(No Model.)

5 Sheets—Sheet 1.

A. C. CAMPBELL.

ORE SEPARATOR.

No. 506,976. Patented Oct. 17, 1893.

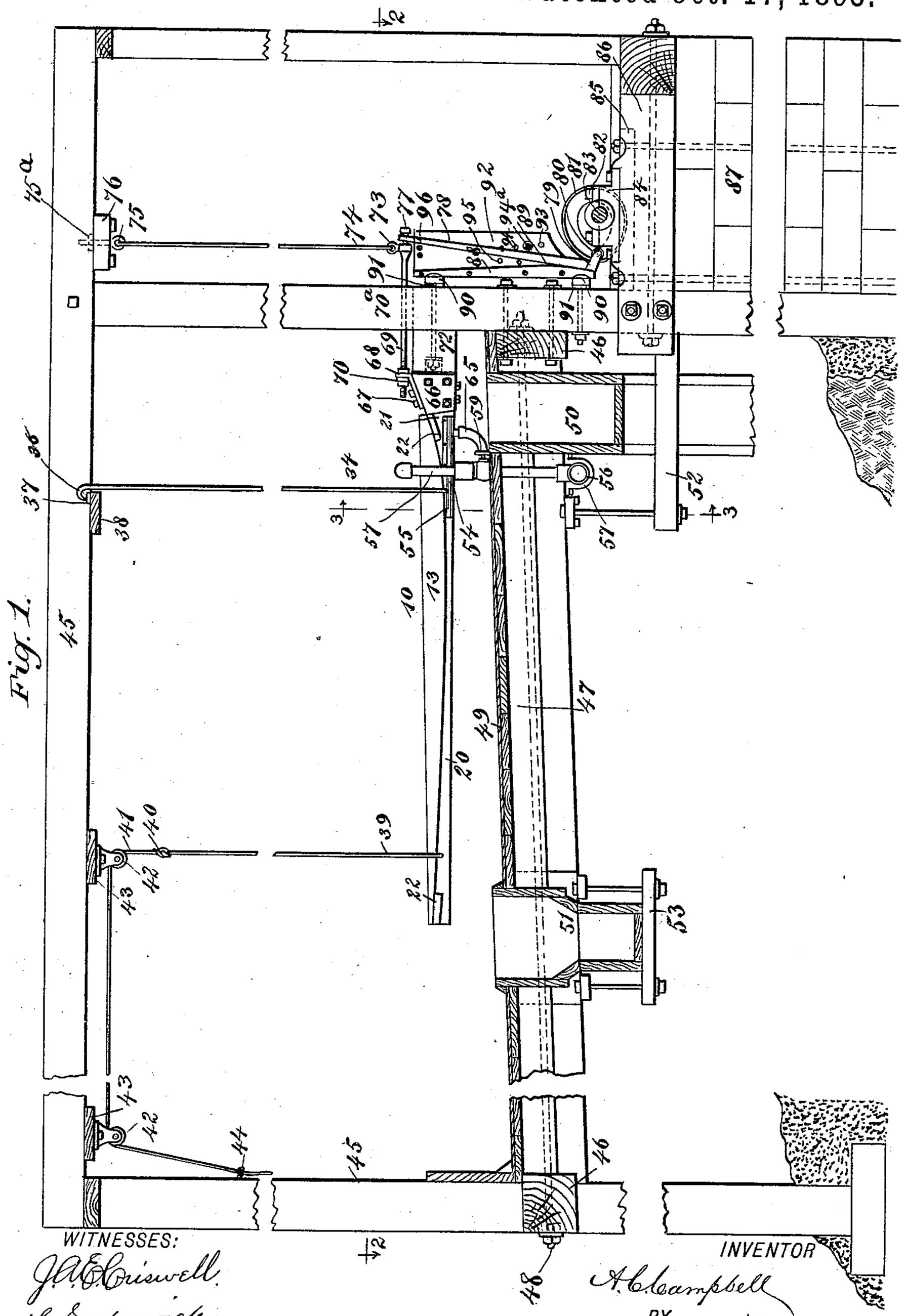

Fig. 1.

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(No Model.) 5 Sheets—Sheet 2.

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Fig. 2.

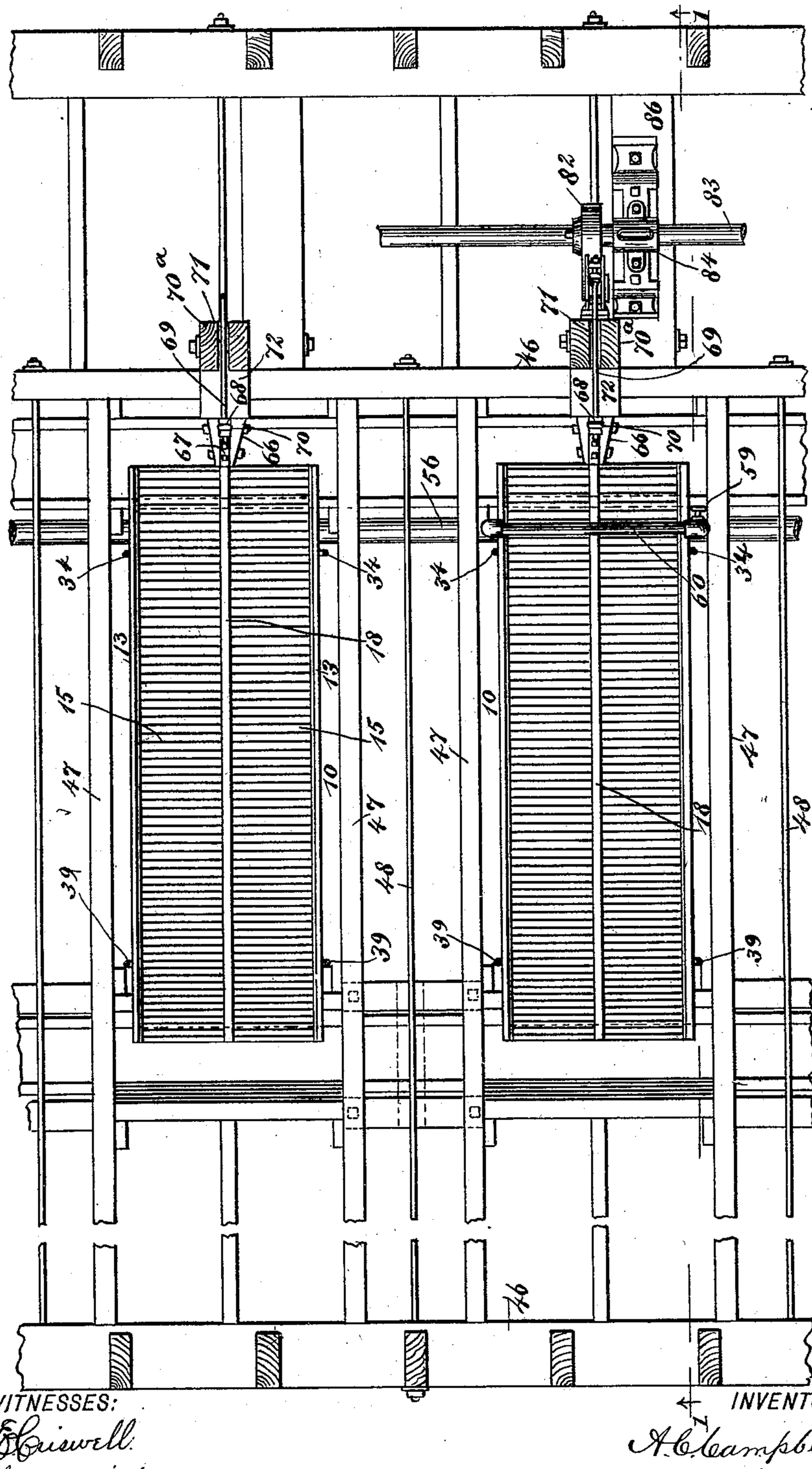

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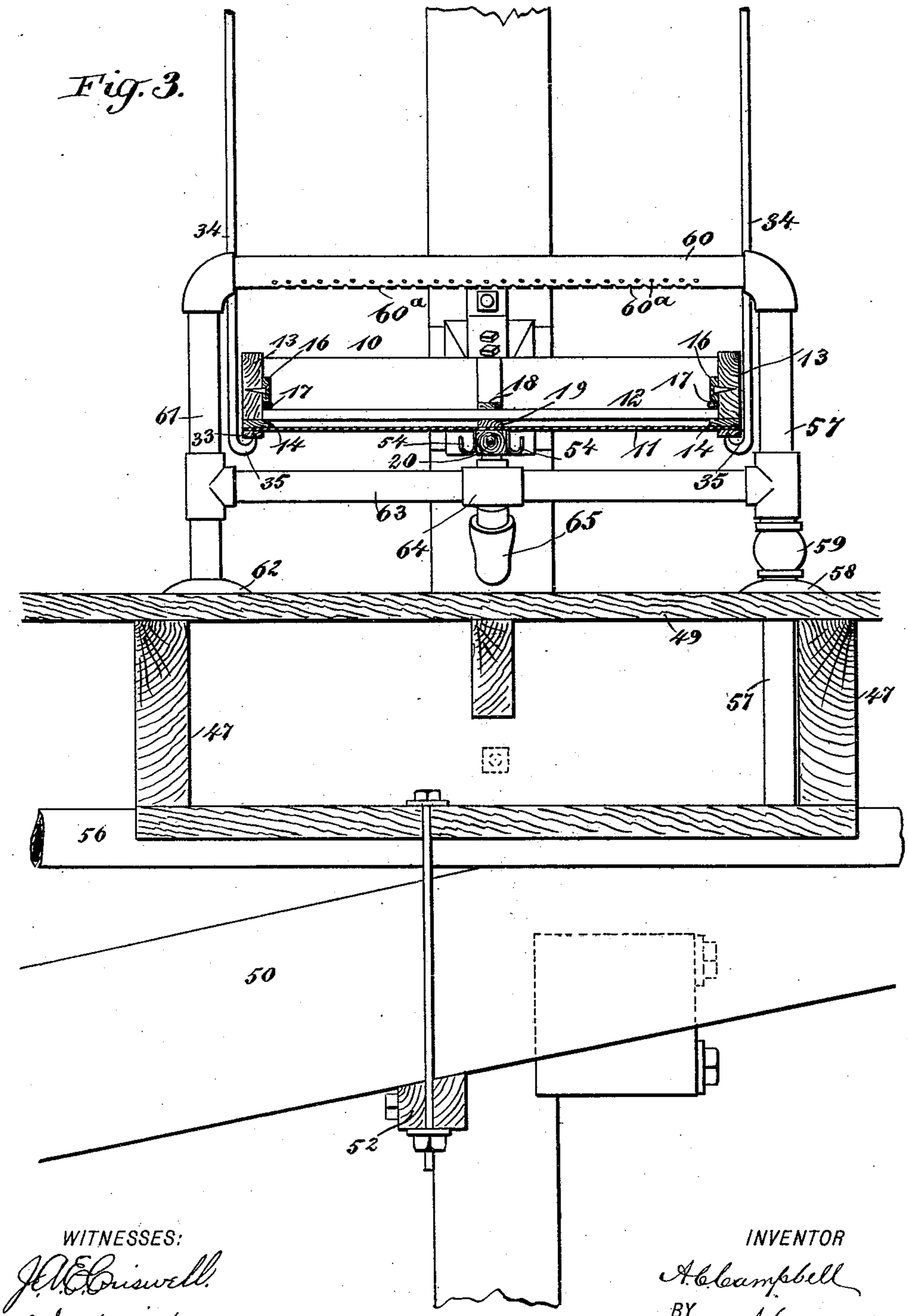
Fig. 3.



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(No Model.)

5 Sheets—Sheet 4.

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Fig. 4.

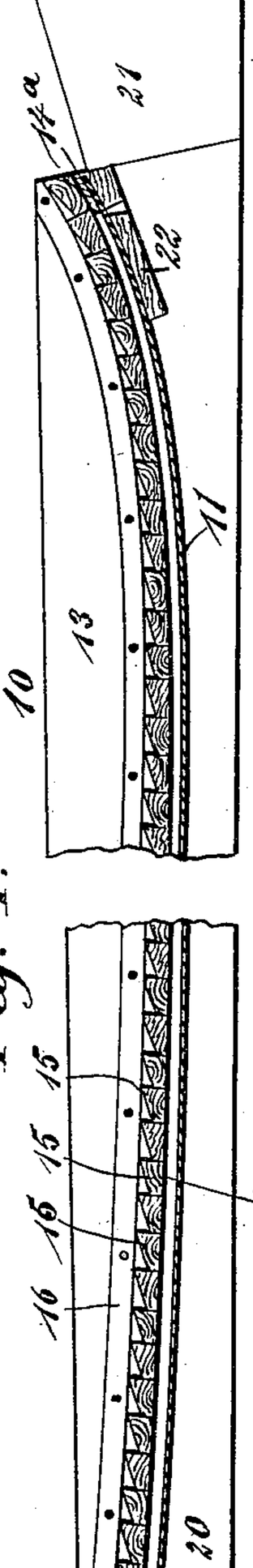


Fig. 5.

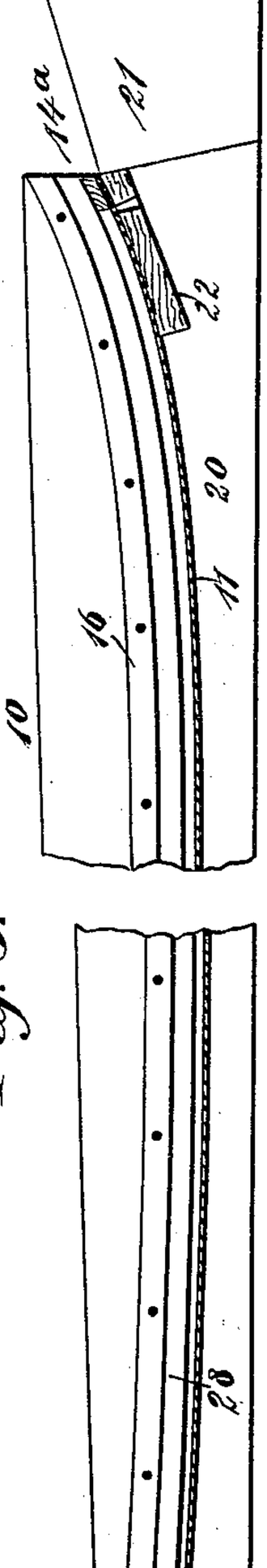


Fig. 6.

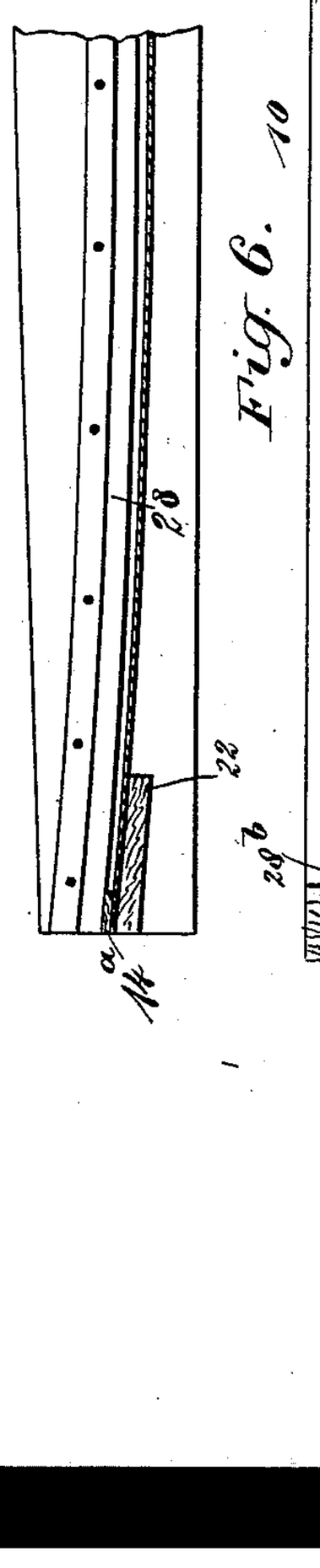


Fig. 7.

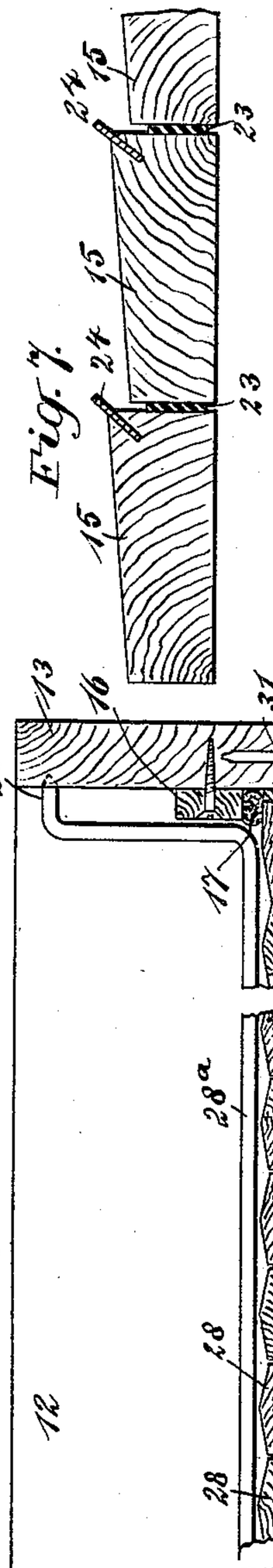


Fig. 9.

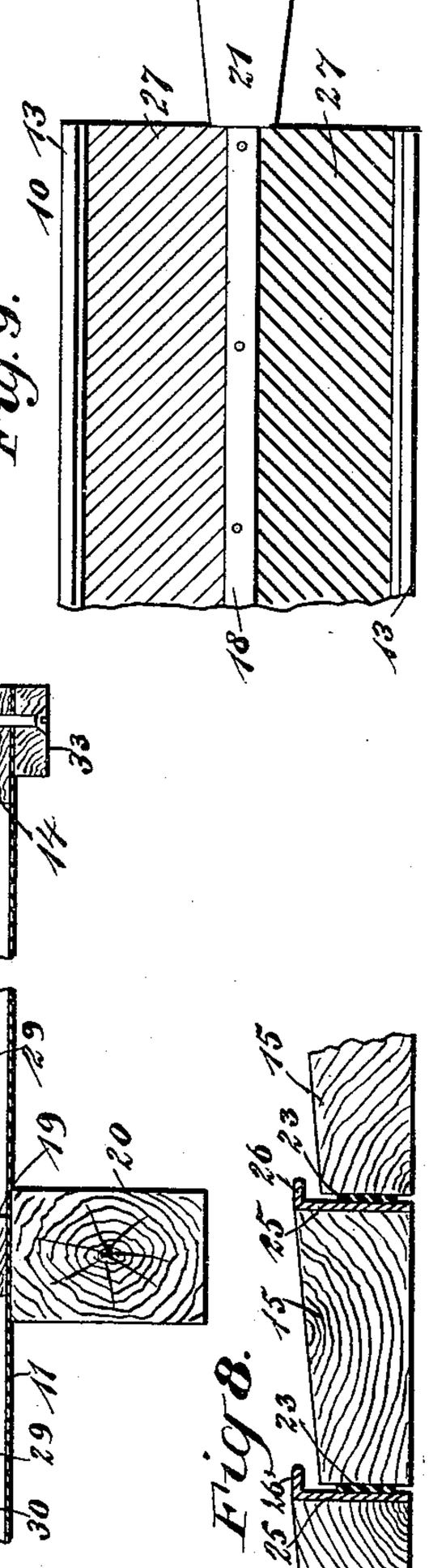
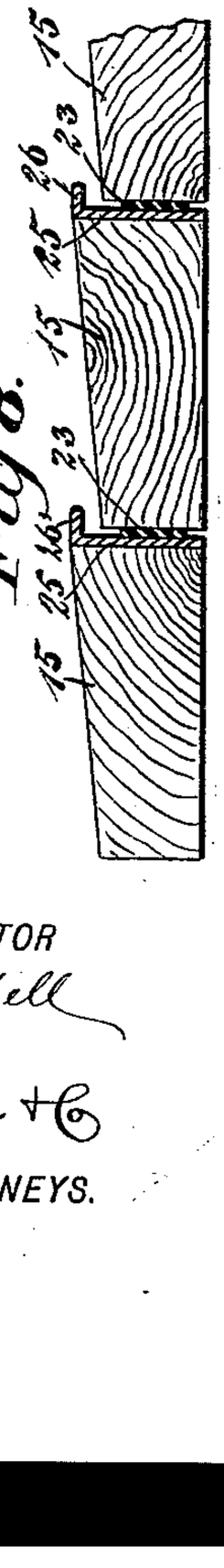


Fig. 8.



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(No Model.) 5 Sheets—Sheet 5.

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No. 506,976. Patented Oct. 17, 1893.

Fig. 6a.

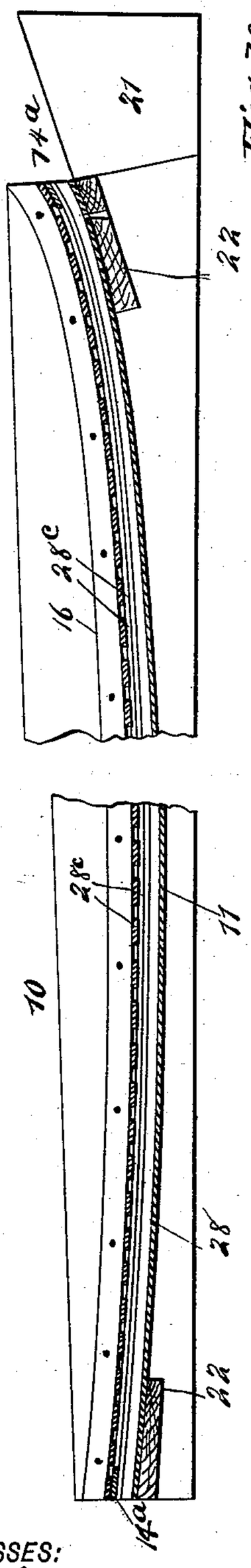


Fig. 10.

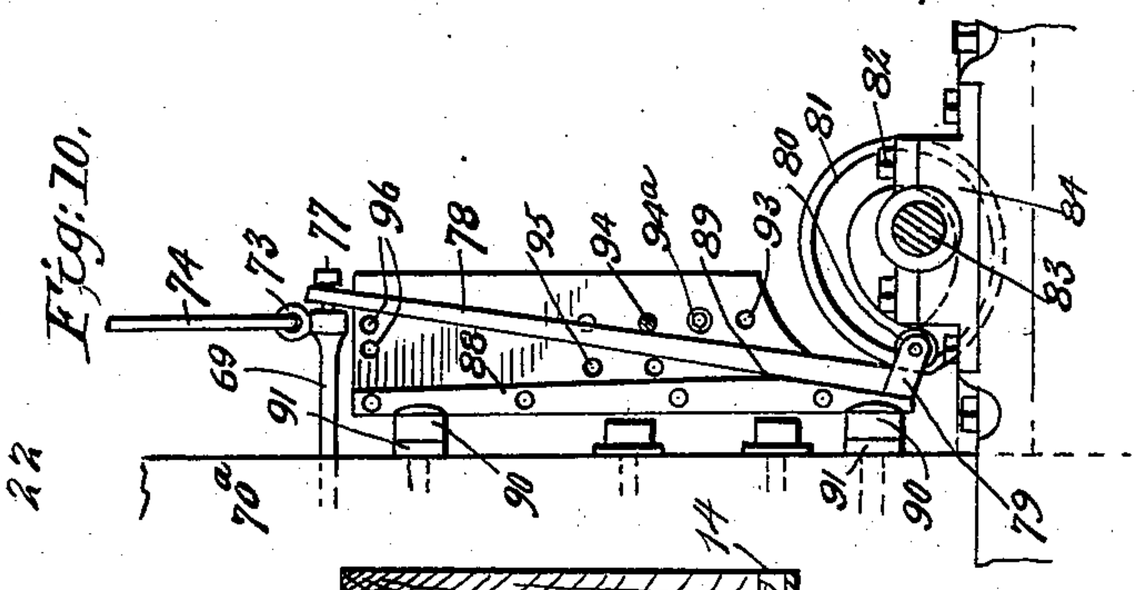
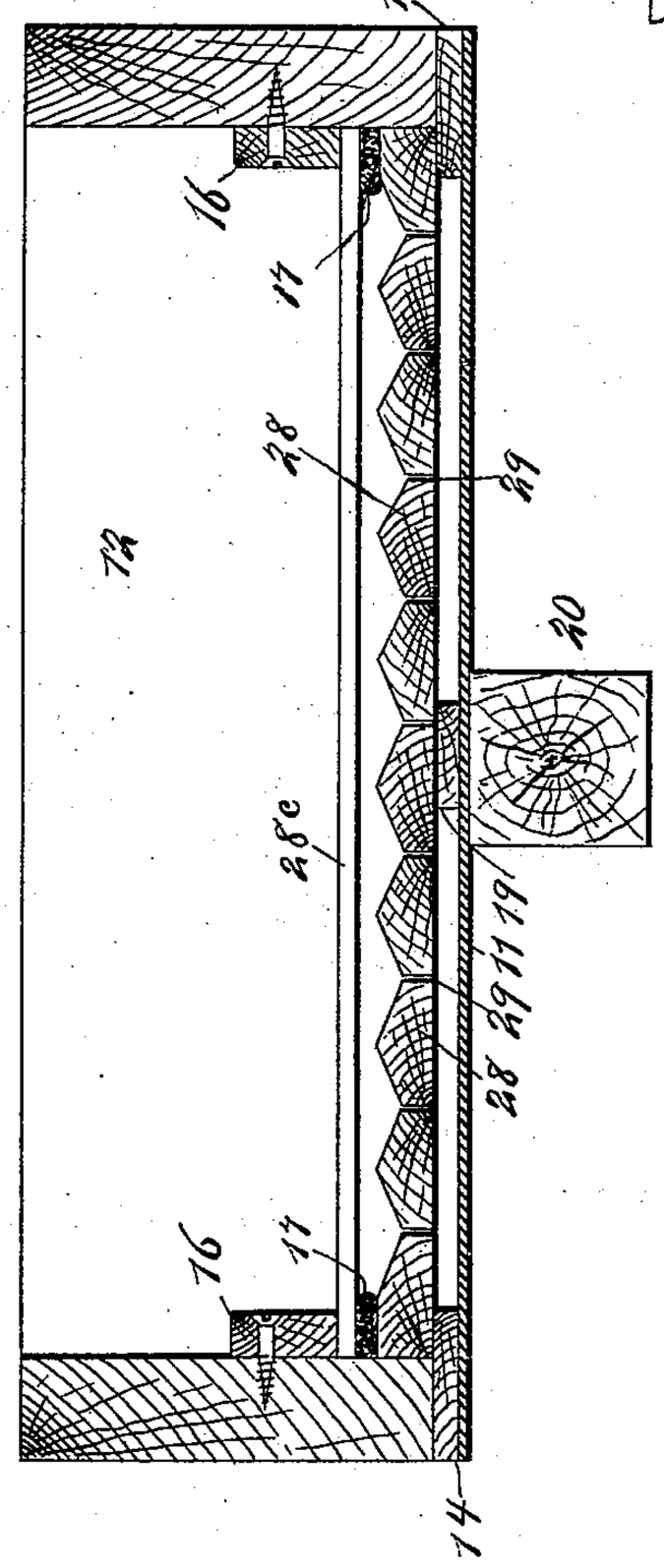


Fig. 6b.



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UNITED STATES PATENT OFFICE.

ALONZO C. CAMPBELL, OF NASHVILLE, TENNESSEE.

ORE-SEPARATOR.

SPECIFICATION forming part of Letters Patent No. 506,976, dated October 17, 1893.

Application filed November 18, 1892. Serial No. 452,415. (No model.)

To all whom it may concern:

Be it known that I, ALONZO C. CAMPBELL, of Nashville, in the county of Davidson and State of Tennessee, have invented a new and Improved Ore-Separator, of which the following is a full, clear, and exact description.

My invention relates to improvements in that class of ore separators in which a reciprocating pan is used, which is adapted to deliver concentrates from one end and tailings from the other, and which is also adapted for use in washing coal.

The object of my invention is to produce a substantial and rapid working separator which may be easily controlled and adjusted so as to work successfully on different kinds of material, such as coarse and fine material, and materials of different densities, to produce a mechanical movement for operating the pan which will shake it in such a way as to produce the best results and cause the mass of pulp or other matter in it to be kept well stirred up, to provide a water supply system which is adapted to deliver water in just the right quantities to the top and bottom of the mass of material being operated upon, to arrange the water supply system so as to have it easily controlled and so that it will economize space, and in general, to provide a separator which will entirely separate metals from their ores, and do this with the utmost rapidity and the least possible expense.

To these ends, my invention consists in certain features of construction and combinations of parts, which will be hereinafter described and claimed.

Reference is to be had to the accompanying drawings forming a part of this specification, in which similar figures of reference indicate corresponding parts in all the views.

Figure 1 is a sectional elevation of the entire apparatus on the line 1—1 in Fig. 2. Fig. 2 is a sectional plan on the line 2—2 in Fig. 1. Fig. 3 is a cross section on the line 3—3 in Fig. 1, and on an enlarged scale, showing the detailed construction of the pan and the arrangement of the water supply system. Fig. 4 is a longitudinal section of the pan, showing the same provided with a riffled bottom formed of cross slats. Fig. 5 is a similar section of a pan when provided with longitudinal slats. Fig. 6 is a cross section of the pan shown in Fig. 5, but with a riffle rod in position therein. Fig. 6^a is a longitudinal section of a modified form of the pan showing it provided with a double series of slats arranged with one series above the other. Fig. 6^b is a cross section through the pan shown in Fig. 6^a. Fig. 7 is an enlarged detail sectional view showing the construction and arrangement of the cross slats of the pan, the slats being however, of a slightly modified form. Fig. 8 is a similar section of another modified form of slat. Fig. 9 is a broken plan view of a pan having still another modification of the slats, the slats in this case being arranged diagonally, and Fig. 10 is an enlarged detail view of the operating mechanism.

The pan 10 has a concave bottom 11, formed preferably of sheet metal and a false bottom 12 above it, this bottom being riffled in some way so as to have the right effect upon the pulp or other material being operated upon, as described below. The pan is provided with vertical sides 13, and the true and false bottoms are separated by longitudinal strips 14 and cross strips 14^a, thus producing a water chamber between the two bottoms, so that water may be admitted, and permitted to pass upward into the pan as hereinafter described. The false bottom 12 is formed of slats arranged in juxtaposition and either transversely, diagonally, or longitudinally.

As illustrated in Figs. 2 and 4, the pan is provided with cross slats 15, which form the false bottom, these slats having inclined upper sides, and the inclination is from the head of the pan toward the rear, thus forming a riffled bottom.

Secured to the sides of the pan above the ends of the cross slats, are strips 16, and rope or other suitable stuffing 17 is jammed in between the ends of the slats and the strips 16, thus binding the slats in position. Extending longitudinally of the pan through the center and above the slats 15, is a binding strip 18, and beneath this and below the slats is a similar strip 19, and beneath this strip and also beneath the true bottom 11 of the pan, is a keel piece 20, which extends the entire length of the pan and has a front end portion 21, which projects beyond the pan and forms the means of connecting the pan with its motive power as hereinafter described. The arrangement of the keel piece and the strips 18 and 19 strengthens the pan and enables it to carry its load easily. The pan is further strengthened by cross pieces 22 which are let

into the keel piece 20 and are secured to the sides of the pan. The slats of the pan, whether cross slats, longitudinal slats or diagonal as described below, are separated by washers, the cross slats 15 having rubber washers 23, placed between them, as shown clearly in Fig. 7, but the washers are thin, and when the slats are jammed together and fastened in place, the spaces between them will be very small so that the water will pass slowly upward between the slats as hereinafter described, and the very fine, dense material in the pan will work its way downward through the spaces.

To guard against the rapid wearing off of the front raised corners of the slats 15, metallic strips 24 may be placed diagonally in said corners, and these strips will also increase the retaining effect of the slats and cause the material which passes downward over them to be given a greater impetus. Instead of the strips or blades 24, plates 25 may be secured to the front faces of the slats 15, and the strips doubled or bent forward at the top, as shown at 26 in Fig. 8, and the slats when arranged in this way will wear well and will also retain the fine dense material which passes into contact with the plates.

As shown in Fig. 9, the slats 27 are arranged diagonally instead of transversely, and there is a series of slats on each side of the strip 18, and when thus arranged, the slats form a riffled bottom which has a tendency to deliver the dense material in a stream along the center of the pan.

As shown in Figs. 5 and 6, the pan is provided with longitudinal slats 28, which have convex upper faces, thus forming a corrugated bottom to the pan, and when the longitudinal strips are used, they are separated by washers 29 and held together by cross bolts 30, which extend through the slats and washers, each bolt having a head 31 which is let into the side of the pan, and at the opposite end a fastening nut 32. When this form of pan bottom is used riffle rods 28^a are employed, these rods being arranged at suitable intervals in the pan and bent to conform to the shape of the pan bottom, the upper ends of the rods being bent outward, as shown at 28^b, and embedded in the sides 13 of the pan, near the top. The riffle rod 28^a is adapted to swing forward with a lurch at each percussion of the pan.

In Figs. 6^a and 6^b I have shown a modified form of the pan, somewhat similar to the construction shown in Figs. 5 and 6, but instead of the riffle rods I use a second series of cross slats, 28^c which are arranged above and at right angles to the slats 28 and which are separated from the slats 28 by a small space, and are also separated from each other. The ends of the slats 28^c are held between the stuffing strips 17 and the fastening strips 16. The object of this arrangement is to effect a greater retention of the lowermost dense stratum so that the percussive action of the pan may carry it to the head, while the uppermost stratum is in great part separated from the lower and exposed to the action of the surface water which causes it, the upper stratum, to be discharged at the tail.

It will be noticed that in the several forms of false bottoms for the pan but very little space is left between the slats. The space is sufficient to permit the water beneath the false bottom to be drawn upward by capillary action, and delivered to the under side of the mass of material in the pan, and as the water is also delivered upon the material in the manner hereinafter described, the whole mass will be kept well saturated, and the water from the bottom will prevent the fine dense material from accumulating in a coat or crust. The uprising of the water from beneath also causes all the tailings to be floated off and the very fine dense material is permitted to work its way downward upon the true bottom, and from this it is delivered to the concentrate chute, as hereinafter described.

On the under side of the pan and at the edges are longitudinal strips 33, and these are adapted to engage the hooks 35 at the lower ends of the suspending rods 34, as best shown in Fig. 3. These suspending rods are arranged near the edge of the pan and extend upward from the opposite sides of the pan and terminate at their upper ends in hooks 36, which extend through cleats 37 on a plate 38, which plate is secured to the joists or other supports above the pan. The tail of the pan is supported by the rods 39, which are united above the pan, as shown at 40, and connected with an adjusting wire rope 41 which extends over guide pulleys 42, these being supported in suitable hangers attached to the plates 43, and the free end of the cable 41 is made fast to a cleat or other fastening device 44 on the adjacent building frame 45. This arrangement is shown clearly in Fig. 1, and by it the pan is freely suspended so as to oscillate and reciprocate, and by means of the wire rope 41 the pan may be given any desired pitch, which pitch will be governed, of course, by the character of the material being operated upon.

The pans are preferably constructed in series as shown in Fig. 2, any necessary number of pans being placed side by side, and the framework 45 of the building in which they are carried should be of the most substantial character. It is obvious that any suitable supporting frame may be employed, but as shown in Figs. 1 and 2, the frame 45 is provided with sills 46 having inclined floor joists 47, and suitable tie rods 48, which prevent them from spreading. The floor 49 is laid upon the floor joists and the inclination enables it to drain readily. The underpinning of the frame is preferably laid in concrete, and it should be very substantial.

The concentrates are delivered from the head of the pan into a chute 50, which carries it to a suitable point of delivery, and

the tailings are delivered into a chute 51, these chutes 50 and 51 being supported in suitable hangers 52 and 53. On the under side of the pan near the edge or front end and near the center, are gutters 54, which are secured to the keel piece 20, and these deliver into the chute 50. There are openings at 55 through the true bottom and into the gutters, and the fine, dense material which is passed downward between the slats of the false bottom is washed downward into the gutters and by them delivered into the concentrates. A water supply pipe 56 extends beneath the floor 49, and beneath all the pans of the series, being arranged preferably near the heads of the pans, and at a point beneath one edge of each pan is a branch pipe 57, which leads from the pipe 56 upward through the floor 49, being supported at this point by a floor-plate 58 and provided with a valve 59, by means of which the supply may be regulated. This branch pipe 57 extends upward above one side of the pan and connects with a cross pipe 60, which extends horizontally across the pan near the head, the cross pipe having jet openings 60ª on its under side, through which water is delivered into the pan beneath. The pipe 60 connects at one end with another vertical pipe 61, the lower end of which is plugged and formed into a leg which is held by a floor-plate 62 on the floor 49. A cross pipe 63 extends beneath the pan and connects the pipe 61 with the pipe 57, so that a rectangular circuit of water is arranged around the pan. Near the center of the cross pipe 63 is a T 64 which connects with a hose 65, and the latter delivers through the true bottom of the pan and into the water space above. It will be seen then, that the water supply is controlled by the valve 59, that any necessary amount may be delivered, and that it is simultaneously delivered to both the upper and lower portions of the material in the pan.

The head 21 of the keel piece 20 of the pan is provided with a head-block 66, which is securely bolted thereto, and to the upper side of this head-block is bolted a crown plate 67, having an upturned flange 68 at the end, to which is bolted a connecting rod 69, and a cushion 70 is arranged between one of the nuts of the rod and the back side of the flange so as to prevent too great shock when movement is imparted to the connecting rod. The connecting rod extends forward through a slot 71 in a vertical bumper beam 70ª which is arranged near the head of the pan, and is fastened securely to the beams above, and abuts with a solid foundation which supports the driving shaft as hereinafter described. Between the bumper beam 70ª and the head-block 66 is a bumper block 72 of cast iron, which is firmly bolted to the bumper beam. The vibrating lever 78, the action of which will be described below, is arranged beneath the front end of the connecting rod 69 and in a nearly vertical position. There is a hole through the upper end of the lever 78 through which passes the bolt 77 which is screwed into the front end of the connecting rod 69; there is a nut on the bolt having an eye 73 which engages a hook on the suspending rod 74 that serves to take the weight and downward thrust of the vibrating lever 78. The upper terminus of the rod 74 hooks into an eye 75 on the end of a bolt extending through the timber 76. The eye bolt 75 has a nut 75ª at its upper end by which the suspension rod may be adjusted and the engagement with the cam wheel 82 regulated. The vibrating lever 78 is arranged in a nearly vertical position in front of the bumper beam and has a bent lower end 79, in the free end of which is journaled a roller 80, and the latter travels in an eccentric path or groove 81, formed in one side of a cam wheel 82, which is carried by a shaft 83, and the latter is supported in suitable boxes 84, these being attached to a plate 85, and the latter is let into timbers 86 supported on a rock foundation 87. This foundation forms a solid abutment for the bumper beams 70ª. The shaft 83 extends in front of all the pans, and a connection is made with each pan in the manner just described. The vibrating lever 78 is backed by a rocker 88, which has a curved front face as shown at 89, and which is firmly secured by bolts 90 to the bumper beam 70ª. A washer 91 is placed on the bolts 90, and by the thickness of the washer, the distance of the washer from the bumper beam is regulated. Secured to opposite sides of the rocker and projecting forwardly therefrom, are guide plates 92, which embrace the vibrating lever 78. There are holes 93 through the plates 92 which are for a fulcrum pin 94 and a bearing, preferably of brass, 94ª; the number of holes serving to adjust the fulcrum pin to suit the length of the stroke of the lever 78. The holes 96 at the top of the plates are to receive the fulcrum pin 94 when removed, the object being to stop the movement of the pan; the bumper being held by the pin securely against the bumping block and the lower end of lever 78 swinging to and fro without imparting motion. There is a second row of holes 95 parallel with the row 93 which are designed to be used when the direct motion of the cam is wanted. A fulcrum pin is placed in each of any two of the holes in horizontal line, the lever 78 going between the pins. This gives a fixed fulcrum in both forward and backward movement of the lever, and the rocker 88 plays no part in giving character to the forward stroke. One machine or several may be operated from the line of the shafting. The shaft is made to revolve by a belt and pulley, or other suitable source of power, and the cams 82 revolve with the shaft. The wheel 80, which revolves upon the lower end of the vibrating lever 78, is caught by the outer rim 81 of the cam, which brings the lever 78 to bear against the fulcrum pin 94ª which as a fulcrum causes the upper end of the lever to move toward the post 70ª

or to the left in the drawings, as shown in Fig. 1, thus driving the bumper 66 from the bumping block 72. This movement is regulated by the curve of the cam and the position of the fulcrum pin. It is designed to give a quick start as if by rebound from the percussion and a slowing up toward the end of the stroke, where it comes to a momentary standstill when the lever 78 rests against the upper terminus of the rocker 88 and tangent to its curvature. When the wheel 80 has approached nearest the center of revolution the inside curved track of the cam is brought to bear against the wheel which is then driven regularly toward the lower terminus of the rocker 88. The lever 78 in the meantime travels on the curved bearing surface 89 of the rocker 88, thus giving a variable fulcrum in its travel from the top to the bottom of the rocker. The motion is thus made of slow acceleration in the beginning, but increases to a high acceleration at the terminus of a stroke or at the instant of the impact, when it is at its maximum. The water is turned on in the main pipe 56 and the cock 59 opened to admit water to each machine, enough being used to thoroughly saturate and float the oil or gold that is fed upon the pan at a point about one-third the length of the pan from the head of the same. The bottom water which seeps through the joints of the slats of the working surface of the pan keeps the mass of stuff in the pan from packing and also favors the passage of the more dense stuff through the enlivened mass to the bottom. The top water which escapes from the perforated pipe 60 is to drive back the top stratum of gangue or less dense stuff from the accumulated mass of concentrates that constitutes the head.

The stuff to be treated may be fed upon the pan dry or wet. If dry a large quantity of water is needed and if wet a lesser quantity. The system of feeding the stuff to the pan is not limited as it forms no part of this invention. The reciprocating motion of the pan, together with the percussion, causes the separation of the more dense and less dense stuff into two principal layers, the top layer of which is floated away by the escaping water and is discharged at the tail and drops into and through the opening 51 and into the sluice beneath. The more dense stuff accumulates in a thick layer near the head of the pan, the percussive action finally carrying it over the head and discharging it into the sluice 50 which is arranged beneath the head of the pan, as shown in Fig. 1. The bed of concentrates passes from under the mass of water as it nears the head and is drained of its water before being discharged. Its emergence from the water gives a more thorough separation of the gangue or the enrichment of the concentrates. Such very fine dense stuff as cannot make its way to the head discharge, is by slow process transmitted through the capillary spaces of the slats and escapes as hutchwork through the holes 55 into the gutters 54 and thence into the sluice 50 with the coarser material of like density. On account of the violence of the percussion the capillary spaces of the slats are kept clear of obstruction. The shock of the impact passes through the working surface causing a momentarily violent opening and closing of the capillary spaces, thus ejecting any stuff tending to clog them, and at the same time giving extra impetus toward enlivening the mass of stuff in the pan. The flow of dense fine stuff through the joints is very slow, but it is uninterrupted over the entire area of the working surface which greatly enriches the product, being made almost entirely free from gangue or fine coal, as the case may be. The adjustment of the inclination of the pan depends upon the grade of stuff, as to size and as to quantity to be treated and character of work to be done. Coarse materials require a greater fall than fine, and an increased fall favors the treatment of a larger quantity as it gives the water greater flotation power. Generally the adjustment should be regulated for any given case so that the concentrates shall be clean as possible, guarding at the same time against driving too much dense stuff into the tailings. The length of the stroke should also be adjusted to give proper impetus to the headings, and which, if in large quantities, necessitates a heavier stroke. Increasing the length of the stroke intensifies the percussion and discharges the concentrates more thoroughly and in increased quantity.

In fixing the adjustment at any given stroke, washers are placed in position at 91, see Fig. 1, so that the revolution of the cam 82 causes the bumper 66 to tighten against the bumping block 72 and at the same time the lever 78 should touch the fulcrum pin 94ª. Holes are made through the bottom at the head terminus of the hutch to prevent any accumulation of stuff and consequent packing, and the water escaping through these holes keeps the hutch always clear of obstruction.

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

1. In an ore separator, the combination of a pan having a false bottom formed of slats in juxtaposition with small spaces between them and provided with a water chamber below the false bottom, and means for oscillating the pan and imparting a percussive action to the same, substantially as described.

2. In an ore separator, the combination of a pan having a false bottom formed of slats spaced a short distance apart by washers and provided with a water chamber below the false bottom, and means for oscillating the pan and imparting a percussive action to the same, substantially as described.

3. In an ore separator, the combination of a pan having a false bottom formed of spaced slats, and rubber washers between the slats, and provided with a water chamber below the

false bottom, and means for oscillating the pan and imparting a percussive action to the same, substantially as described.

4. In an ore separator, comprising an oscillating pan having a concave bottom composed of a series of longitudinal slats forming the working surface of the pan, a second series of slats arranged across the pan above the longitudinal slats, and a water system arranged to deliver above and below the slats, substantially as described.

5. In an ore separator, the pan having a series of longitudinal slats separated by small spaces and arranged to form the working surface of the pan, a bottom arranged beneath and separated from the longitudinal slats, and a plurality of cross slats arranged above the longitudinal slats, substantially as described.

6. An ore separator, comprising an oscillating concave pan having a riffled working surface composed of slats in juxtaposition and separated by small spaces, a true bottom arranged beneath the slats so as to form a water space between itself and the slats, a water system arranged to deliver into the pan and into the water space beneath the slats, and gutters into which the water space discharges said gutters delivering beneath the head of the pan, substantially as described.

7. In an ore separator, the pan, comprising side pieces connected by a suitable bottom, a keel piece extending longitudinally beneath the center of the pan and terminating in a head adapted to connect with the motive power which moves the pan, and a riffled false bottom arranged a little above the true bottom so as to form a water space between the true and false bottoms, the false bottom being composed of a series of slats separated by small spaces, substantially as described.

8. An ore separator, comprising an oscillating pan having a concave and riffled working surface, suspending rods having hooks at their ends engaging the pan and cleats above the pan, and a vertically adjustable cable arranged to suspend the opposite end of the pan, substantially as described.

9. In an ore separator, the combination with the oscillating pan having a water space beneath its working surface, of a water supply pipe extending adjacent to the pan, a branch pipe leading from the water supply pipe and arranged to embrace the pan, a plurality of jet openings produced in the upper portion of the branch pipe so as to deliver into the pan, and a pipe connection between the lower portion of the branch pipe and the water space in the lower part of the pan, substantially as described.

10. In an ore separator, the combination with an oscillating pan, of a reciprocating connecting rod secured to one end of the pan, a revoluble cam wheel arranged beneath the rod and provided with a cam groove in its side, and a vibrating lever having a variable fulcrum one end of said lever engaging the cam wheel and the other end secured to the connecting rod, substantially as described.

11. In an ore separator, the combination, with an oscillating pan, of a reciprocating connecting rod having one end secured to the pan and the opposite end freely suspended, a cam wheel held to turn beneath the connecting rod and provided with a cam groove in its side, and a vibrating lever fulcrumed between the cam wheel and the connecting rod, one end of the lever engaging the groove of the cam wheel and the other end being secured to the connecting rod, substantially as described.

12. In an ore separator, the combination, with an oscillating pan, of a connecting rod fastened to one end of the pan, a curved rocker arranged beneath the connecting rod and at right angles thereto, a cam wheel held to turn beneath the rod and rocker, said wheel having a cam track in one side, a bell crank lever held to rock on the curved surface of the rocker and having one end held to run in the groove of the cam wheel, and the other end secured to the connecting rod, and a fulcrum pin supported on one side of the lever so as to fasten the lever between itself and the rocker, substantially as described.

13. In an ore separator, the combination with the oscillating pan, of a reciprocating connecting rod secured thereto, a curved rocker arranged beneath the connecting rod and provided with side guide plates, a revoluble cam wheel arranged beneath the guide plates and having a cam track in its side, a vibrating lever held to rock on the rocker, said lever having one end provided with a wheel which runs in the track of the cam wheel and the other end secured to the connecting rod, and a fulcrum pin held in the guide plates of the rocker, so as to fasten the lever between the pin and curved surface of the rocker, all substantially as described.

14. In an ore separator, the combination, with the oscillating pan and the connecting rod secured thereto, of a rocker arranged beneath the connecting rod and provided with guide plates secured to its sides and having rows of holes therein to receive a fulcrum pin, a revoluble cam wheel held to turn beneath the guide plates and provided with a cam track in its side, a vibrating lever held to rock upon the rocker, the lever being operatively connected with the cam wheel and the connecting rod, and a detachable fulcrum pin adapted to fit in the holes of the guide plate and bear against the vibrating lever, substantially as described.

15. In an ore separator, the combination with a pan having a working surface formed of slats spaced a short distance apart, of swinging riffle rods in the pan above its working surface, substantially as described.

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Witnesses:
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