.

Encircling the slime separating hopper E and sorting chamber H, and partially submerged in the water tank A, is the rotor L, Figs. 1, 2, 3, 5, 9, 14, 15 and 23, consisting of a short cylinder with closed periphery and relatively large end openings forming a U-shaped section thereof, the projecting end plates of which terminate in tires which rest and roll upon two pairs of rollers suitably mounted on shafts projecting through the sides of the tank A and caused to revolve thereon by power transmitted by a link chain belt to a circular rack concentric with the periphery of the rotor.

Pivoted between the end plates of the cylinder and movably secured thereto are a series of scoop shaped buckets or dehydrating ore dischargers M, Figs. 5, 22, 30 and 35, spaced at intrevals near the wall of the periphery, the purpose of same being to elevate out of the water, dehydrate and finally to overturn about their pivots by gravity, or if need be, by a positive mechanical means, and discharge the gravel deposited therein after its passage through the sorting chamber H, through a forcible impact against the next preceding bucket, down into the discharge hopper N, Figs. 1, 3, 5 and 30, whereafter the ore passes through a spout in same and may be carried off by the usual means for subsequent treatment.

In order to steady the rotor while revolving and maintain its vertical position on the rollers, two pairs of guide rollers are provided above the water in tank A at diametrically opposite points of the tires and bearing against the sides of same, in opposition to each other.

The driving mechanism O, Figs. 1, 2, 15 and 16, consists of a rigid frame supporting the bearings for the shafts, pulleys and reduction gearing, power to which may be transmitted by belt or any usual means and thereby operating a relatively small sprocket chain wheel in alinement with the circular rack surrounding the periphery of the rotor L and imparting motion to same by an endless link chain belt in mesh therewith.

The eccentric jacks P, Figs. 8, 13 and 14 consist of shafts at suitable places below the rotor projected through the sides of the water tank A, with stuffing boxes for same secured thereto, and rigidly mounting two pairs of eccentrics with straps opposite the

tires on the rotor, by means of which a lifting force can be exerted against same when the shafts are turned by a lever and the rotor held in position, should it become necessary to remove the supporting rollers for repairs through suitable doors provided in the ends of water tank A opposite the rollers.

The water tank A is rectangular in shape, and in length and height considerably greater than it is wide, with its opposing ends 1 converging downwardly from the top of the tank, and is supported by short iron pedestals 2 projecting downwardly with reference to each end and the opposing sides thereon, preferably resting upon concrete columns 3, on a foundation 4, suitable therefor, which tank, as before stated, is preferably formed from sheets of steel riveted together, and reinforced by suitable angle irons as shown in Figs. 1 and 8.

In each end near the bottom and opposite the rollers 127, see Fig. 8, openings are provided for the removal of same for repairs and closed water-tight by covers 147^b.

At the top A^1, Figs. 1, 2 and 3 and extending a distance each side of the center, a portion of the tank is flared out to accommodate the slime separating chamber E.

The water reservoir B consists, see Fig. 3, of a tank 5, the bottom of which is supported by means of a suitable structure 6, above the water level to be maintained in the water tank A, and constitutes essentially a low-pressure constant level system; the difference in height between the water levels in the reservoir 5 and in water tank A when in operation, being only from one to two feet and sufficient to overcome the friction of the water through the pipes comprising the water supply system C.

This reservoir furnishes the major quantity of water supplied to tank A under an even pressure, due to the constant level maintained therein.

Water supply system C from the reservoir consists of a downwardly projecting pipe 7, provided with a contracted end portion 8, secured thereto by a suitable coupling 9, in open communication (see Fig. 33) with three separate pipes, 10, 11 and 12, branching laterally therefrom, respectively closed at their outer ends by cocks 13, 13, each of which is provided with an adjustable plug 14, for cleansing purposes.

Branch pipes 10 and 12 are connected toward their opposite ends with the bottom of the tank A, by means of upwardly projecting short pipes 15—15, and couplings 16—16, suitable therefor, and the branch pipe 11 being likewise connected with the bottom of the tank A, by means of short pipes, and suitable couplings 17—17, inwardly from the pipes 15, and a short distance removed from the pipe 8, the several branch pipes 10, 11 and 12 extend approximately the full length of the tank and the several pipes, or nipples, 16 and 17, serving to so distribute the supply of water to the tank in such a manner as to maintain uniformity in the admission of water ascending in tank A.

When necessary, the water inlets 16, 17 serve also as drain-outlets for ore dropped through the holes 107, Figs. 5, 19, provided therefor in the periphery of the rotor L, to the bottom of water tank A and thereafter discharged from the tank by opening cocks 13.

The contracted end portion 8 of the pipe 7 is continued to the opposite side of tank A, and terminates at a point 8^a distantly up from the bottom and in open communication with same, thereby insuring a water supply should the other inlets 15, 17 become choked.

The water for the tank 5, is supplied from any suitable source through a pipe 18, provided with a cut-off consisting of a stop-cock 19, and whence the water is conducted through a pipe 20, and is discharged at the ends of a horizontal outlet 21, located at a point sufficiently below the level of the water in the tank to prevent the contents of the tank from being charged with air from the water discharging therein, so as not to disturb the surface.

The pipe 20 is connected to the pipe 18 by means of a balanced float valve 22, the valve of which is automatically actuated by means of a float structure 23, of any construction adapted for maintaining a constant water level in the tank and further augmented by an overflow through an opening 24, located well toward the top of the tank.

High-pressure water-supply D (see Figs. 1 and 2) consists of a pipe 25, connected with an elevated tank (not shown) or other high-pressure system, provided with a shut-off valve 26, discharging near the top of the operating tank A, the discharge of water into the tank being regulated by means of a balanced float valve 27, the valve of which (see Figs. 2) is connected with a float 28, by an arm 29, the purpose of same being to maintain a constant level in tank A.

The valve structure as a whole is of a construction in ordinary use for similar purposes.

The pipe 25 is also terminated in a horizontal outlet a sufficient distance below the surface of the water in tank A, for similar reasons as given above for outlet 21 in tank 5.

Slime separating hopper E, is supported from the side walls of the tank A, as indicated in Figs. 2, 3, 4 and 6, is of pyramidal form, inverted and submerged in the contents (see Fig. 6) of the tank A, and provided at two of its ends with troughs 30—30, and along one side with a trough 31 of greater width than the troughs 30—30, and

from which latter their overflow is discharged through pipes 33—33, and whence the separated slimes may be conducted and stored for subsequent treatment, recovering the minerals therefrom.

Feed box F (see Figs. 3 and 4) is arranged in a plane above and adjacent to one side of the slime-separating chamber and is provided with a discharge opening 34, and preferably with a metallic lining 35, through which opening crushed ore mixed with water is discharged upon a sectional liner plate 36 protecting the opposing wall of the slime-separating hopper E from wear.

Mounted upon the upper section of the liner plate 36, are a series of spaced wedge-shaped fingers 37, which (see Fig. 4) are pivoted at their lower ends upon lugs 38, upon which they may be swung to vary their adjustment relatively to each other and to the stream of ore discharging from the feed box, the fingers being secured in their adjusted position by means of screw bolts 39, passing therethrough to impingement with lugs 38.

At the top of the hopper above the fingers 37, and inclosing a small area of the water surface above same, is a baffle plate 36ª, secured to lugs (not shown) on plate 36, for the purpose of preventing surface disturbances in the area beyond, from the ore and water descending from feed box F.

Below the fingers 37, are a number of rows of wedge-shaped dividers 40, 41 and 42, in horizontal planes one below the other, the dividers of the upper row being in staggered arrangement with reference to the fingers 37, and likewise those of successive rows with reference to each other, with the result that the ore flowing from the feed box is first divided into a number of separated streams by the fingers, redivided by the adjacent row of dividers 40, and again successively redivided by rows of dividers 41 and 42, whereby there is a uniform distribution of the coarser and finer particles of ore entirely across the surfaces of the plate and then discharged therefrom.

The liner plate 36, (see Figs. 4 and 10) is provided with a number of tapered arms 43, projecting therefrom and provided at their lower ends with bosses 44, the purpose of which will be hereinafter described.

The agitators and disintegrators G, consist of a plunger 45, of which there may be any number, Figs. 4 and 11, formed of V shaped perforated plates, provided at their apices with an elongated opening 46, and suspended from a rod 47, passing through, and respectively having their bearings in the bosses 44.

The upper end of the rod 47, is provided with an eccentric strap 48, for an eccentric 49, the shaft 50 of which is provided with a beveled gear 51, meshing with a beveled gear 52, on a shaft 53, provided at its outer end with a pulley 54, operated (see Figs. 1, 2 and 6) by a belt 55, the opposite end of said belt engaging with a pulley 56, on a shaft 57, provided with a pulley 58, the power for operating which may be supplied from any suitable source (not shown) through a power transmitting bolt 59.

Sorting chamber H, Figs. 4 and 6, is so designated for the reason that the slimes are separated from, and the crushed ores sorted therein for subsequent treatment, and consists of a rectangular sheet metal structure 60, secured to the lower end of the slime separating chamber by bolts 61 (see Fig. 4), from which it projects downwardly (see Fig. 5) to a point between the opposing side flanges of the rotor hereinafter described, and is supported toward its lower end by angle clips 61ª resting on and detachably secured by screw bolts 61ᵇ to cross bars 61ᶜ, Figs. 4 and 6, bracing the sides of the water tank A.

As shown in the drawings, there are three plungers 45, each of which is inclosed by an open end box, formed by means of inverted L plates 62, riveted to the opposite sides of the sorting chamber H, and inverted U plates 63, riveted at their ends to the side walls of the sorting chamber adjacent thereto, so that the boxes together with their plungers are spaced apart and form the side walls of the receptacle, and the ore prevented from passing between them. The top surfaces of the above plates form shelves which build up with ore to a peak, thereby protecting the plates, and also divide the ore between the several plunger boxes.

The opposing side walls of the sorting chamber H, are, Figs. 6 and 11, provided with a series of openings 64, at intervals of each other, for the admission of clear water to the sorting chamber at a point between the plungers and the classifying column I, the admission of water therethrough being regulated by means of gates 65, consisting of bars 66, supported in guides 67, and provided with a corresponding number of openings 68, the ends of the bars being bent to form catches 69, for convenience in adjusting, either by hand or by a rod introduced downwardly through the tank A. The purpose of these openings is to permit the entrance of clear water to cause a rising current through and around the plungers 45.

Located toward the bottom of the sorting chamber (Figs. 6 and 12) are a number of transverse partitions 70, for rectangular chutes 71, open at their bottom ends and closed at their upper ends by means of gates 72 suspended from hanger rods 73, secured to a cross bar 74, in turn secured to the main hanger rod 74ª, and maintained in closed position shown by a latch construction above 74ᵇ, terminating in a handle 74ᶜ,

by means of which the gates 72 can be tilted in a vertical plane about their pivots 74^a, and thereby dropping and clearing the gates of any foreign matter or an over supply of ore in the passage above.

Classifying columns I, are located between the chutes 71 last above described, and the agitators and distintegrators G, and consist of arch-like chambers 75, open at their bases, and of which three are shown, side by side, extending transversely across the sorting chamber, and may consist of flanged sectional castings secured to the opposing side walls of the sorting chamber by means of rivets 76.

The arch-like chambers 75, are spaced apart longitudinally from each other and form the end walls of the sorting chamber a sufficient distance for the larger as well as the smaller particles of ore to descend between them out from between the plunger boxes 45, which latter are located immediately above the arches, as will be seen by reference to Fig. 6.

Within and extending lengthwise of each arch, is a trap 77, U-shaped in form, and provided at its opposite ends with flanges 78, riveted to the opposing side walls of the sorting chamber, and from which the trapped sands are discharged through an opening 79, and thence (see Fig. 4) by means of a pipe 80, into a sand discharging hopper J, there being as many sand discharging hoppers and connecting pipes as there are traps. From the hoppers J a suitable pipe connection J^1 conveys the discharged sand and water away for subsequent treatment.

As shown in Fig. 4 the openings 79 in the trap preferably register with a nozzle 81, connected by a flexible hose-pipe 82, with an elbow 83 for and bolted to the pipe 80, as indicated at 84, the elbow 83 being secured to the wall of the tank A by countersunk bolts 85, and provided with an internal nipple 86, in order to render the joint between the elbow 83 and the sorting chamber water tight, and for convenience in disconnecting the elbow from the sorting chamber for repairing purposes.

For cleansing the elbow 83 is provided with a branch 87, closed by a valve 88, the body of which provides a means for connecting a hose therewith, if necessary, for supplying water under pressure, for removing obstructions occurring anywhere in the passage between the traps and the sand discharge hopper therefor; the tank A may also be provided with a manhole 89, and a cover 89^a therefor, located shortly above the elbow 83, for access to the pipe 82.

The trap 77 supports longitudinally a division plate 90, below which and in central alinement therewith, is a by-pass 91, formed by plates 92 and 93 extending transversely of the sorting chamber and open top and bottom, the narrow, opposing end walls 94—94, composed of wood inserts, which preferably converge downwardly, forming (see Figs. 3 and 12) a correspondingly contracted discharge opening 95, through which sands rising in the classifying chambers and not trapped are discharged out of the classifying columns formed by the arches 75, and deposited upon the opposing surface of the rotor.

With reference now to Figs. 4 and 6, the dispositions of the various structures in the sorting chamber H, described in the foregoing, form a series of compartments and certain arrangement of parts, the passage of ore through which, will be pointed out in the following.

From the opening 34 in the feed box F, the ore descends by gravity over the liner-plate 36 and is divided and distributed by the fingers 37 and dividers 40, 41 and 42 into equal portions into each of the plunger chambers, where it settles on the steeply inclined faces of the plungers 45, which are operated with a vertical reciprocating movement by eccentrics 49.

In passing over the perforated plunger faces, some of the ore falls through the perforations and the balance also through the larger openings 46, and is thereby disintegrated and distributed on the top of the arches 75; whereafter it descends the passages between the arch chambers 75, until it meets the opposing surfaces of the drop-gates 72, forming of itself thereon, peaks of ore, with the sides sloping at an angle of approximately 45 degrees and extending transversely between the side walls of the sorting chamber H.

The bottoms of the arches 75 are placed sufficiently high enough above the drop-gates 72, so as to leave an elongated opening between same, through which the ore then passes into the classifying column I, where the separation of the sand from the gravel is accomplished; the sand being lifted by the rising current of water over the edges of the trap 77 and thereafter discharged through the pipes 80 into the hoppers J, while the gravel settling further against the rising current in the classifying columns formed between the plates 92, 93 composing the by-pass 91, and the transverse partitions 70 is finally deposited on the opposing surface of the periphery of rotor L, and thereby discharged from the machine.

Rotor L consists (see Figs. 1, 2, 3, 4, 5 and 15) of a short cylinder 96, provided with opposing side flanges 97—97, projecting at a right angle thereto and is therefore U-shaped in cross-section.

Projecting outwardly from the inner edges of the sides of the rotor at an angle of about

45 degrees are circular flanges 98—98, provided with angular bends 99, and riveted to plates 97, the upper sides of which come in close proximity to stationary deflecting plates 100, conforming thereto and converging inwardly from the opposing side walls of the water tank A, and to which they are detachably secured by L-shaped plates 101 with gun-lock or slip connection, and riveted to the deflecting plates, and which (see Figs. 2 and 3) are provided with perforations 102 for securing thereto the bent ends of tie rods 103, connecting and laterally bracing the sides of the water tank A.

The clearance space between flanges 98 and deflecting plates 100 is the only means of passage for the clear water surrounding the outside of the rotor into the interior space occupied by the sorting chamber H, the direction of current varying from horizontal at the surface to an angle of 45 degrees downward at the bottom according to the particular point considered with reference to a level line.

The peripheral wall 96 of the rotor is preferably made in sections provided with opposing flanges 104, which (see Figs. 17 and 19) are secured together by means of bolts 105 and provided at intervals with bosses 106, surrounding openings 107, providing draining outlets for material at intervals of the periphery of the rotor in case the space below the sorting chamber and the rotor becomes choked with same.

Openings 107 are respectively closed by a slide-valve 108, provided with a hollow stem 109, telescoping in a socket 110 projecting from a sectional rack 111, the sections of which (see Fig. 17) are provided with perforated lugs 112, and secured together by bolts 113 passing therethrough.

The slide valve 108 is seated upon a spring 114, resting upon the bottom wall of the hollow lug 110, through which spring and secured at one end of the valve, is a rod 115, projecting through the bottom wall of the socket 110 and provided with a nut 116 forming a stop limiting the thrust of the valve against the seat.

Straddling the flanges 104 of the peripheral wall 96 of the rotor is a U-shaped hollow casting 117, secured to the peripheral wall by bolts 118—118, which casting (see Fig. 20) confines an anti-friction ball raceway comprising a movable member 119 adjustable by means of screw-bolts 120—120 toward and from a raceway 121 formed in a lug 122 projecting inwardly from the circular rack 111 for anti-friction balls 123 separated by means of a perforated plate 124.

The peripheral openings 107 of the rotor are normally closed by valves 108, but when for any reason the space below the classifying chamber becomes choked, the valves may be unseated by reversing the direction of rotation of the circular rack as will hereinafter be described, until the classifying chambers are discharged of their choking material, and following which on reversing the movement of the rack while the rotor is stationary, the rotor will be again revolved in its operating direction, as will follow when the ends of the lugs 122 come in contact with the opposing end walls 125 of the castings 117.

The periphery of the rotor is provided toward its opposite side edges with segmental tires 126 rigidly secured thereto by any suitable means and resting upon rollers 127 (see Figs. 5, 9 and 15) of which there is a pair at the opposite ends adjacent the bottom of the operating water tank A, which several rollers are provided with flanges 128 between which the rotor is confined against lateral movement.

Each pair of rollers is respectively mounted upon an axle 129, the projecting ends of which are supported in journal boxes 130 inclosed in a casing 131, one-half of which is cast with a base support 132 resting upon a suitable foundation 133 of cement or other material, the other half 134 of which casing is detachably secured in its operative position for inclosing the journal box by means (see Fig. 8) of bolts 135.

The journal box 130 (see Figs. 8 and 9) is provided with a suitable lining 136 and is formed in two longitudinal sections respectively provided with trunnions 137 and 138, the axis of which is on a line extending through the axle 129 and the axis of the rotor, the ends of which trunnions are convexed and adapted to fit in concave bearing surfaces, one of which is in the end of a hollow screw 139 working in a boss 140 in the fixed half of the casing 131, the outer end of which screw is provided with an oil cup 141, for supplying oil to the journal boxes.

The journal boxes 130 are further supported in a direction transverse to the axis of the screws 139 and 146 by bearing against lugs 142 and 143, respectively secured to the fixed and removable members of the casing.

The convex end of the trunnion 138 has its bearing against a concave surface formed in the end of a step-bearing 144, slidable in a boss 145 on the fixed member 131 of the casing, and is adjustable therein by means of a screw bolt 146 working in the boss and against the end of the step bearing 144, with the result that the journal box automatically adjusts itself to alinement with the axle.

In this connection it should be noted that substantially the entire weight of the axle, rollers 127, also the rotor L is supported upon the concave surface of the lower step bearing 144, which remains stationary while the adjusting screw 146 may be easily turned

for adjustment, and that the screw-threads are amply proportioned for a strain tending to break them.

As a means for allowing the removal of the rollers and shafts from the tank A, a slot 147 in the sides of the water tank (see Figs. 8 and 9) is cut away extending to the end of the tank, as indicated by dotted lines in Fig. 8, adapted to be slidably filled by a diaphragm 148 seated in the slot and provided at its inner end surrounding the shaft with a faced boss 148ª for forming a tight joint between the adjacent edges of the walls of the tank A projected therein and the interior of the journal casings 131, 134.

An extension, 149, of the removable cover 134 (see Fig. 9) closely fitting and bolted to the sides of the tank A forms a final water tight joint inclosing the rectangular openings 147.

For the removal of the rollers and shaft through the end wall of tank A an opening is provided, 147ª, closed by a removable cover 147ᵇ bolted to suitable angle iron connections.

Surrounding the axle and bearing against the boss 148ª is a packing ring (see Figs. 7, 9 and 13) consisting of a transversely divided casing 150, inclosing a flat star-shaped spring 151, surrounding and bearing against a fibrous packing 152 embracing the axle, the points of the star-shaped spring bearing against the inner periphery of the casing, through which latter are projected screw-bolts 153 for adjusting the tension of the spring, and taking up wear.

Projecting from lugs on the adjacent end of the journal box 130 are pins 154 screwed therein forming supports for coiled springs 155—155, for holding the packing box 150 tight against the boss 148ª, and for which purpose one end of each spring abuts against a collar on the pins 154, and the other against the packing box.

Seated against the outer surfaces of the opposing side walls of the rotor L and projecting through suitable openings therein (Figs. 1, 5, 21 to 30 inclusive) are bushings 156, from which (see Figs. 21 and 23) project lugs 157—157, each of which is provided with curved slots 158 through which project a rod 159, provided at its outer end with nuts 160, and on which between and bracing the side walls of the rotor is a pipe separator 161.

Seated against the outer end of and projecting into concave bushings 156 are sleeves 162, in which is respectively confined and seated against their inner ends are convexed sockets 163 and 164, the inner surfaces of which sockets diverge outwardly from their center of length as indicated at 165 (Fig. 21) and furnish rocking bearings for the ends of a hollow angular shaft 166 to which is fixed buckets 167 having the form of scoops, which by means of brackets 168 are secured (Fig. 22) to the bottom of the buckets by bolts 169, the brackets being provided with square openings for the passage of the shaft therethrough, and whereby the buckets are fixed to the shaft.

Projecting outwardly from the seating flanges of the sleeves 162—162 are brackets 170 (Figs. 21 and 26) for a tightening rod 171, provided at its projecting ends with nuts 172 for tightening the sleeve 162 against the bushing.

Surrounding the spherical socket piece 163 is a collar 173 provided with a screw hole 174 for a tightening screw securing the collar to the socket piece, the collar (see Fig. 28) being provided with a boss 175 in which one end of a rod 176 is screwed, from the other end of which is likewise suspended a bucket counter-balancing weight 177 designed and arranged to tilt the bucket over and face down previous to the discharge of the load therefrom as indicated in Fig. 5, and in position for receiving another load as it approaches the bottom of the rotor.

The swinging movement of the bucket is limited by projecting stops 156ª from the bushings 156 making contact with similar projections 168ª on the brackets 168, and as a result of which the bucket is prevented from making a complete revolution around its axis of rotation.

By turning and adjusting the bushings 156 about their axes within the limits of the slot 158, the position of the projecting stops 156ª can be changed; thereby affording a means of giving to the bottom of the buckets 167 more or less slope with relation to a level line, and resulting in a dewatering period of greater or less duration, as will be further explained.

As will be seen by reference to Fig. 5 there are a series of these buckets so arranged that when tilted over to their discharging position the closed end of one swings to a striking overlapping engagement with the other, that is to say with the end wall of one overlapping the opposite end of the bottom of the other, until they are successively moved by gravity to their filling position, in which they are maintained by the end of the projections 168ª coming in contact with the rigid opposing projections 156ª on bushings 156.

It will now be observed that with the buckets arranged and suspended as above described, their contact with the peripheral surface of the rotor is confined to the edge of their end wall, and that when loaded and following their passage above the level of the water in the tank their bottoms are gradually tipped downwardly toward their open end, and so gradually that the water is drained from their ore contents until by the time they reach their discharging posi-

tion the ore is dehydrated before discharging into the hopper N.

The sides 178, bottom 179 and end wall 180 of the bucket are for lightness, strength and durability perferably formed from sheet metal with the bottom and end wall covered with a reticulated material such as coarse wire fabric 181, overlaid with canvas, felt, or any other substantially porous material 182, protected for wearing purposes by a sheet metal plate 183 provided with a series of perforations 184 throughout its surface (see Figs. 22 and 24).

The object of the wire fabric and canvas is to provide for an air space between the contents of the bucket and the bottom and end wall thereof for quickening and insuring the discharge of the contents of the bucket in its entirety by preventing the clinging of the ore thereto, which heretofore has been a serious detriment in discharging ore from buckets not so fitted, and caused by the capillary attraction or vacuum formed between a layer of sand and a smooth, even surface.

In other words, with the commencement of the draining of the water from the buckets on rising to a plane above the surface of the tank water, the water that has accumulated between the canvas and the bottom of the bucket discharges therefrom between the wires forming the meshes in the coarse wire fabric, whereupon the space becomes filled with air, the effect of which is to break the vacuum forming beneath the ore and prevent it from clinging to the perforated wearing plate, or in its absence to the canvas, while in the meantime more or less drainage of the water from the ore takes place through the chamber.

The air space is continued a short distance beyond the edge of the bucket bottom and around underneath, and is formed by a U-bend 185 in the wearing plate 183, unperforated at this section, and which terminates in a drip 186, from which the water elevated in the buckets drops onto a drip apron 187, thence by means of a spout 188 back into tank A, (see Figs. 3, 4, 5, 22 and 24).

The wearing plate 183 is bolted to the body of the bucket by means of bolts 189 and 190. Between bolts 189 and spaced a suitable distance therefrom, are shown three soft rubber buffers 191, cylindrical in shape, grooved to fit a corresponding hole in plate 183 and canvas 182, with its base in firm contact with the bucket bottom 179, due to the pressure on plate 183 by bolts 189.

The purpose of the buffers is to reduce the vibration caused by the closed end wall of the bucket following, in tilting and striking the inverted open end of the preceding bucket, and therefore prevent a possible loosening of parts.

The water level control K, Figs. 1, 2, 4, 5 and 6, constitutes an over-flow device or maximum level regulator for the water in tank A, and consists principally of a knife-edge adjustable weir of either wood or metal, supported by one of the sides of a trough 192, adjacent to troughs 30—30 of the hopper E, communication between same being prevented by a partition 193, extending transversely across the top of tank A and therefore forming a receptacle for an overflow of water on the weir K.

The pipes 194 projecting from the side of the tank A, opposite the troughs 192, and in open communication therewith, convey the water to the sand discharge hoppers J, wherein it is discharged for convenience of disposal though not necessarily limited to same.

The weirs K are secured in their adjustment by screw bolts 195 through elongated slots (not shown) in the weir and therefore easily adjustable for height and level. Similar adjustable weirs K are provided on the inner edges of the troughs 30 and 31 for over-flowing slimes from hopper E, the difference in height between these weirs and weirs K being predetermined by the required depth of flow over the weirs on troughs 30 and 31. Weirs K are then adjusted in position a trifle higher than the water surface in hopper E, thus giving the necessary hydraulic head between same and causing the water constantly supplied to tank A from reservoir B to rise through the passages in sorting chamber H and overflow from the hopper E, thereby accomplishing the separation of the slimes from the sand and gravel.

Ore discharge hopper N, Figs. 3, 4, 6 and 30, consists of a rectangular box-like sheet metal structure, with an open top and two of its ends diverging upward from the bottom, constituting a receptacle for the ore discharged from the buckets M.

It is supported on top of tank A at a suitable height therefrom, by an angle iron structure 196, which also forms a support for the bearings of shafts 50 and 53, operating eccentric straps 48 and eccentrics 49.

From an opening in either side of the hopper and a spout 197, the ore may be conveyed to suitable machines for recovery of the mineral therein, either direct or by means of a belt conveyer.

The driving mechanism O, Figs. 1, 2, 15 and 16, consists of a rigid frame 198, mounted on top of the water tank A over one end of same and secured thereto, containing a bearing for the ends of a shaft 199. Mounted in the middle of the shaft, in alinement with the circular rack 111, surrounding the rotor L, is a sprocket wheel 200, keyed to the shaft by a key 201. Motion is transmitted to rotor L by a link chain

belt 202, passing over the circular rack 111, and the sprocket 200 and in mesh with the teeth thereof.

At one end of shaft 199, and secured thereto, is a gear wheel 203, meshing with a smaller pinion gear 204, secured to one end of a shaft 57, to which power may be transmitted by any suitable means, (not shown) through a pulley 58 mounted on same.

Attached to the frame 198, are lugs 205, mounting therein a short shaft 206, secured in place by screw bolts 207, and supporting at the other end, free to turn thereon, a roller 208, the periphery of which, makes contact and rolls against the opposing side of the rotor tire 126, its axis being in alinement with a radial line from the center of the rotor L. Two opposing rollers are placed at nearly diametrically opposite positions in a similar manner and supported by a rigid frame 209, thereby maintaining the rotor L in a vertical position and limiting its lateral movement.

Separating the frames 198 and 209, is a pipe separator 210, held in place by tie-rods 211, threaded at each end for nuts 212, for the purpose of maintaining the alinement of shafts 206.

The eccentric jacks P, Figs. 8, 13 and 14, consist of shafts 213 projecting through the sides of the water tank A, each end having a shoulder 214 for support in stuffing boxes 215 and terminating in a squared portion 216, for a socket lever operated by hand and by means of which the shaft may be turned. Mounted upon each shaft are two eccentrics 217, preferably made in halves, keyed to the shaft by a key 218, and held together by screw bolts 219.

The eccentrics, Figs. 13 and 14, are grooved for and confine a strap 220, free to revolve therein, in alinement with the tires 126 of the rotor L, and adapted to exert a lifting pressure against same, thereby supporting the rotor and allowing the removal of the rollers for repairs when necessary.

With the foregoing description in mind, it will now be possible to follow a detail description of the operation when fed with ore and its various actions during its passage through the machine.

With the commencement of operations, the water tank A is first filled with water from the reservoir B, to a point level with the overflow weirs on the slime separating hopper E, and the level maintained by regulating the shut-off valve on the water supply system C, after the level in tank 5 has risen to a predetermined height above the level in tank A and maintained by means of a float-valve on the supply pipe therefor.

Under these conditions, water would be continuously discharged from the end of pipes 80 into hoppers J, the said pipes terminating a considerable height below the level in tank A and with relation to their individual area, calculated for a discharge that will cause a rising current of desired velocity in the classifying columns I, by way of the traps 77.

Water is also turned on at the high pressure system D, until the hopper E has a slight overflow and maintained thereat by a float-valve 27 causing thereby a rising current in the agitation chambers G, by way of the openings 64, 68, Figs. 6 and 11.

Power is next applied to the pulley 58 setting in motion the rotor L and the agitating plungers 45, through the perforations of which the water surges and recedes in its vertical movements, thus giving an upward impulse on the down stroke and a suction downward on the up stroke of the plunger through each perforation.

The rotor now slowly revolving, the buckets attached therein emerge from the water on the upward moving side, each elevating in its upward travel a quantity of water. As the movement continues, the bottom of the bucket gradually assumes a position approaching the horizontal, thus pouring off the water, until when near its uppermost position, the front of the bucket points downward, and the water elevated by the buckets will have been discharged back into tank A by means of the apron 187 and spout 188.

When about to reach its uppermost position, the bucket is over-balanced by the tilting weight therefor, and overturns on its pivot, each bucket in turn striking the inverted bottom of the preceding bucket for ore discharging purposes, and continuing its travel, is gradually brought back to its original position when it has reached its lowest position.

The crushed ore it is desired to separate and classify, is then fed into feed box F, together with sufficient water to make a dilute pulp, and preferably in a manner that will give an even distribution over the full width of the opening therein 34.

The ore then descends over the liner plate 36, between the fingers 37, and is thereby divided into several separate streams, the quantities of which are controlled by adjusting the fingers.

The slimes, being already dilute, now detach themselves from the coarse grains by the movement through the water thereof, and wander to a position near the center of the hopper, where the commotion is less and thus tend to settle to a lower position.

The gravel and sand, together with some slimes inclosed therewith, descend farther and are again divided successively by the staggered rows of dividers, and thereby evenly distributed over the disintegrating chambers G.

Ore and water now entering the hopper E

in a constant stream, the level rises, causing an increased overflow at the weirs thereon, and simultaneously therewith, the water level in tank A also rises, due to the constant addition of water thereto; but, the weirs K having been previously adjusted to a height in excess of the anticipated rise in level, no water overflows; and the levels in hopper E and tank A have thereby become equalized momentarily, but overflowing at the top of E.

The final adjustments are now made by means of the stop-valve and float-valve on the high pressure water supply D, which will cause a continuous current to rise from the bottom of the hopper, through and around the plungers, having its entrance through openings with gates therefor, 64 and 68.

When the quantity of water has been so regulated that the hopper E overflows in a smooth even manner, and without visible turbulence, the weirs K are then adjusted in a position even with the level of water in tank A; the maximum level of which is thereby controlled.

The level in tank A will now be a slight amount higher than that in hopper E, being actually the hydraulic head necessary to overcome the friction of the openings and passage through the plungers, and cause a flow of the water upward through the hopper.

Any excess of water now entering tank A, or obstruction of any of the passages, will cause a rise of level and overflow at the weirs K; which is carried off by means of troughs 192 and pipes 194 and discharged into the tops of hoppers J, to join with the clear water discharging therefrom.

The slimes which have become detached from the coarse grains in the hopper, are now carried up by the rising current to the surface and finally overflow into troughs 30; whence they are conducted away by pipes 33 for subsequent treatment to recover the valuable mineral.

The ore descending into the agitation chambers G, containing the plungers 45 operating therein with a rapid reciprocating movement of short stroke, meets the rising current issuing through the perforations and the clearance spaces thereof, the surging and recession through which, together with the general agitation, results in the disintegration of the sands inclosing slimes, separating them therefrom and carrying them up to the surface of the water, whence they also finally overflow into troughs 30.

The gravel and sand, not being lifted by the current, descends through the perforations and openings in the plungers, being thereby thoroughly mixed and evenly distributed over the arch structures inclosing the classifying columns, and then descend farther in the passages between the same, until deposited on the drop-gates 72 on which the ore forms a sloping heap conforming with its angle of repose, and henceforth rolls off same through a transverse opening in one side, and enters the classifying chamber I, about midway of its height.

Opposite the opening and forming one side of an upwardly tapering contraction thereby, is a by-pass extending transversely the full length of the opening and with its entrance 91 adjacent to the narrow width of the contraction. The other side of the contraction at its narrowest width is formed by a bead on the end of the arch chambers and off-set toward the by-pass with relation to a vertical plane through a point over the greatest width of the contraction.

The ore thus enters at one side of an upwardly tapering contraction and is projected at an angle downward thereto.

As stated before, a rising current is caused in the classifying columns by the discharge of water from the ends of pipes terminating in hoppers J; the velocity of which, however, differs in places thereof, due to increasing or decreasing the area of the column.

The gravel and sand, being now free from slimes, enter the rising current, the velocity of which being increased by the contraction at the inlet, separates immediately the lighter coarse grains and sand, projecting them upward to a chamber above, where the velocity of current is less and sufficient only to lift grains of the desired maximum size.

The grains easily lifted by the current, pass up and out of the chamber in a current of greatly increased velocity, which may be twice that in the chamber and thereby counteracting the tendency of the grains to settle.

At the upper limit of their movement, the grains enter the trap 77, the general direction of current therein being downward, and are thereby prevented from returning and also removed from the path of other rising grains.

From the trap, the classified sands are discharged through openings 79 and pipes 80 into the hoppers J, the velocity of current in the pipes being again increased and may be four or five times that necessary to lift the grains in the classifying column.

The grains lifted into the chamber above the contraction, too heavy to be carried upward into the trap, tend to settle; but meeting the current of high velocity at the contraction are again lifted up, thus continuing a teetering movement, until finally reaching a position over the by-pass inlet 91, in which the current is of less velocity, they settle and descend therein and drop

out of the by-pass through the opening 95, whence they are deposited on the inner surface of the rotor periphery.

The gravel now being free from sand, descends through the rising current below the contraction, and also passes out of the classifying column, separate and adjacent to the by-pass, and is finally deposited on the inner surface of the rotor periphery.

With the rotor now slowly revolving, the gravel resting on the inner surface of the periphery is carried along and elevated to a point where the periphery assumes an angle too steep for the gravel to remain thereon, whence it rolls into and is picked up by the scoop shaped buckets and continues its upward travel.

Emerging from the water, the bucket now contains the gravel and a quantity of water filling the interstices thereof, and in its upward travel, any solids still held in suspension, have an opportunity and time to settle therein.

As the bucket continues upward, the bottom thereof gradually assumes a horizontal position, thereby pouring off the water, until when near its uppermost position, the front of the bucket points downward and the water elevated by same, will have been discharged back into tank A by means of the apron and spout therefor.

When about to reach its uppermost position, the bucket is over-balanced by the tilting weight and overturns on its pivot, the gravel thereby falling out and dropping into the discharge hopper N, whence it is discharged through an opening and spout 197 and carried off in any suitable manner for subsequent treatment.

At the limit of its overturning movement, the back edge of the bucket strikes the inverted bottom of the preceding bucket with enough force to dislodge any grains still remaining therein, and prevented from clinging to the bucket by the air space provided between the bottom thereof and a porous false bottom on which the gravel has rested; the air space also having been cleared of water during the upward travel of the bucket, by gradually pouring out the water therein.

The bucket now being cleared of ore, its travel continues downward; and half-way, again enters the water; whereafter, it turns back on its pivot until when near its lowermost point, it has been returned to its original position; thus completing one of a continuous cycle of operations.

From the foregoing description it will readily be seen that I have produced such a device as substantially fulfils the objects of the invention as set forth herein.

While this specification sets forth in detail the present and preferred construction of the device, still in practice, such deviations from such detail may be resorted to as do not form a departure from the spirit of the invention.

It will now be observed that with a machine constructed and operating as above described, my invention provides a means by which is is not only possible, but practical to separate the slimes from ores, classify the sands therein, dehydrate the coarser particles of the ore, and discharge them in a dehydrated condition from the machine continuously, and therefore by a single operation.

My invention, however, also provides a means for the separation of the slimes from the coarser sands and particles of crushed ore and dehydrating the separated coarser sands by a single continuous operation, when for any reason it is necessary or desirable to do so, as will now be pointed out with reference to Figs. 30 to 35 inclusive, of the drawings, and by substantially the same means before described for separating the slimes from the sands, and coarser particles before the classification of the sands and the subsequent dehydration and discharge of the coarser particles from the machine.

In other words, as will be seen by reference to Figs. 30 and 31, the agitators, the sorting chamber and the classifiers are omitted, and a slime separating chamber 221 is provided, consisting of opposing downwardly converging side walls 222 extending across, secured to and closed at their ends by the side walls of the operating tank, and extending from the upper edge of the tank downwardly to a point shortly above the opposing inner edges of the side flanges of the rotor.

The converging sides of the slime separating chamber together with deflecting plates 223 secured to the side walls of the water tank serve to contract the bottom-opening 224 of the slime separating chamber, for directing the crushed ores therefrom to the rotor, for their elevation and dehydration by means of the buckets before described for that purpose, and their discharge into the ore discharging hopper N, as before described.

In operation the crushed ore is introduced to a hopper 225 provided with a perforated bottom 226 submerged in the contents of the water tank and through which the ore discharges into the slime separating chamber, with the result that the coarser particles descend therethrough, and are conducted as before stated into the rotor in the path of the dehydrating buckets, and from which the slimes are carried upwardly by the rising currents of water, and discharged through openings 227, therein, into supplemental slime separating chambers 228 at op-

posite sides of the slime separating chamber 221.

It will now be observed that the velocity of the ascending currents of water in the slime separating chamber is substantially greater than that of the water in the supplemental slime separating chambers 228, and from which the slime-containing water overflows into troughs 229, one for each supplemental slime separating chamber, from which the slimes are conducted through pipes 230 for subsequent treatment, and that as a result of this difference in velocity coarser particles of sand will be precipitated from the slimes discharging into the supplemental slime separating chambers 228 depositing on the bottom thereof, and which it is desirable to remove and dehydrate with the still coarser particles discharging through the bottom of the slime separating chamber 221.

As a convenient and effective means for this discharge of the sands from the supplemental slime separating chambers there is preferably employed a shaft 231 journaled at its opposite ends in suitable stuffing boxes 232 in the outer end walls of the water containing tank, to which are secured screw conveyers 233, one for each supplemental slime separating chamber, the inner ends of which project through and beyond the opposing walls of the slime separating chamber 221, which inner ends are inclosed by a pipe 234, through which the deposited sands are conducted and thence directed to the elevating dehydrating buckets by means of spouts 235, which may be formed integral with the pipe.

Each pipe 234 at its opposing ends is provided with openings through which are projected adjustable stuffing boxes 236 and a bar 237, the opposite ends of the pipe being fixed to the side walls of the water tank.

Sleeved on the shaft 231, and rigidly secured to the casing 234 is a follower 238, one end of which projects into the stuffing box and the other into a casing 239 forming an oil chamber to which the oil is supplied from a cup 240, connected by a pipe 241 with the oil chamber 239 and supported by such pipe in a plane above the level of the water in the tank.

The follower 238 performs three functions, that of an oil tight closure for the oil chamber 239, a bearing for shaft 231, and at the same time a plunger for adjustably compressing and tightening a suitable packing contained in a chamber 242 in the stuffing box 236, and for which purpose the follower is provided with a flange 243 for the reception of one or more adjusting screw bolts 244 passing therethrough into the bar 237 supporting the stuffing box, and therefore a means of drawing same against the follower to compress the packing.

For operating the shaft and the screw conveyers thereon, one end of the shaft is provided with a pulley 245 for a belt 246, passing around a pulley 247 on a shaft 248, connected by a belt 249 around pulleys 250 and 250[a], on a shaft 251, supported by and having its bearing in brackets 252 secured to (see Fig. 30) a frame supported on the water tank on which shaft is a pulley 253 driven by any suitable means from any source adapted therefor.

As a convenient means for conducting the dehydrated, coarser sands from the hopper N to some suitable place for subsequent treatment, the hopper (see Fig. 35) is provided with a spout 254, discharging upon a belt conveyer, the bottom side 255 of which is supported upon rollers 256, upon a shaft 257, journaled at its ends in suitable brackets 258.

The top side 259 of this belt is supported at intervals of its length upon horizontally arranged rollers 260, between which and at the opposite edges of the belt are converging rollers 261, suspended from suitable supports (not shown) sustaining the adjacent sides of the belt in an upwardly inclined position, and thereby converting the top side of the belt into a traveling trough for conducting the dehydrated ore away from the separating machine, but for which purpose any other suitable form or construction of conveyer may be used.

In operation for the separation of slimes from coarser sands subsequently dehydrated, the tank is first filled with water as above described, from any source suitable therefor, to a level with the overflow of the water therefrom into the trough 229, followed by the introduction of water to the bottom of the tank from the pipe system 7 before described, and in turn followed by the discharge of ore from the feed hopper 225 through the perforations in the bottom thereof, downward by gravity into the slime separating chamber.

Following the entrance of the ore into the slime chamber the rising current of water meeting the slimes descending in the hopper are thereby prevented from settling in the slime hopper, but are lifted and pass out through the opposing end openings 227 in the side of the hopper, which pass thence into the auxiliary chamber, where after in their passage toward the overflow, the heavier particles thereof settle to the bottom, and are conducted thence by the screw conveyer to and through the contracted end of the slime separating chamber, whence they descend by gravity to a position of rest upon the opposing surface of the rotor and are thereafter elevated above the surface of the water, dehydrated and discharged from the hopper N as before described.

With the rising of the slimes, and their discharge into the trough 229, and thence through the pipe 230, the finer sands are discharged from the machine with the slimes, it being the purpose and intention in the structure described to separate and dehydrate only the coarser sands contained in crushed ores, the machine in this instance not being intended to either separate or classify the finer sands, as in the construction shown in the preceding figures of the drawings.

It is now to be observed that in the common usage of the term "slimes" in ore milling, considerable latitude is taken in grouping minute particles of ore of various sizes under this term, as for example, the slimes may include particles that would pass through a one hundred mesh screen, but remain on a two hundred mesh screen, together with particles that could pass a two hundred mesh or even finer screen, such as bolting cloth.

When slimes first separated from crushed ores, however, contain particles not desirable to be subsequently treated as slimes, because of their coarseness, my invention provides a means for separating these coarser particles from the slimes and also for classifying them with the ores from which the slimes were originally separated, and this before the discharge of any of the ore from the separator for subsequent treatment accordingly.

To these ends, (see Figs. 30, 31 and 32) my invention includes the use of a supplemental slime separating chamber 228, located adjacent to and receiving the slimes discharging from the slime separating chamber, and in turn overflowing into a trough 229 from which they are conducted by a pipe 230, for subsequent treatment, of which supplemental slime separating chamber, trough and pipe there may be two, that is to say, one at each side of the slime separating chamber E.

The supplemental slime separating chamber 228, or chambers as may be, are by means of the pipes 234 provided with open passages communicating with the bottom of the slime separating hopper above the agitating plungers 45, which pipe however if desired may be extended downwardly and have the discharge openings in the vicinity of the inner peripheral surface of the rotor, but in either event it will be apparent that the velocity of the rising currents of water in the supplemental slime separating chamber will be less than in the primary slime separating chamber E, because of the deflection of the overflow of the slimes from the path of the water ascending directly through and from the bottom of the reservoir.

As a result of this reduced velocity in the rising column or currents of water in the supplemental slime separating chamber and the time required for the passage of slimes from the primary slime separating chamber, across the supplemental slime separating chamber, the coarser particles above referred to are by gravity separated from slimes, and unite with the ores in the separator from which the slimes had before been separated on conducting them into the pipe 234, when its discharge end opens below the agitating plungers 45, or in the classifying columns wherein these slime particles will be classified simultaneously with the classification of the ores with which they are then united, or when the openings of the pipe are adjacent the inner peripheral surface of the rotor as may be when the classifying columns, etc., are omitted from the separator as specifically shown in Figs. 30, 31 and 32.

Any means suitable for conducting the deposited particles from the supplemental slime separating chamber into the pipe 234, may be employed, but in practice I have shown the use of a screw conveyer 233 projecting into the pipe.

Although my invention finds its embodiment in the preferred form of construction herein shown and described various changes and modifications may be made therein without departing from the spirit of my invention, and I therefore do not wish to be limited to the precise details of construction set forth, but on the other hand that my invention be extended to include any and all such variations and modifications as come within the scope of the appended claims.

Having described my invention, what I claim and desire to secure by Letters Patent is:—

1. A hydraulic separator comprising in combination a slime separating chamber, a rotating dehydrator surrounding said chamber, and means for producing directly rising currents of water in and common to both said separator and dehydrator.

2. A hydraulic separator comprising in combination a slime separating chamber, a rotating dehydrator surrounding said chamber, and means for producing currents of water common to and directly ascending through said separator and dehydrator.

3. A hydraulic separator comprising in combination a slime separating chamber, a rotating dehydrator surrounding said chamber, and means for producing currents of water rising on a vertical line from the lower portion of the dehydrator and ascending directly through the separating chamber.

4. A hydraulic separator comprising in combination a slime separating chamber, a rotating cylindrical dehydrator, discharging buckets directly pivoted thereto and encircling said slime separating chamber, means for producing currents of water as-

cending in a direct line from the dehydrator upwardly through said separating chamber, means by which crushed ores are conducted by gravity through said separating chamber and ascending currents of water from the dehydrator, said dehydrator being provided with a continuous receiving surface encircling said chamber and upon which the descending ores are deposited by gravity in a plane below the separating chamber.

5. A hydraulic separator comprising in combination means for separating slimes from crushed ores, a rotatable dehydrator for and surrounding said means, and means by which crushed ores are deposited by gravity from the slime separating chamber to a position of rest upon the surface of the dehydrator by rising currents of water ascending on a line through the axis of the rotatable dehydrator and directly through the separating chamber.

6. A hydraulic separator comprising in combination a slime separating chamber, means for conducting crushed ores therethrough by gravity, a continuously moving circular receiving surface surrounding and in the path of the ores descending through the separating chamber, and means for producing currents of water ascending from said receiving surface directly through the slime separating chamber.

7. A hydraulic separator comprising in combination a slime separating chamber, a concentrically rotating dehydrator surrounding said separating chamber in the path of crushed ores descending by gravity from the separating chamber, and means for producing currents of water upwardly in the dehydrator, and through the separating chamber in the path of said descending ores.

8. A hydraulic separator comprising in combination a water tank, an open end cylinder projecting therein, rollers for supporting said cylinder above the bottom of the tank, a slime separating chamber surrounded by said cylinder from which ores are deposited by gravity upon the inner surface of the cylinder, a number of pivoted scoops arranged at intervals on and opposing the inner surface of the cylinder, and means for automatically swinging said scoops gradually from their loading to their discharging position for discharging the water and dehydrating the ore contained therein.

9. A hydraulic separator comprising in combination a slime separating chamber, a revolving means surrounding said chamber, adapted to receive and elevate above the surface of the water solid material deposited therein by gravity, from said slime separating chamber, and means for producing currents of water in the slime separting chamber in a vertical line passing through said chamber and the revolving means.

10. A hydraulic separator comprising in combination a fixed slime separating chamber, means for producing a continuously rising column or currents of water therein passing through the bottom end of said chamber, a moving surface surrounding said chamber for receiving solids discharging from the bottom thereof, and means pivotally supported from said moving surface for elevating and concurrently therewith dehydrating the solids so deposited.

11. A hydraulic separator comprising in combination a slime separating chamber, means for producing a rising column or currents of water therethrough, an open end cylinder revolving on a horizontal axis and surrounding the slime separating chamber receiving the solids deposited by gravity from said chamber, and means yieldingly engaging, lifting, dehydrating, and discharging said deposited solids from the separator.

12. A hydraulic separator comprising in combination a fixed slime separating chamber, means for producing a rising column or currents of water therethrough, a revolving surface below and for receiving the solids deposited in said chamber, elevating receptacles pivotally supported by said revolving means, and a surface for automatically gradually tilting said receptacles from their loading position to a position dehydrating and finally discharging their solid contents.

13. A hydraulic separator comprising in combination a fixed slime separating chamber, means for producing rising currents of water throughout, a continuous surface moving in a circular path and in a vertical plane around said chamber and receiving the solids deposited from the chamber on the inner periphery thereof, elevating receptacles pivotally supported by said moving surface, a means for automatically gradually tilting said receptacles from their loading position to a position dehydrating and finally discharging their solid contents.

14. A hydraulic separator comprising in combination a slime separating chamber, means for producing ascending currents of water therethrough, a tank adjacent thereto, and a submerged passage or passages between and connecting said chamber and tank, and a shifting, supporting surface below the separating chamber projecting entirely across the path of the solid materials descending through and discharging therefrom.

15. A hydraulic separator comprising in combination a slime separating chamber, means for producing column or currents of water rising therethrough, a water tank adjacent thereto, a water conducting passage or passages between said chamber and tank, a movable surface below said chamber and within said tank in the path of the ascending currents of water adapted to receive and

discharge from the separator the solid materials deposited thereon from the slime separating chamber.

16. A hydraulic separator comprising in combination a slime separating chamber, means for producing ascending currents of water therethrough, a revolving structure in the path of solid materials descending through said rising currents of water adapted to elevate said materials deposited thereon to a position above said slime separating chamber, and overlapping flanges for forming spaced connection between said revolving structure and the stationary walls for the slime separating chamber.

17. A hydraulic separator comprising in combination a slime separating chamber, means for producing a rising column or currents of water contacting with crushed materials descending therethrough, a tank for clear water projecting in a plane below the slime separating chamber, a revolving cylindrical conveyer surrounding the slime separating chamber, provided with a bottom isolating the contents of the tank from contact with the solid materials discharging from the slime separating chamber.

18. A hydraulic separator comprising in combination a slime separating chamber, provided with a bottom opening for the discharge of solid materials, means for producing a rising column or currents of water contacting with said materials, a water tank projecting in a plane below a slime separating chamber, means for supplying clear water to said tank in a plane below the slime separating chamber, a rotatable elevator surrounding the slime separating chamber, and means for preventing the escape of solid materials therefrom in passing from the slime separating chamber to the receiving surface of the elevator.

19. A hydraulic separator comprising in combination a slime separating chamber open at its bottom, a tank from which clear water is supplied thereto, means for producing currents of water rising from the bottom of said tank and ascending through the slime separating chamber, an elevating means interposed between said chamber and the bottom of the tank, and means for preventing solid materials descending through the slime separating chamber from contaminating the clear water in the tank.

20. A hydraulic separator comprising in combination a stationary water containing tank, means for maintaining throughout the body of water therein, constantly vertically rising currents of water, means for introducing crushed ores into said rising currents, and reciprocating means mechanically agitating said water at a point between the rising slimes and the separating point of the sands therefrom, provided with perforations adapted for the passage of all the ores therethrough, whereby the slimes are prevented from settling with the sands.

21. A hydraulic separator comprising in combination a slime separating chamber, a sorting chamber in open communication with said slime separating chamber, a reciprocating means for agitating crushed ores in rising currents of water at a point between their passage from the slime separating chamber and the sorting chamber.

22. A hydraulic separator comprising in combination a slime separating chamber, a sorting chamber, a contracted passage connecting said chambers, means for directing rising currents of water therethrough, a reciprocating agitator provided with a series of perforations through which the ores are conducted, whereby said ores are thereby confined with the zone of agitation of said agitator.

23. A hydraulic separator, comprising in combination a slime separating chamber, a sorting chamber below the slime separating chamber, provided with separated passages opening into the slime separating chamber, means for agitating in the sorting chamber the materials passing from the slime separating chamber.

24. A hydraulic separator comprising in combination a water containing tank, a slime separator and a sorting chamber submerged therein, means constantly maintaining ascending currents of water in said tank, slime separating and sorting chamber, a contracted passage connecting said chambers, and a mechanical means located in said passage reciprocating in the path of and agitating the column or currents of water ascending therethrough.

25. A hydraulic separator comprising in combination a slime separating chamber, a sorting chamber provided with a plurality of passages in open communication therewith, and a perforated reciprocating agitator located in each of said passages.

26. A hydraulic separator comprising in combination a water containing tank, a slime separating chamber submerged therein, a sorting chamber secured to and projecting below the slime separating chamber, means for supplying water thereto from the tank, means for continuously maintaining rising currents of water in and upwardly through said sorting chamber and slime separating chamber, and means for mechanically agitating said currents of water in the sorting chamber below the point at which the slimes are separated from crushed ores supplied thereto.

27. A hydraulic separator comprising in combination a water containing tank open at its upper end, a slime separating chamber, and a sorting chamber submerged in the contents thereof, means permanently maintaining currents of water of constant velocity as-

cending directly through said slime separating and sorting chambers, and means for conducting clear water from the tank directly into the sorting chamber at a point intermediate the ends thereof.

28. A hydraulic separator comprising in combination a water containing tank, a slime separating chamber, and a sorting chamber submerged in and surrounded by the contents thereof, means for maintaining rising currents of water in said slime separating and sorting chambers, means for conducting clear water from the tank directly into the sorting chamber at a point intermediate the ends thereof, means for conducting clear water from the tank directly into the sorting chamber toward the upper end thereof, and means internally of the tank for regulating the amount of said clear water.

29. A hydraulic separator comprising in combination a water containing tank, a slime separating chamber, a sorting chamber immersed in the contents of said tank provided with passages in open end communication with said chamber, means for producing rising currents of water ascending centrally through the bottom ends of said chambers, and means for introducing clear water from the tank into the sorting chamber between said passages.

30. A hydraulic separator comprising in combination a water tank, a slime separating chamber submerged therein, a sorting chamber provided with open end passages in communication therewith, a separate agitator for and located in said passages, means for actuating said agitators, and means for introducing clear water from the tank into the sorting chamber at a point below the agitators.

31. A hydraulic separator comprising in combination a water containing tank, a slime separating chamber, and a sorting chamber submerged therein, provided at its upper end with spaced passages, agitators confined by and reciprocating in said passages, said sorting chambers being provided with openings through the sides thereof between said passages and above the lower end thereof through which to supply clear water to the sorting chamber downwardly into rising currents of water ascending in said chamber, and means for actuating said agitators.

32. A hydraulic separator comprising in combination a tank containing clear water, a slime separating chamber and sorting chamber, means for producing rising columns or currents of water in said tank, separating and sorting chambers, said sorting chambers being provided with a number of passages formed in their upper end wall separated from each other, and with openings between said passages, reciprocating agitators in said passages, means for operating said agitators whereby clear water is conducted from the tank to crushed ores discharging from said passage and into the rising column or currents of water therefor.

33. A hydraulic separator comprising in combination a slime separating chamber, a sorting chamber, provided with passages in open communication with the slime separating chamber, classifying columns in a plane below the sorting chamber and in the path of crushed ores descending through said passage, and means for maintaining rising currents of water in said chambers and both rising and descending currents of water within said columns.

34. A hydraulic separator comprising in combination a slime separating chamber, a sorting chamber provided with passages opening in the slime separating chamber, classifying columns below and opposing said passages open at their bottom, means for producing and maintaining rising currents of water respectively in and through said chambers and columns, and means for discharging directly from said columns the coarser particles of ore descending through the bottom thereof.

35. A hydraulic separator comprising in combination a slime separating chamber, a sorting chamber provided with passages therein opening into the lower end of the slime separating chamber, classifying columns below said passages, means for producing rising currents of water through said chambers and in said columns, and a by-pass submerged in its entirety for the particles of ore descending through said columns.

36. A hydraulic separator comprising in combination a slime separating chamber, means for producing rising currents of water therein, classifying columns in a plane below said chamber in the path of said current, closed at their upper and open at their bottom ends, a by-pass submerged in said currents and means for deflecting into said by-pass particles of ore descending the sides of said columns.

In witness whereof, I have hereunto set my hand and affixed my seal, this 4th day of November, A. D. 1915.

HENRY R. WAHL. [L. S.]

Witnesses:
MILDRED ELSNER,
JNO. G. ELLIOTT.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."