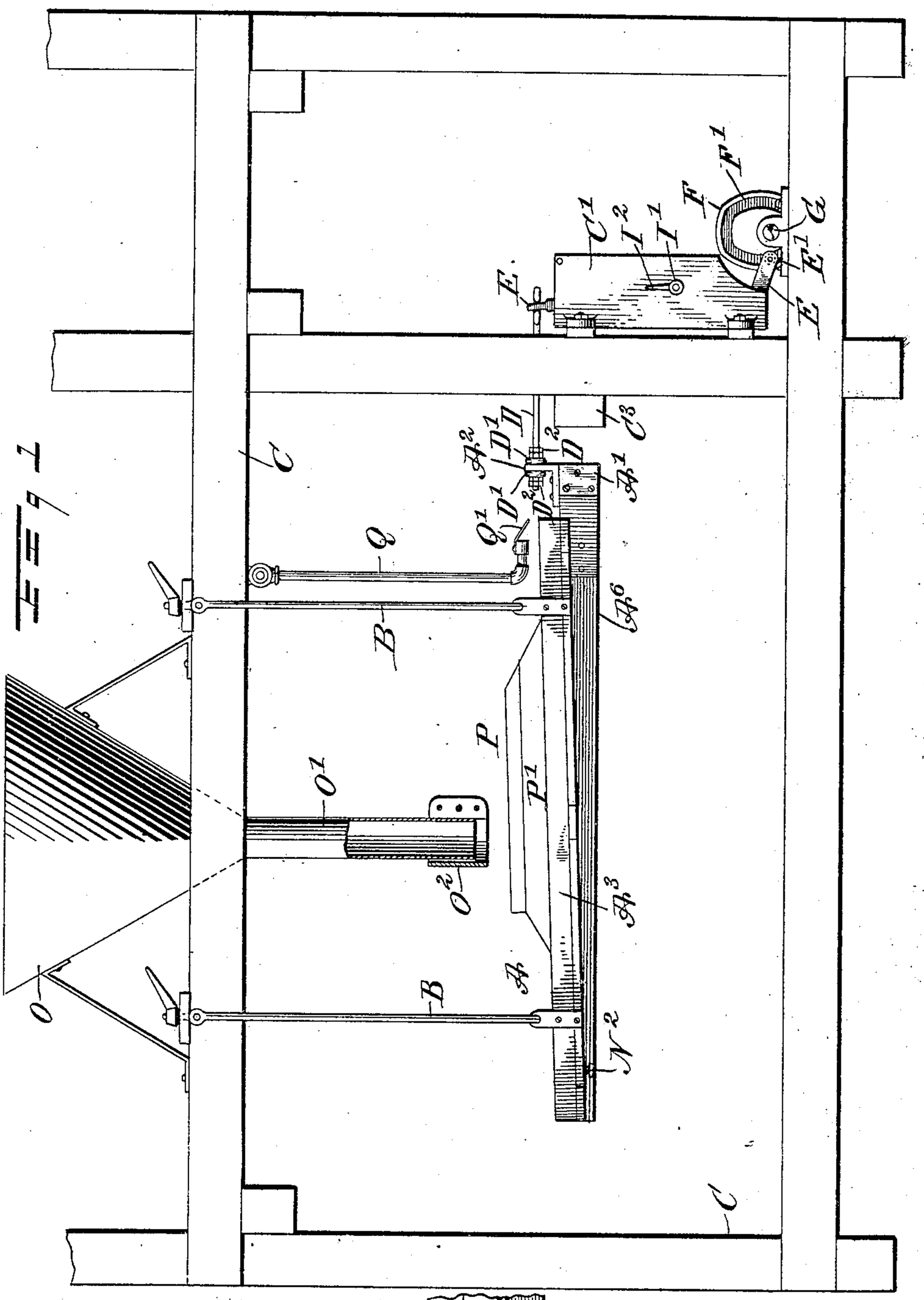
No. 835,397. PATENTED NOV. 6, 1906.

A. C. CAMPBELL.

COAL WASHER AND ORE CONCENTRATOR.

APPLICATION FILED OCT. 17, 1904. RENEWED SEPT. 14, 1906.

3 SHEETS—SHEET 1.



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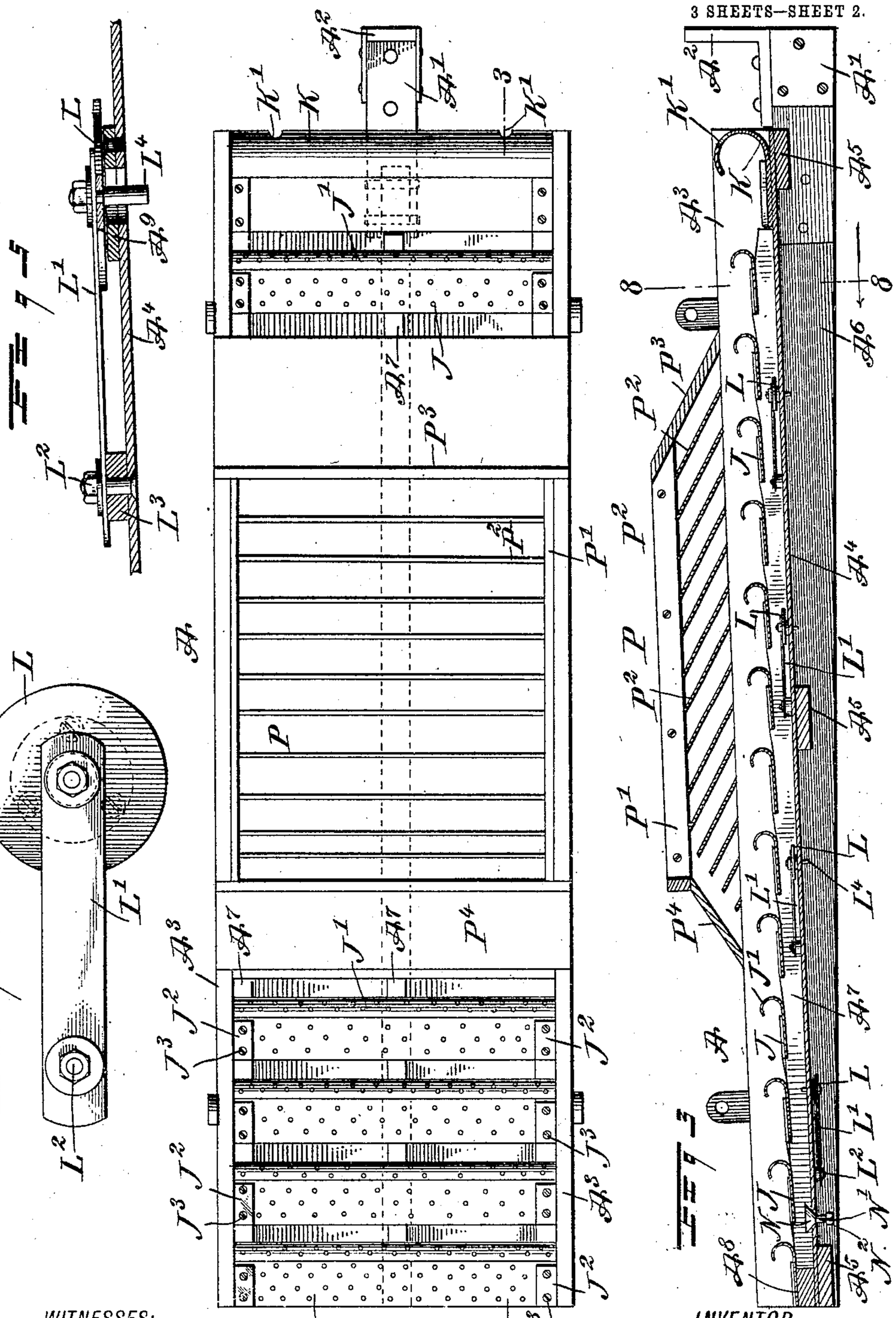

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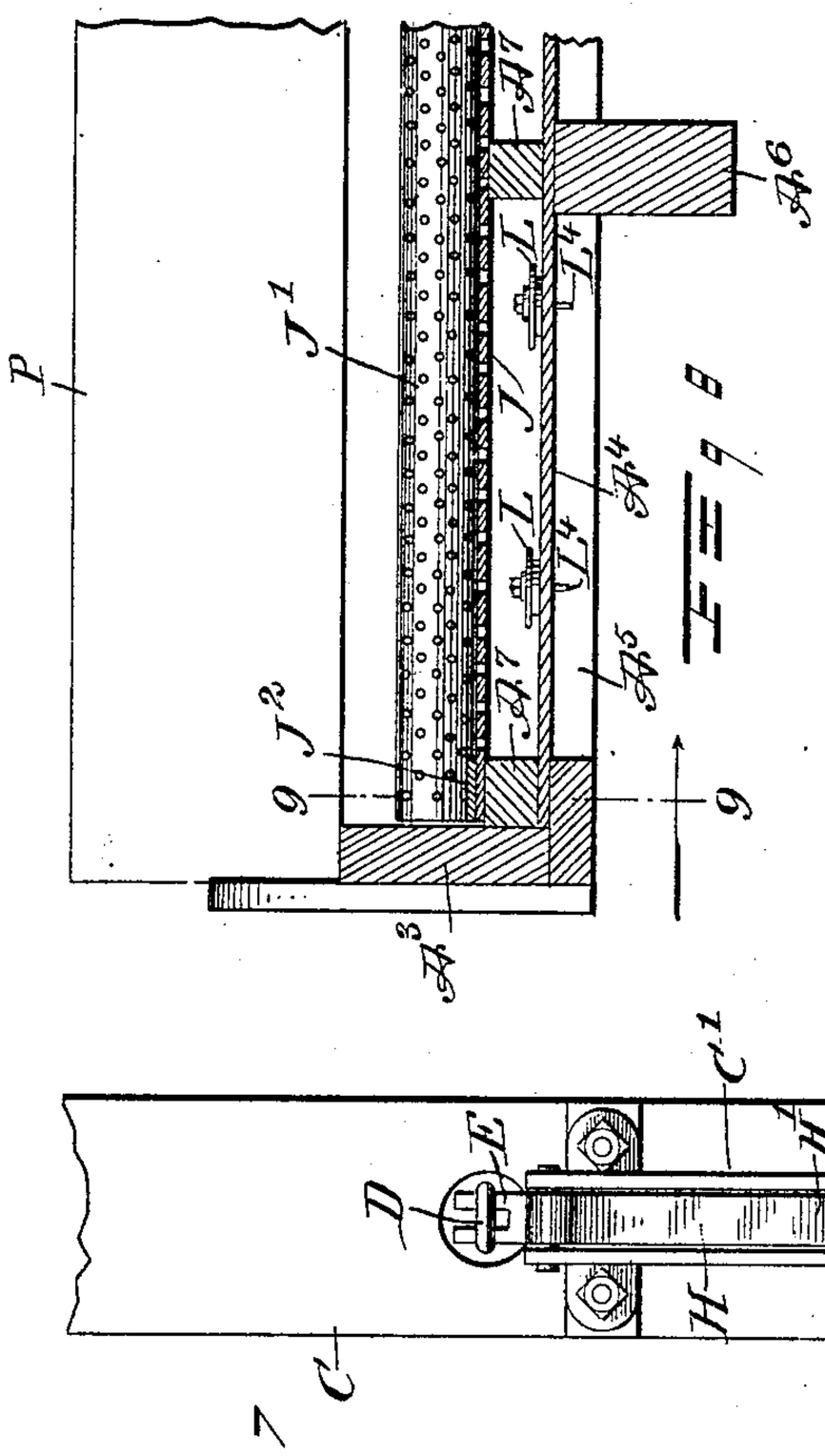

Fig. 8.

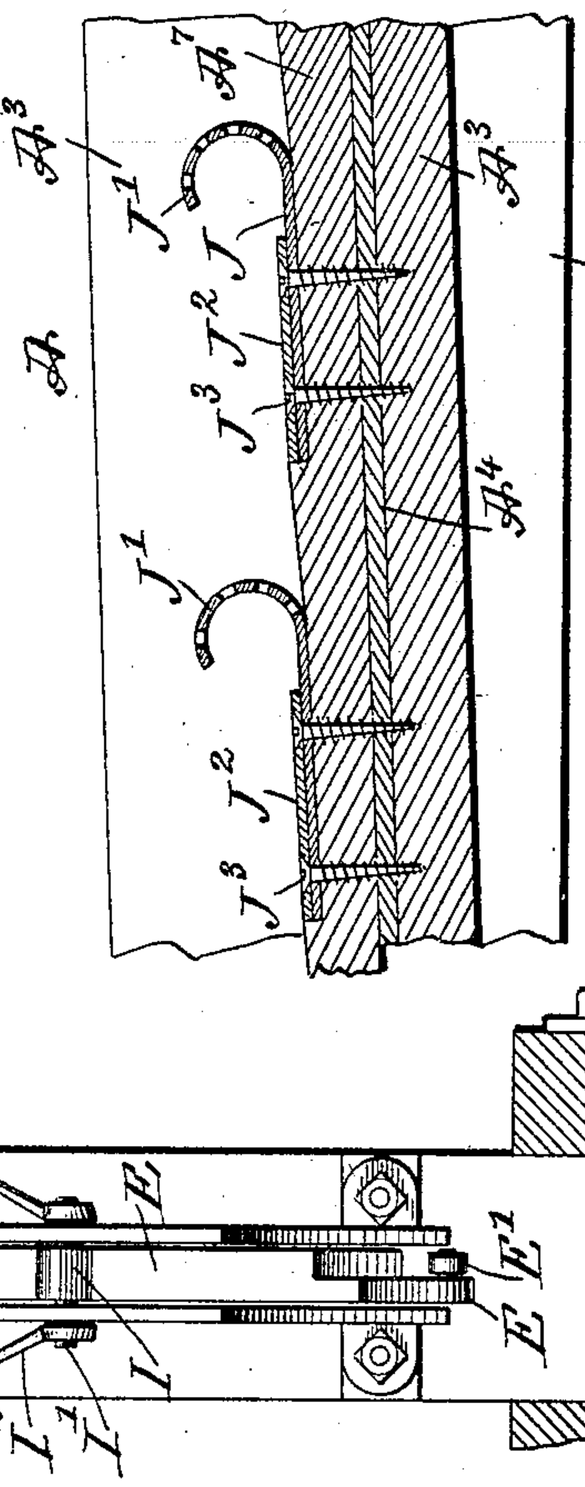

Fig. 9.

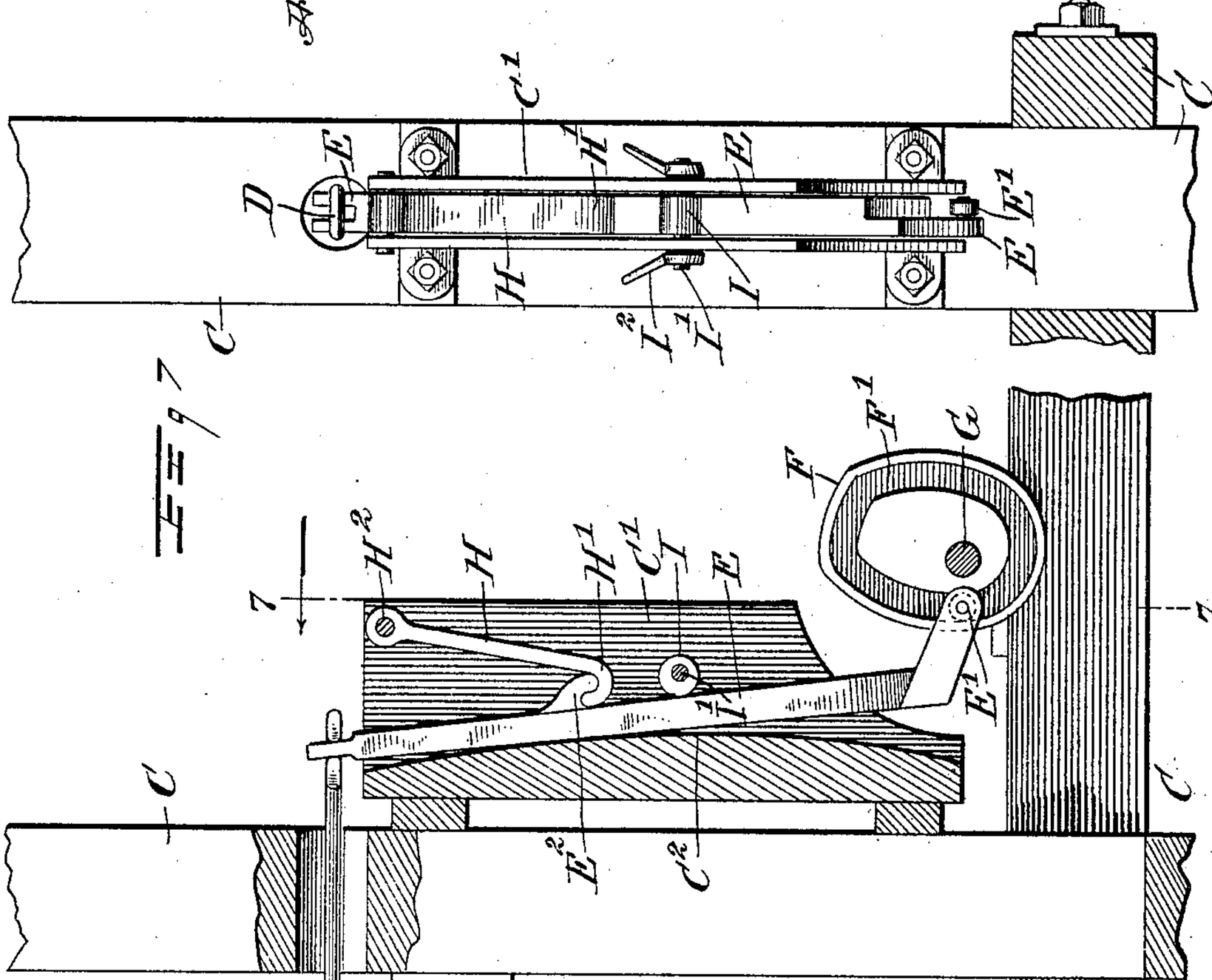

Fig. 7.

Fig. 6.

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UNITED STATES PATENT OFFICE.

ALONZO C. CAMPBELL, OF ASHEVILLE, NORTH CAROLINA.

COAL-WASHER AND ORE-CONCENTRATOR.

No. 835,397. Specification of Letters Patent. Patented Nov. 6, 1906.

Application filed October 17, 1904. Renewed September 14, 1906. Serial No. 334,598.

To all whom it may concern:

Be it known that I, ALONZO C. CAMPBELL, a citizen of the United States, and a resident of Asheville, in the county of Buncombe and State of North Carolina, have invented a new and Improved Coal-Washer and Ore-Concentrator, of which the following is a full, clear, and exact description.

The invention relates to coal-washers and ore-concentrators such as shown and described in the Letters Patent of the United States, No. 695,790, granted to me March 18, 1902.

The object of the present invention is to provide a new and improved coal-washer and ore-concentrator arranged to effectively separate the more dense material from the less dense material and to insure a uniform distribution of the material into the separating-pan.

The invention consists of novel features and parts and combinations of the same, as will be more fully described hereinafter and then pointed out in the claims.

A practical embodiment of the invention is represented in the accompanying drawings, forming a part of this specification, in which similar characters of reference indicate corresponding parts in all the views.

Figure 1 is a side elevation of the improvement, part of the feed-spout being in section. Fig. 2 is an enlarged plan view of the reciprocating or percussion pan. Fig. 3 is a longitudinal sectional elevation of the same on the line 3 3 of Fig. 2. Fig. 4 is an enlarged plan view of one of the seep devices. Fig. 5 is a longitudinal sectional elevation of the same in position on the bottom of the pan. Fig. 6 is an enlarged sectional side elevation of the bumper mechanism. Fig. 7 is an end view of the same, the cam and main driving-shaft being omitted. Fig. 8 is an enlarged transverse section of the percussion-pan, the section being on the line 8 8 of Fig. 3. Fig. 9 is an enlarged sectional side elevation of the same on the line 9 9 of Fig. 8; and Fig. 10 is a sectional side elevation of a portion of the pan, showing a modification.

The pan A is hung on suspending-rods B, depending from a frame C of any approved construction, and the said pan A is provided at its head-block A′ with a flange A^2, engaged by one end of a connecting-rod D, connected with the upper end of a vibrating lever E, provided at its lower end with a friction-roller E′, engaging the cam-groove F′ of a cam F, secured on the main driven shaft G, journaled in suitable bearings on the frame C and connected by pulleys and belt or other devices with machinery for imparting a rotary motion to the shaft G.

The lever E is provided at its forward face with a lug E^2, (see Fig. 6,) engaged by a hook H′ on the free end of a link H, fulcrumed at H^2 on a rocker C′, bolted or otherwise secured to the main frame C. The inner face of the lever E rocks on the curved surface C^2 of the rocker C′, and the outer face of the said lever rests against the peripheral face of an eccentric I, having its shaft I′ journaled in the sides of the rocker C′, the outer ends of the shaft being threaded and engaged by handled nuts I^2, screwing up against the sides of the rocker to securely lock the shaft I′, and consequently the eccentric I, in position against rotation after the eccentric has been adjusted relative to the face of the lever E. Now when the shaft G is rotated the cam F imparts a rocking motion to the lever E, which by the connecting-rod D imparts an oscillating motion to the pan A, which by its head-block A′ bumps against a fixed bumper-block C^3, attached to or forming part of the frame C, so as to give the desired percussion to the pan A.

The flange A^2 is engaged on its forward and rear faces by elastic bumpers D′, resting against nuts D^2, screwing on the rod D, so that when the upper end of the lever E nears the end of its forward stroke the head-block A′ bumps against the bumper-block C^3 to give the desired percussion to the pan A, the bumpers D′ permitting such action.

The pan A is provided with sides A^3 and a bottom A^4, inclined downwardly from the forward end of the pan to the tail end thereof, and the said bottom is supported at intervals by transverse bars A^5, joined with the sides A^3, and the said bottom is also engaged at its under side at the middle of the pan by a longitudinally-extending beam A^6, carrying at its forward end the head-block A′ and the flange A^2, previously referred to. On the upper surface of the bottom A^4 of the pan A and at the sides and middle thereof are secured longitudinally-extending supporting-beams A^7 for supporting perforated riffles J, arranged transversely and spaced suitable distances apart, so as to form in the pan alternating riffle and plain working areas or spaces, as will be readily understood by reference to Fig. 3, the said spaces running

one in the other—that is, forming a wholly uninterrupted space throughout the length of the bottom of the pan. The riffles J are located a suitable height above the upper surface of the bottom A^4, and the said riffles are slightly inclined in a downward and rearward direction, and their forward ends terminate in transversely-extending perforated pockets J′. The ends of the riffles are engaged by plates J^2, fastened by screws J^3 to the end beams A^7, so as to securely hold the riffles in position in the pan A. The lowermost riffle in the pan A rests on a transverse beam A^8, secured on the bottom A^4 and extending to the sides A^3 of the pan. For coal washing I prefer to set the riffles reversely on the end beams A^7, so that the curved pockets J′ are turned backward toward the rear of the pan, as shown in Fig. 10.

The upper end of the pan is formed by a pocket or pouch K, extending transversely and having openings K′ for the discharge of the concentrates, as hereinafter more fully explained, the said pouch or pocket K extending from the bottom A^4 to the top of the sides A^3. The bottom A^4 is provided with a number of seep devices for allowing the fine concentrates to seep through the bottom, and each of these seep devices is preferably provided with a disk L, seated on the top of an apertured valve-seat A^9, arranged on the upper face of the bottom A^4, (see Fig. 5,) and the said disk L is held on a spring-arm L′, fastened by a bolt L^2 and spacing-block L^3 to the bottom A^4 of the pan. An agitating-pin L^4 is secured to the disk L and extends into the aperture of the seat A^9, so that when the disk vibrates the pin L^4 vibrates with it, and thereby agitates the concentrates seeping between the disk L and the upper surface of the seat A^9 into the aperture thereof.

The lowermost seeping device in the pan A is preferably arranged on the under side of the bottom A^4; but otherwise the detail construction of this seeping device is the same as the one above described and shown in detail in Fig. 5. Between this last-mentioned seeping device and the lower terminal of the pan A is arranged another seeping device in the form of a valve N, held by gravity in a seat in the bottom A^4, the said valve having a depending pin N′, provided with a nut N^2, adapted to abut against the under side of the bottom A^4 to limit the upward or opening movement of the valve N.

It is understood that when the pan A is oscillated or receives a percussive action by the mechanism above described then the seeping devices are sufficiently vibrated or actuated to allow the extremely-fine material to seep through the same—that is, to pass out of the pan by way of the said seeping devices in the bottom of the pan.

The material to be treated is placed in a hopper O, mounted on the frame C and having an outlet-spout O′, having its lower end O^2 made vertically adjustable to bring the same nearer to or farther from a distributing device P, attached to the pan A and moving with the same. This distributing device P consists of a box-like frame P′, supporting transversely-extending slats P^2, spaced apart and inclined downwardly and forwardly, as plainly illustrated in Fig. 3, the slats being arranged parallel and parallel with the upper end P^3 of the box-like frame P′. The lower end P^4 of this frame P′ is inclined downwardly and rearwardly, and its inner face is a distance from the upper ends of the lowermost slats P^2. (See Fig. 3.) Now by the arrangement described the material passes down the spout O′, flows into the distributing device P, and by the slats P^2 therein is distributed evenly into the pan, it being understood that when the pan is at a standstill and the material passes into the distributing device from the spout O′ then it accumulates therein in a cone-shaped pile, and when the pan is oscillated the material readily slides down the slats P^2 and is thus distributed uniformly in the pan over the riffles J.

Water is discharged into the upper end of the pan A, adjacent to the pouch K, through a water-supply pipe Q, connected with a suitable water-supply suspended from the frame C, the lower or discharge end of said pipe being provided on its top with a forwardly and downwardly extending shield Q′ to direct the water down into the pouch K.

When the machine is in operation and the pan A is oscillated and receives a percussive action, as previously described, then the material fed into the distributer P is evenly distributed on the upper portion of the pan—that is, part of the material falls onto the riffles J and part into the spaces between adjacent riffles. At the same time the water is admitted by way of the pipe Q to the upper end of the pan, and by the combined action of the water and the oscillating and percussive action given to the pan A the denser material is readily separated from the less dense material, of which the former settles on the bottom A^4 of the pan and is constantly caused to travel upwardly toward the pouch K, from which the concentrates are discharged by way of the openings K′. Now as each riffle has a slight inclination toward the tail end of the pan a sufficient relief clearance is formed for the dense stuff that passes under the riffle.

The alternating working surfaces previously referred to and formed by spacing the riffles apart act and react one upon the other and serve to form a dense layer of fine concentrates, which rests on the bottom A^4 and extends under the riffles. The mass of coarse dense stuff that cannot pass through the perforations of the riffles, and hence is compelled

to ride on top of the surface, serves as a bed to gage the penetration of the fine dense stuff that is destined to go through the perforations of the riffles. The peculiar feature about this arrangement is the opening up of the two working surfaces one into the other, so that the surface action of the water has equal play upon the plain area as well as upon the riffled area as the water actuated by the reciprocating and by the percussive violence of the pan is lurched from riffle to riffle, and the fine dense stuff that travels on the plain surface is broken up and rearranged at each passage across the blank space between the riffles, thus favoring and insuring more thorough classification of densities of the material. At each turning over the material that rises upon the riffles is agitated over and over again in its passage from one riffle to another.

By the arrangement described the material is constantly kept in action, and hence is not liable to pack or form into a dense mass and can be penetrated by the water. In the arrangement described in my previous patent referred to the material could only move very sluggishly as a solid stratum and discharge as a distinct heading from that which discharges above the riffles. By the present improved arrangement but one discharge is had at the head of the pan, the coarse and fine stuff being intermittently intermingled and discharged together as a homogeneous mass. The pervious riffles act as check-surfaces, since at each lurch of the pan the water flows under the surface and through the perforations and through the bed of stuff riding upon the riffles, thus acting as miniature jigs.

By having the seep devices arranged as described very fine concentrates of ore, or of refuse in the case of coal, can readily pass out of the pan A at the bottom thereof, and for discharging minimum quantities of the fines of concentrates near the tail end of the washer use is made of the valve N.

By having the distributing device arranged as described the material is not liable to drop into the pan at one point and clog the riffles, but the material is well distributed by means of the slats E^2 to the pan as soon as the latter is oscillated and percussive action is given to it.

The degree of the percussive action will somewhat regulate the feed capacity, and in a like manner the effective capacity of the pan depends upon the degree of percussive action, so that the feeding of the material is self-controlling. When the pan stops, the feed of the material stops, and for a successful operation of the machine a well-regulated feed is very essential—that is, one that gives the desired capacity, the water used being gaged to suit the feed-capacity. The concentrates accumulate in greater part at the head of the pan and are retarded the desired degree by the pouch K. The fine concentrates that cannot reach the pouch K accumulate along the working surfaces, and the very fine—that is, slimes of ore or refuse of coal—are liable to mass near the tail of the machine. It is understood that these fine materials can only seep through the seeping devices, and hence are not lost with the tailings. The percussive action of the pan and the seep devices serves to keep the pulp in a liquid state, so that it can readily seep through or leak between the joints formed between the disks L and the surfaces of the seats A^9.

Before describing in particular the operation of the new improved working surface I will give a general idea of the process of concentration or enrichment of ores, assuming that practically the same principles hold in the process of washing coal.

If a homogeneous mass of ore be placed on any working surface and left undisturbed, it is evident that there can be no force of gravity acting upon the variable sizes and densities of the mass to cause any change in the relative positions of the grains that are thoroughly interlocked. The mass of ore must be disarranged and kept in that state to permit of the free or unrestricted action of gravity, so that the more dense and finer particles of matter may settle, as they are wont to do, and the lighter particles may be buoyed toward the surface. In order to bring about this effect, water is urged in many ways to enter the interstitial spaces of the compacted mass and tear asunder the individual grains. This done, the mass will become heterogeneous, all the forces being free to establish an equilibrium. There are many ways that water may be urged to intermingle with pulverulent ore. It may be by agitation, with a large volume or a small volume, as in the well-known process of panning, or vanning on a plane surface, the water remaining to the surface and the ore more or less compacting, the more dense gravitating to the bottom. All the vanners and all of the plain percussion-tables utilize this principle. The water may be urged through a more or less pervious working surface and through the mass of ore, thus severing the contact of the multitude of grains and allowing freedom of action of gravity on the variable densities. This is known as the principle of the "jig." Now either principle may in any one machine operate distinctly, or the two principles may combine in the one machine in variable degrees.

I will now describe the process of my new invention: The ore is evenly distributed over an enlarged area of the working surface, as already explained. Water is supposed to cover the entire surface and is by process of agitation and percussive action mixed with the ore, as in the process of panning. Agitation and interaction of the ore and water are

made more effective by the riffles being spaced far apart and standing high. There is every gradation of action. First, on the bottom and under the riffles there is gentle undulation, thoroughly away from the suface agitation; second, on the bottom and uncovered by the riffles ,where there is more active undulation and agitation, due to deep-seated surface action; third, entirely above the bottom and resting on and between the upturned riffles, where the mass is lurched and splashed; fourth, entirely above the tops of the upturned riffles, where the light gangue of ore floats and is discharged as tailings and the large-size grains of dense ore are carried mechanically by the percussive action to the head and discharged as headings. In conjunction with this panning action there is the principle of the jig that operates conjointly with the panning. The perforated riffles constitute the jig-working surface in that water is urged through the bed of stuff resting on the pervious area. The impulses of water are rapid and varied, depending upon the reciprocating motion and the percussive action. The tilted riffle furnishes not only clearance for the passage of the bed of fine stuff on the bottom, but also water-space between the lower area of the pervious surface and the bed of ore resting on the bottom of the pan. This jig action causes the fine and coarse dense stuff to settle lowest, the fine stuff penetrating the coarse dense bed and thence through the perforations to the protected space under the riffles and on the bottom. Each riffle and spacing of riffles gives a distinct concentration, and each advance of a riffle or spacing gives a reconcentration. The finishing concentration is near and at the head pouch, where there is the maximum enrichment and where all the coarse and fine concentrates mass and are enriched to any degree by suitable inclination of the pan and by the rate of the discharge of the concentrates, regulated by the size of the discharging-holes in the pouch, also by the quantity of head-water and its place of delivery—all of which may be so arranged that the rate of discharge may give any desired quantity and richness. The very fine concentrates that cannot withstand the agitation at the head pouch, or that which may be of such shape—shelly, flaky—that is crowded out, will seek refuge at places more or less remote from the head. At these places the seep discharges serve the purpose to deliver them as second or third grade densities or as poor concentrates worth saving.

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

1. A machine of the class described provided with a pan having a downwardly-inclined bottom, and means for oscillating the pan and imparting a percussive action to the same, the said pan having transverse riffles perforated throughout their area and arranged above the bottom of the pan, the riffles being spaced apart a distance to leave spaces between them to form panning-surfaces, whereby alternate jig-working and panning surfaces will be formed in the pan.

2. A machine of the class described provided with a pan having its bottom inclined downwardly from the forward end to the tail end thereof, and means for oscillating the pan and imparting a percussive action to the same, the said pan having transverse riffles perforated throughout their area and arranged above the bottom of the pan, the riffles being spaced apart a distance to leave spaces between them to form panning-surfaces in the pan and the said riffles having perforated pockets at the forward ends.

3. A machine of the class described provided with a pan having its bottom inclined downwardly from the forward end to the tail end thereof, and means for oscillating the pan and imparting a percussive action to the same, the said pan having transverse riffles perforated throughout their area and arranged above the bottom of the pan, the riffles being spaced apart a distance to leave spaces between them to form panning-surfaces in the pan and the said riffles being inclined downwardly and rearwardly.

4. A machine of the class described provided with a pan having its bottom inclined downwardly from the forward end to the tail end thereof, and means for oscillating the pan and imparting a percussive action to the same, the said pan having transverse riffles perforated throughout their area and arranged above the bottom of the pan, the riffles being spaced a distance to leave spaces between them to form panning-surfaces in the pan and the said riffles having perforated pockets at the forward ends, and the riffles being inclined from the said pockets in a downward direction.

5. A machine of the class described provided with a pan, means for oscillating the pan and imparting a percussive action to the same, and a distributer for the material on top of the pan and moving with the same, the said distributer having transverse parallel slats for discharging the material into the pan, said slats inclining downwardly.

6. A machine of the class described provided with a pan, means for oscillating the pan and imparting a percussive action to the same, a distributer for the material on top of the pan and moving with the same, the said distributer having transverse parallel slats for discharging the material into the pan, said slats inclining forwardly and downwardly, and a feed-hopper above the distributer and having its discharge-spout opening onto the slats of the distributer.

7. A machine of the class described pro-

vided with a pan, means for oscillating the pan and imparting a percussive action to the same, and a distributer for the material, on top of the pan and moving with the same, the said distributer comprising a bottomless box-like frame, and transverse parallel slats in the frame, the said slats being inclined forwardly and downwardly.

8. A machine of the class described provided with a pan, means for oscillating the pan and imparting a percussive action to the same, and a distributer for the material, on top of the pan and moving with the same, the said distributer having slats for discharging the material into the pan, the said slats being inclined forwardly and downwardly and the forward end of the distributer being arranged parallel with the slats and the rear end of the distributer standing at an angle to the slats.

9. A machine of the class described provided with a pan, means for oscillating the pan and imparting a percussive action to the same, and a distributer for the material, on top of the pan and moving with the same, the said distributer having slats for discharging the material into the pan, the said slats being inclined forwardly and downwardly and the forward end of the distributer being arranged parallel with the slats and the rear end of the distributer standing at an angle to the slats and spaced from the upper ends of the rearmost slats.

10. A machine of the class described provided with a pan, means for oscillating the pan and imparting a percussive action to the same, the pan having transverse perforate riffles above the bottom of the pan, the riffles being spaced apart to leave panning-surfaces in the pan, and seep devices in the bottom of the pan, arranged to allow the fine material only to seep through and out of the pan.

11. A machine of the class described provided with a pan, means for oscillating the pan and imparting a percussive action to the same, the pan having transverse perforate riffles above the bottom of the pan, the riffles being spaced apart to leave unobstructed areas in the pan, and seep devices in the bottom of the pan, arranged to allow the material to seep through and out of the pan, each of the seep devices consisting of a spring-supported disk held over an apertured seat in the bottom of the pan.

12. A machine of the class described provided with a pan, means for oscillating the pan and imparting a percussive action to the same, the pan having transverse perforate riffles above the bottom of the pan, the riffles being spaced apart to leave unobstructed areas in the pan, and seep devices in the bottom of the pan, arranged to allow the material to seep through and out of the pan, each of the seep devices consisting of a spring-supported disk held over an apertured seat in the bottom of the pan and agitating-pins on the disk, extending into the aperture of the seat.

13. A machine of the class described provided with a pan, means for oscillating the pan and imparting a percussive action to the same, the pan having transverse riffles above the bottom of the pan, spaced apart to form panning-surfaces in the pan, and a pouch having a discharge-opening and forming the head of the pan, said pouch extending from the bottom to the top of the sides of the pan with its end terminating short of the first riffle.

14. In a machine of the class described, the combination with a pan having openings in its bottom, and means for oscillating the pan and imparting a percussive action thereto, of a disk over each of the openings of the pan, and a spring-support for the said disk.

15. In a machine of the class described, the combination with a pan having an opening in its bottom, and means for oscillating the pan and imparting a percussive action thereto, of a spring secured at one end to the bottom of the pan, and a disk secured to the free end of the spring over the opening in the pan, said disk having a pin projecting into said opening.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

ALONZO C. CAMPBELL.

Witnesses:
GEO. L. HACKNEY,
ARLINE STOCKTON.