(No Model.) 6 Sheets—Sheet 1.

B. S. CHURCH.

APPARATUS FOR EXTRACTING GOLD OR OTHER PRECIOUS METALS FROM EARTH, &c.

No. 594,521. Patented Nov. 30, 1897.

FIG. 1.

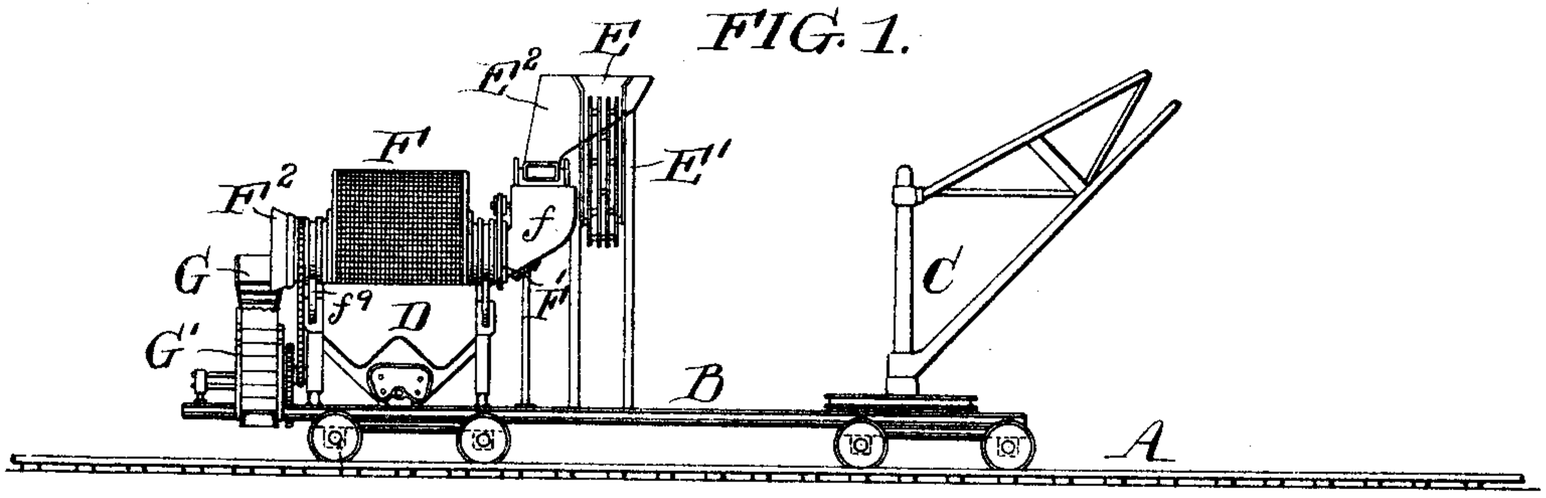
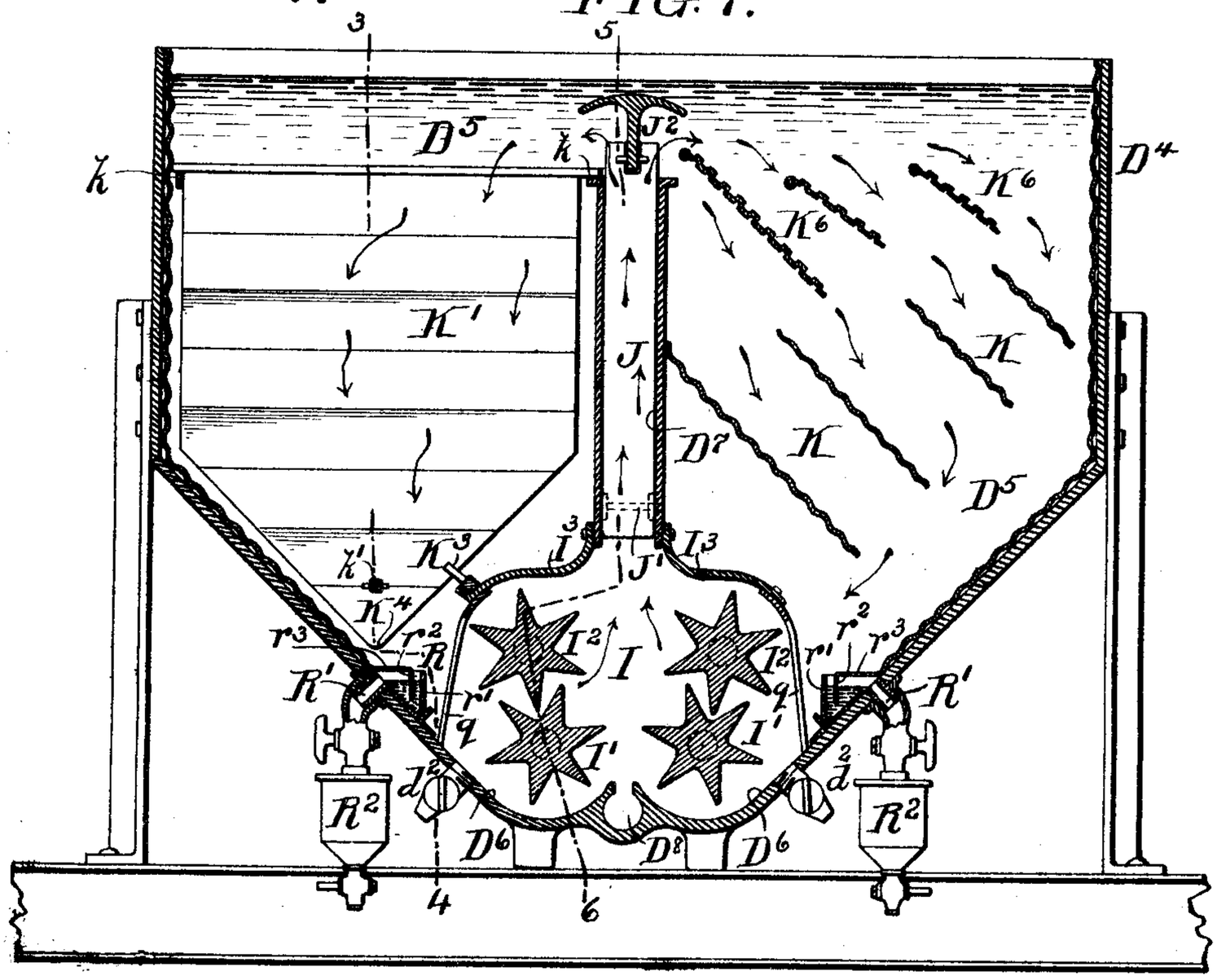


FIG. 7.



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(No Model.) 6 Sheets—Sheet 2.

B. S. CHURCH.

APPARATUS FOR EXTRACTING GOLD OR OTHER PRECIOUS METALS FROM EARTH, &c.

No. 594,521. Patented Nov. 30, 1897.

FIG. 2.

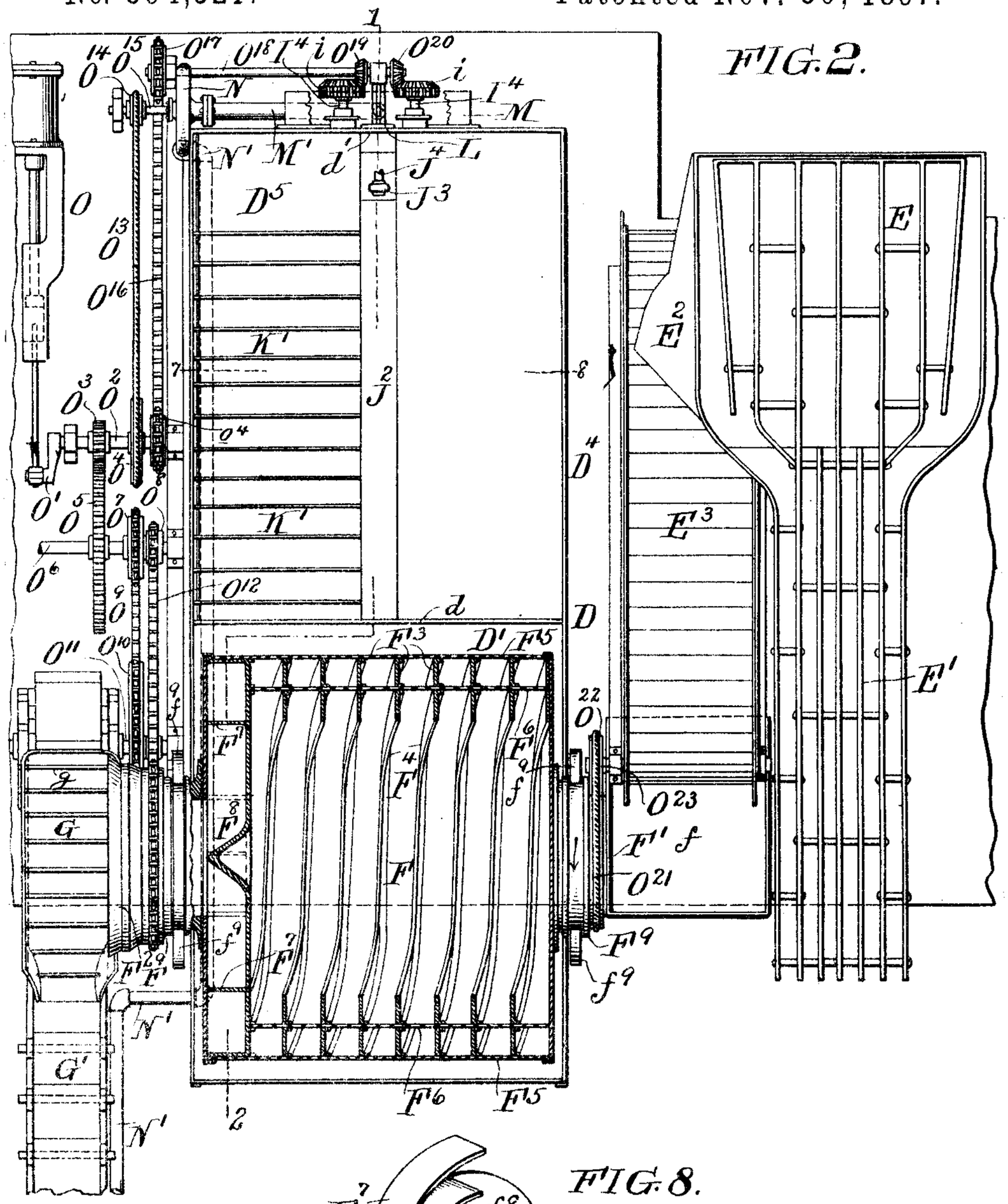
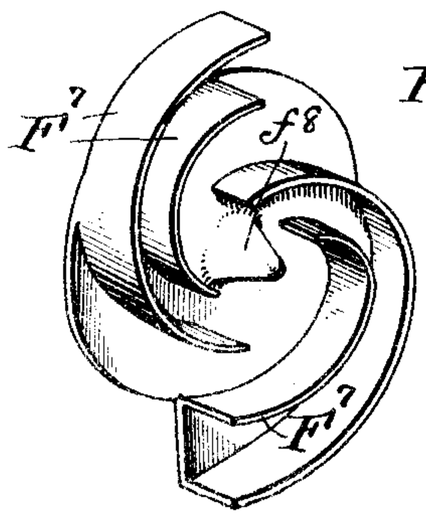


FIG. 8.



Witnesses:

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(No Model.)

6 Sheets—Sheet 3.

B. S. CHURCH.

APPARATUS FOR EXTRACTING GOLD OR OTHER PRECIOUS METALS FROM EARTH, &c.

No. 594,521. Patented Nov. 30, 1897

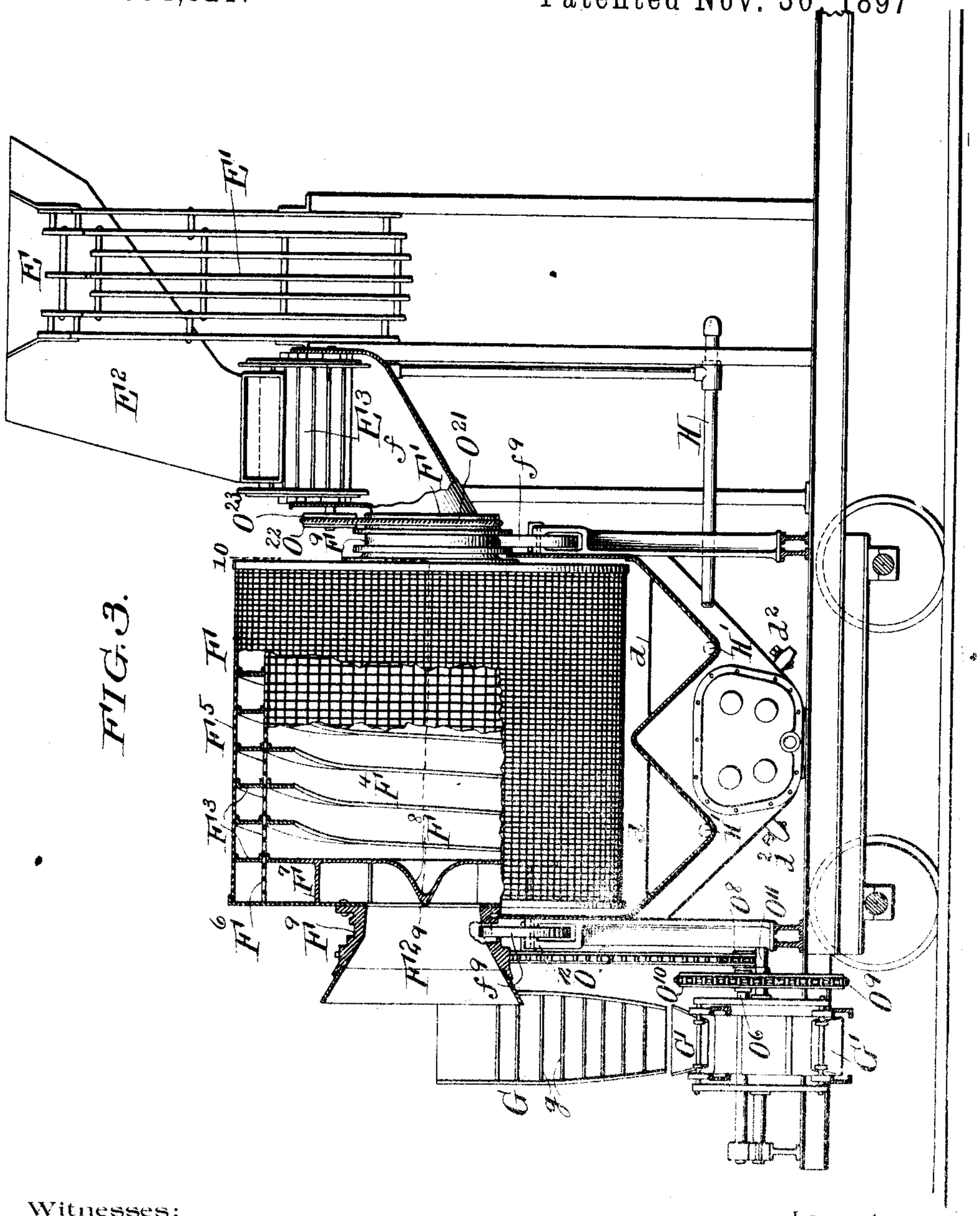

FIG. 3.

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(No Model.)

6 Sheets—Sheet 4.

B. S. CHURCH.

APPARATUS FOR EXTRACTING GOLD OR OTHER PRECIOUS METALS FROM EARTH, &c.

No. 594,521. Patented Nov. 30, 1897.

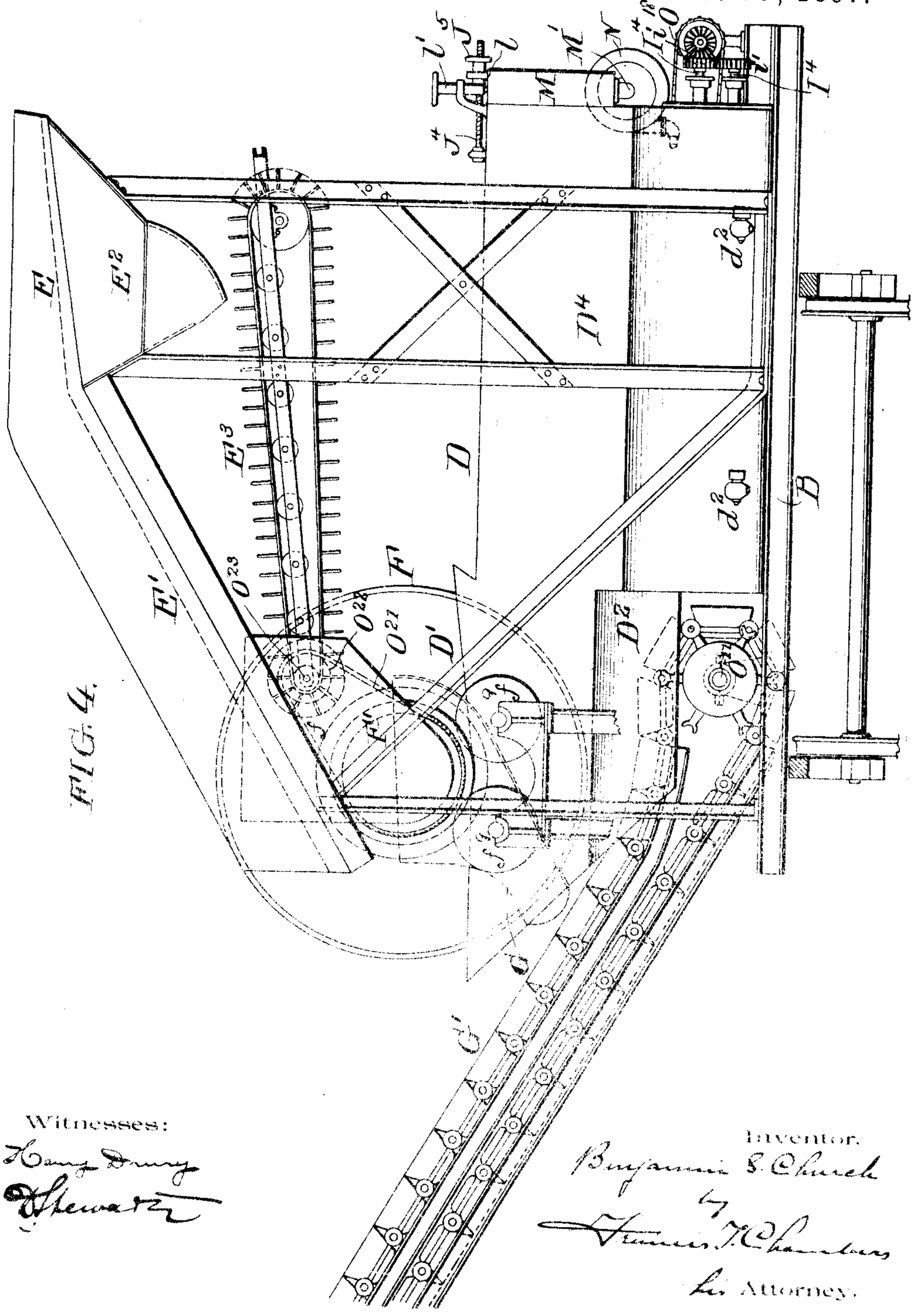

FIG. 4.

Witnesses:
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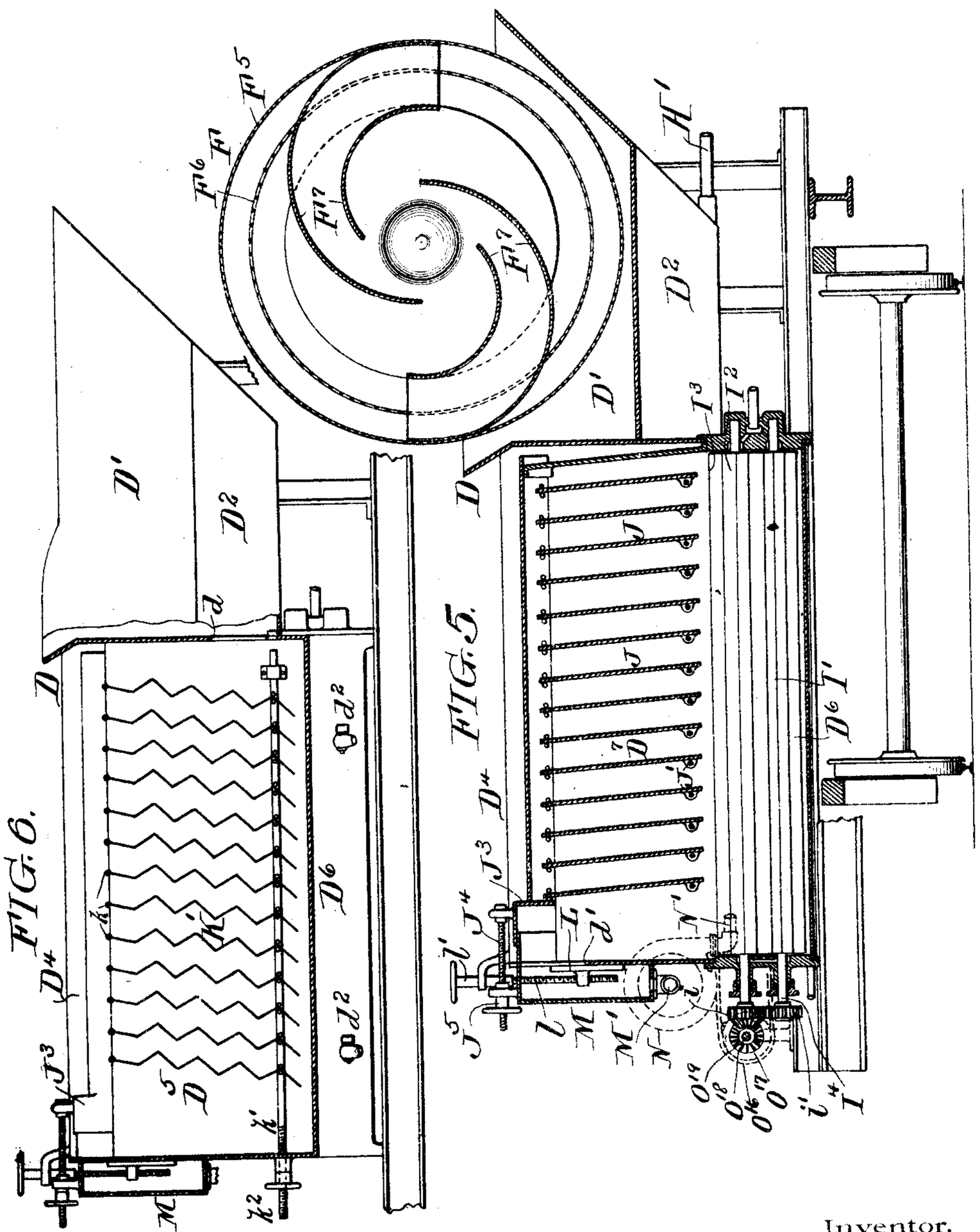
(No Model.) 6 Sheets—Sheet 5.

B. S. CHURCH.

APPARATUS FOR EXTRACTING GOLD OR OTHER PRECIOUS METALS FROM EARTH, &c.

No. 594,521. Patented Nov. 30, 1897.



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(No Model.) 6 Sheets—Sheet 6.

B. S. CHURCH.

APPARATUS FOR EXTRACTING GOLD OR OTHER PRECIOUS METALS FROM EARTH, &c.

No. 594,521. Patented Nov. 30, 1897.

FIG. 9.

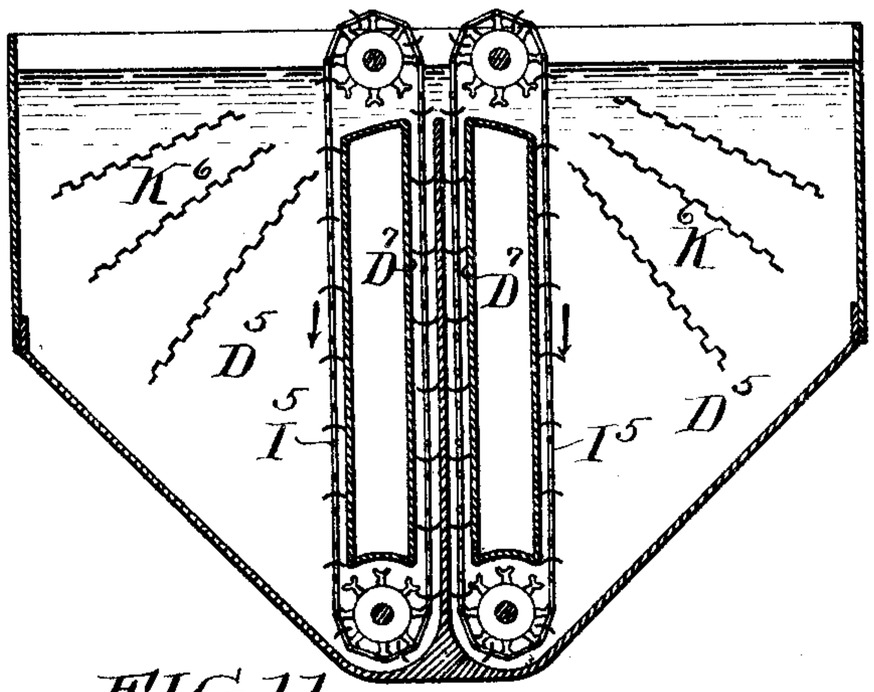


FIG. 10.

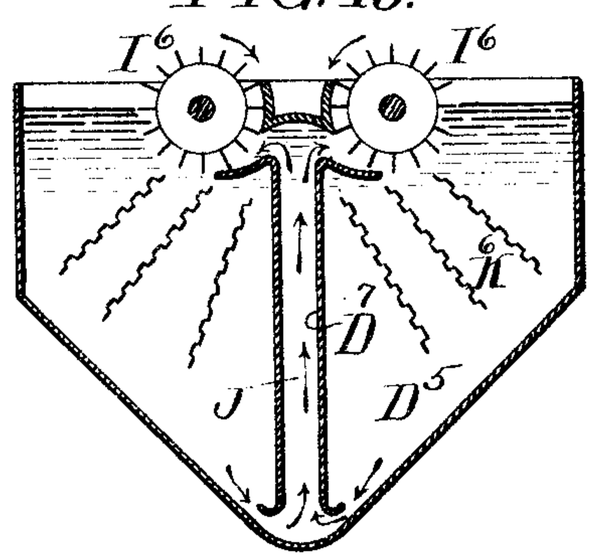


FIG. 11.

FIG. 12.

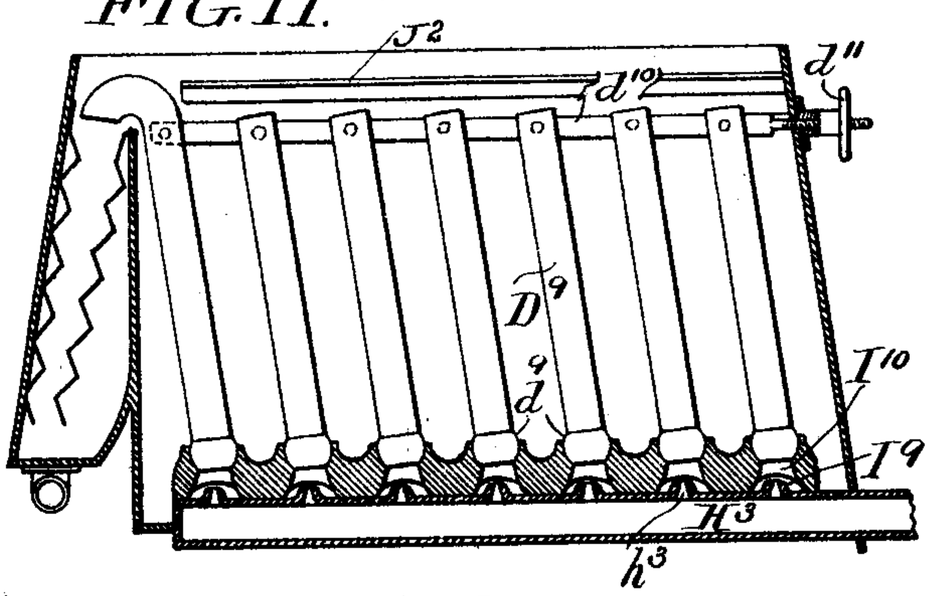


FIG. 13.

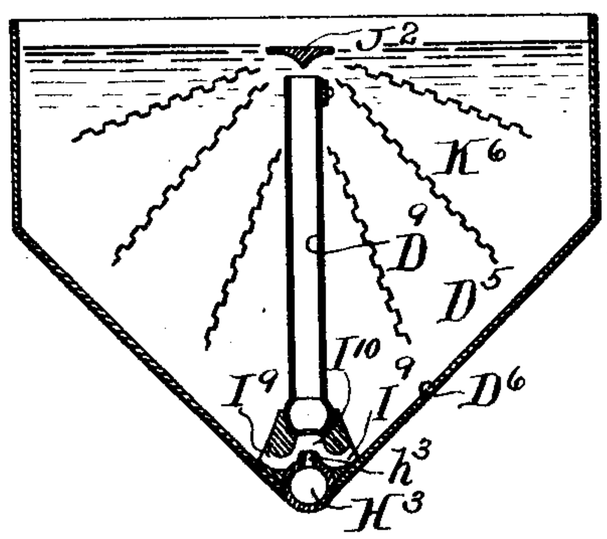
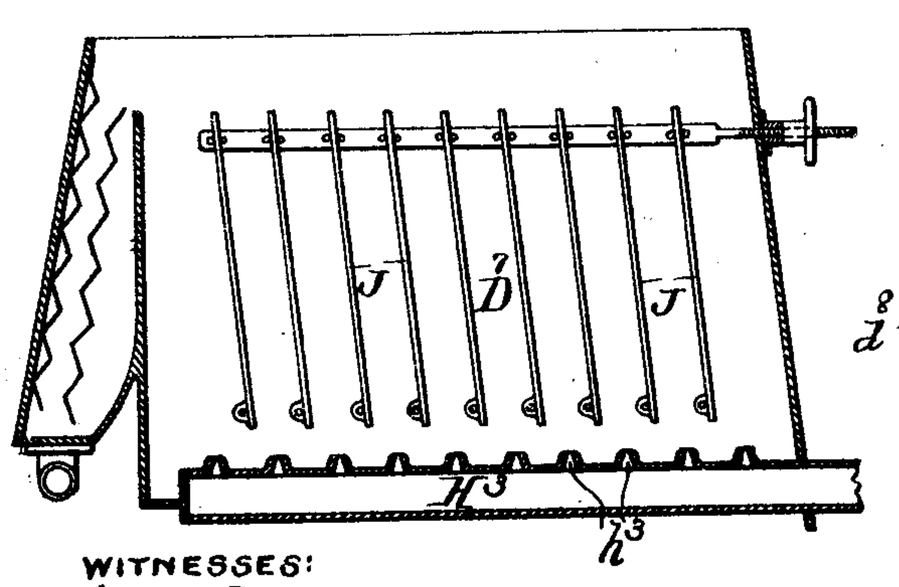
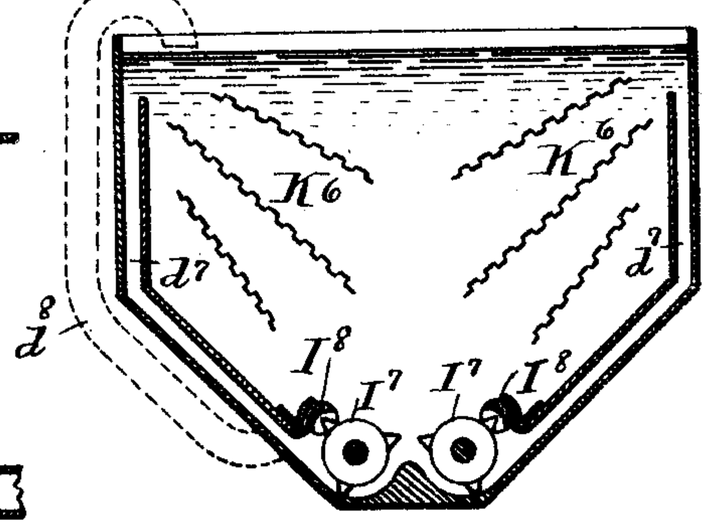


FIG. 14.





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UNITED STATES PATENT OFFICE.

BENJAMIN S. CHURCH, OF NEW YORK, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE CHURCH MACHINERY COMPANY, OF NEW JERSEY.

APPARATUS FOR EXTRACTING GOLD OR OTHER PRECIOUS METALS FROM EARTH, &c.

SPECIFICATION forming part of Letters Patent No. 594,521, dated November 30, 1897.

Application filed November 22, 1893. Renewed May 7, 1897. Serial No. 635,601. (No model.)

To all whom it may concern:

Be it known that I, BENJAMIN S. CHURCH, a citizen of the United States, residing in the city, county, and State of New York, have invented a new and Improved Apparatus for Extracting Gold or other Precious Metals from Earth, Sand, Crushed Rock, or other Metal-Bearing Material, of which the following is a true and exact description, reference being had to the accompanying drawings, which form a part thereof.

My invention relates to the extraction of gold or other precious metals from sand, gravel, &c., either by settling or by what is known as the "amalgamation" process, and is particularly applicable to the treatment of auriferous gravel-beds, generally known as "placer-mines." In such auriferous deposits the gold occurs in varying degrees of fineness, ranging from nuggets of considerable size to what is known as "float" and "microscopic" gold, and in the method of treatment heretofore generally practiced it is well known that a very large portion of the gold occurring in a very finely-divided condition is entirely lost. This is particularly so in the method of so-called "hydraulic" mining, which has been that most successfully used with placer-deposits. Hydraulic mining, however, not only involves the sacrifice of a large portion of the gold present in the placer, but also requires a very large volume and head of water, which cannot always be obtained where valuable placers exist and which, when obtainable, as a rule involve great expense and a destructive and injurious filling up of the beds of the rivers and streams into which the water flows.

The object of my invention is to provide methods and devices for treating placer-deposits which will involve the use of but small quantities of water and by which also the very fine gold can be saved as well as that existing in larger grains or nuggets.

I am aware that attempts, more or less successful, have been made to treat auriferous sands in amalgamating-tanks—that is to say, in tanks filled with water and provided with amalgamating-plates, with which the sand is brought in contact and which, being covered with a film of mercury, tend to intercept and form an amalgam with the gold present in the sand. In such apparatus various means have been used for bringing the auriferous sand in contact with amalgamating-plates, but difficulties, however, are met with in regulating the duration and efficiency of the treatment of any particular body of sand, and my invention particularly relates to the handling of the sand in the amalgamating-tank so as to insure that each volume of sand fed thereto shall come in contact with sufficient aggregate amalgamating-surface and shall be fed through the machine with a regulated speed, which may be varied at the will of the operator.

To prevent misconception, I will here state that while my method and apparatus relate particularly to what is known as the "process of amalgamation" they are also applicable to the extraction of gold and other precious metals from sand, earth, &c., by taking advantage of their greater specific gravity and the use of riffles partly or entirely taking the place of amalgamating-plates in the tank. The riffles will not, of course, save the very fine gold to the same extent as the amalgamating-plates, but I believe that in my treatment they will be found to give better results than the well-known sluicing treatment.

I have discovered that the best results in the treatment of auriferous sand are obtained by throwing or feeding sand into tanks containing amalgamating or riffle plates and in which is contained a comparatively quiescent body of water, so that the sand can settle gradually downward over the plates, which, as usual, are set at an angle to a horizontal plane, then collecting the sand as it settles to the bottom of the tank, and again throwing or feeding it into the top of the tank, but without making upward or cross currents in the water, continuing this treatment until the gold is thoroughly or practically exhausted from the sand. In carrying out this method of treatment I also find it in the highest degree advantageous to feed or shift the mass of sand under treatment longitudinally in the tank with each upward and downward motion of the mass, so that the mass of sand thrown into one end of the tank will be gradually fed from that end to the other or dis-

charge end, growing constantly poorer in gold with each successive treatment and making way for a fresh volume of sand fed into the receiving end of the tank.

While any convenient means may be used for lifting the sand from the bottom to the top of the tank between each successive treatment in contact with the amalgamating-plates, so long as provision is made for avoiding the undue agitation of the mass of water surrounding the plates, I prefer to carry out my method of treatment by whirling the sand upward through the action of a rapidly-moving current of water forced through a return conduit or conduits communicating with the tank at top and bottom, so as to receive the sand from the tank and discharge it into the tank. This current through the return passage or passages may be created by any convenient means, the only essential condition being that it shall be energetic enough to pick up and carry to the top of the tank the particles of sand settling to the bottom thereof. This method of handling the sand in the tank is not only compatible with the gradual shifting of the mass from one end of the tank to the other, but lends itself particularly well to this design, the sand and water being given what may be called a "spiral" circulation, the upward motion being exceedingly quick and the downward motion slow and gradual.

Essentially, then, my invention, considered as a method, consists in the novel treatment of the gold-bearing material or pay-dirt, the leading feature of which is the repeated passage of the material through the separating-tank in the same direction and the intermediate elevation of the material in such a way as not to disturb the settling action in said tank. In connection with the treatment the method in more perfect application involves the employment of a large comparatively quiescent body of water in the settling-tank, so that the pay-dirt will settle gradually over the separating-plates without exposure to the effect of strong cross-currents. Next in order of importance is the provision that the pay-dirt should be given a circulation with the water in the tank, the sand and water settling quietly in the separating-tank and being drawn violently upward out of contact with the separating-plates to again pass through the tank, as before. The desirability of this mode of handling the material will be apparent, except, perhaps, in the feature that by causing the water to so circulate I insure that the very fine gold shall come in contact with the amalgamating-plates, as the water carrying it follows the same course through which gravity carries the heavier particles. Lastly, but by no means the least important, is the method of gradually feeding the pay-dirt through the tank as it circulates therein, so that the material will pursue in effect a spiral course through the separator and its attachments. In this way the treatment is made continuous, and by adjusting the means used for so feeding the material through the tank I am enabled to nicely determine the duration of treatment, suiting it to the quality and quantity of material fed to the separator. These methods of handling the pay-dirt I believe to be entirely new with me and essentially independent of the mechanism used to carry them into effect.

In addition to the methods of handling the mass of sand indicated in a general way above, my invention also comprises novel mechanical constructions designed for the efficient and economical embodiment of my said new methods. Essentially I provide a tank containing amalgamating plates or riffles suitably disposed and combine it with suitable means for elevating the sand which settles to the bottom of the tank and discharging it again into the upper part of the tank, so as to effect a continuous downward motion of the sand among the amalgamating or riffle plates in the tanks. This is most conveniently effected by providing one or more conduits extending from the bottom to the top of the tank and communicating with it at bottom and top and combining the elevating device, whatever it may be, with this return-conduit, so that the sand will be carried upward without disturbing the body of water in the tank proper or interfering with the gradual settling of the sand over the amalgamating-plates. With mechanism of this kind I also preferably combine mechanism for feeding the mass of sand gradually forward in the tank, so that with each succeeding treatment in contact with the plates the sand is shifted forward until it reaches the end of the tank, from which it is withdrawn practically free from admixture with gold. The most convenient and simple mechanism for effecting this I have found to be angularly-set deflecting-plates arranged either in the return-conduit, so as to divide it into practically a series of angularly-inclined conduits, or arranged, if desired, in the amalgamating or separating tank proper, and in this latter case the amalgamating-plates themselves may serve as the deflecting-plates, which shift the sand longitudinally. It is also an important feature of my invention that the inclined conduit, conduits, or plates should be adjustable in their angular direction, so that the speed with which the sand is fed through the tank can be regulated at will, the regulation of the speed also regulating and determining the number of spiral revolutions which the sand makes in the tank.

While positive mechanical feeders or shifting devices are preferable, they are not essential to good work, and the shifting of the sand may be effected even by the current of water passing through the separating-tank. It is, however, an obvious advantage of the deflecting-plate system, apart from its definite regulatable actions, that it enables me to shift the sand entirely independently of the

water-current, and this enables work to be done with the smallest quantity of water.

The features above noted may be said to be the leading features of my invention. I have also devised a number of detailed improvements which are illustrated in the drawings and the nature of which will be pointed out in connection therewith.

Reference being now had to the drawings which illustrate an apparatus embodying the mechanical features of my invention and adapted for use with my improved process, Figure 1 is a side elevation of a railway-car upon which is supported a screening and separating apparatus and also a steam-shovel. Fig. 2 is a plan view of the screening and separating apparatus, the rotating screen, forming part thereof, being shown in section on the line 9 10 of Fig. 3. Fig. 3 is an end view of the apparatus with the revolving screen partly broken away to show its internal construction, the tank beneath the screen being also shown in section. Fig. 4 is a side elevation of the apparatus. Fig. 5 is a sectional elevation taken on the section indicated by the section-lines 1 2 in Fig. 2 and 5 6 in Fig. 7. Fig. 6 is a transverse section through the tank, taken on the line 3 4 of Fig. 7. Fig. 7 is a transverse section taken on the line 7 8 of Fig. 2. Fig. 8 is a perspective view of a portion of the revolving screen. Figs. 9, 10, 13, and 14 illustrate various modifications in the means for transporting the sand from the bottom to the top of the tank. Figs. 11 and 12 illustrate still another modification, shown in longitudinal section in Fig. 11 and transverse section in Fig. 12.

My device being, as already stated, principally intended as an amalgamating device, I shall hereinafter for the most part refer to it as such, but without intending to be understood as thereby excluding the use of riffles either with or without mercury, except, of course, in the claims, where the presence of amalgamating-plates will be called for only where they are of the essence of the invention intended to be covered.

A, Fig. 1, indicates a railway-track which is placed in front of a gravel-bed the material of which is to be treated in the amalgamating apparatus.

B indicates a car-body supported upon trucks running on the track.

C is a device for transporting the gravel to the screen. Preferably a steam-shovel of ordinary construction is supported upon the car-body at this point.

D indicates the tank or tank system of the screening and amalgamating apparatus. As shown, it consists of a tank chamber or compartment D′, in which revolves the screen F, to be hereinafter described, and the bottom of which chamber is preferably made in the form of one or more hoppers—two, as indicated at D^2 D^3.

D^4 is the amalgamating-tank or tank-compartment, which is made to communicate with the compartment D′ and preferably placed, as shown, at a lower level. It is also preferable that the communication should only take place at the bottom of the chamber D′, a partition *d* separating the upper part of the two tanks or tank-chambers.

In the machine illustrated in detail in Figs. 1 to 8, and also in the machine constructed in accordance with the modified plans indicated in Figs. 9, 10, and 13 and to a certain extent in the construction shown in Figs. 11 and 12, the tank-compartment D^4 is divided longitudinally into compartments D^5 D^5, lying upon each side of a narrow upright divisional conduit D^7, which extends from a point at or near the bottom of the tank to the top or upper part thereof and is of much less sectional area than either of the chambers into which it divides the tank. It is highly desirable that the tank should have a hopper-shaped bottom, as indicated at D^6, Fig. 7, the object being that the sand settling in the tank should tend to accumulate along one or more lines. I also prefer to provide a mercury-trough, as indicated at D^8, at the extreme bottom of the amalgamating-tank, its function being to receive any nuggets of gold which may be too heavy to be lifted by the devices used for elevating the sand or too large to be held upon the amalgamating-plates with which the tank-compartments D^5 are filled and which are indicated at K and K′.

d′ indicates the delivery-opening of the amalgamating-tank, and d^2 cocks for drawing off the contents of the tank under certain conditions.

Before describing further the construction and appliances used in connection with the amalgamating-tank, I will refer to the screening system by means of which the said tank is fed with material in proper condition to be operated upon.

In Figs. 1, 2, 3, and 4, E is a grating or screen upon which the material dug out of the gravel-pit is dumped and through which all the gravel, together with boulders of less than a determined size, pass to a chute E^2, from which in turn they are delivered to a conveyer E^3, said conveyer in turn dumping the material into a hopper *f*, which delivers it through the hollow trunnion F′ into the interior of a rotating screen F.

E′ indicates a chute extending from the screen E and which operates to deliver the larger boulders which cannot pass the screen upon the same part of the apparatus to which the material after being screened is delivered. This is particularly important where an arrangement such as that indicated in Fig. 1 is used, because it automatically transfers all the material dug from the bank to the opposite side of the track, upon which side, of course, lies the dump-pile.

Returning now to the screen F, it is provided, as shown, with hollow supporting-trunnions F′ and F^2, serving, respectively, for the admission and delivery of material. As

shown, it is made up of two spirally-formed sets of iron beams F^3 and F^4, a perforated or wire screen F^5 being secured upon the outside and a second perforated or wire screen F^6, having holes of somewhat greater diameter, being secured between the beams F^3 and F^4. At the delivery end of the screen are arranged converging spirally-curved plates F^7 F^7, (see Figs. 2 and 8,) the function of which is to pick up the material reaching the delivery end of the revolving screen and dump it into the hollow trunnion F^2. The gradually-converging curves of the plates lift the material gradually and easily, so that it is elevated to the level of the trunnion-opening without jar or shock. These plates F^7 are, as shown, secured between the end plate of the screen and a divisional plate f^8, having a conical outward projection F^8, which assists in pushing the material into the hollow trunnion.

F^9 F^9 indicate two portions of the hollow trunnions F' F^2, upon which the weight of the screen is supported. As shown, they rest upon wheels f^9, which facilitate the revolution of the screen.

The hollow trunnion F^2 is provided, preferably, with a flaring mouthpiece, as indicated, and immediately below this mouthpiece is a chute G, upon the face of which I form riffles, as indicated at g, for the purpose of catching gold nuggets. They may contain mercury, which will tend to amalgamate any nuggets of gold which may pass through the screen without entering the tank in which it revolves. The chute G in turn delivers the material to a conveyer G', by which it is carried to the dump-pile.

Here I may note the mechanism shown for actuating the moving parts heretofore described. This consists of an engine, indicated at O, Fig. 2, and, acting upon a crank O' of a driving-shaft O^2, a gear-wheel O^3 on said shaft communicates motion to a gear O^5 on a counter-shaft O^6, upon which is secured the sprocket-wheel O^7, which communicates motion to the conveyer G' by means of a chain O^9, passing over a sprocket-wheel O^{10}, secured in turn to the shaft O^{11}, which communicates motion to the conveyer. A second sprocket-wheel O^8, secured to the shaft O^6, communicates motion to the screen F by means of the chain O^{12}, passing around a portion of the trunnion F^2, which is provided with sprockets. The conveyer E^3 is actuated by means of a rope, belt, or sprocket-chain O^{21}, which passes around a portion of the trunnion F' and around a wheel O^{22}, secured to a shaft O^{23}, which in turn actuates the conveyer E^3. This feature of construction, by which the motion of the conveyer E^3 is regulated by the motion of the revolving screen F, is of value, as it prevents the material being fed too rapidly to the revolving screen.

The revolving screen has its lower portion submerged in water contained in the tank-compartment D', and as the screen revolves the placer material dumped into it is thoroughly stirred and washed, the finer material passing through the screen F^6 and still finer material passing through the outer screen F^5 into the tank D'. The washing and stirring is sufficient to separate particles of gold from the earthy matter, and the openings in the screen are sufficiently large to pass gold of such size as usually occurs. Larger nuggets than can pass the perforated plates are, however, not infrequently met with, and they, of course, are dumped with the coarse material passing out of the trunnion F^2, but are intercepted by the riffles on the chute G, owing to their greater specific gravity or affinity for mercury. Therefore the material delivered from the chute to the conveyer G' may be taken as free from gold. The auriferous sand passing through the revolving screen falls to the hopper-bottoms D^2 of the tank-compartment D', and thence passes to the amalgamating-tank D^1. As indicated, I feed the tank with water from pipes II' II', entering the rear of the tank D' and at the bottom of its hopper-shaped bottom sections. In this way the force of the entering jet or jets of water is utilized to carry the sand into the amalgamating-tank; but of course any means may be used to effect this transportation of material.

The next feature of my invention relates to the means applicable to raise the auriferous sand and earth in the amalgamating-tank and permitting it to settle gradually over the amalgamating-plates.

In a broad sense I do not wish to be understood as confining myself to any particular method or apparatus for effecting the rapid elevation of the sand. I prefer, however, to do this by means of a rapidly-moving current of water which will carry the sand upward with it, but without agitating and making upward or cross currents in the portions of the tank in which the amalgamating-plates are situated. For this purpose I have found it best to use a pump which will act to draw the water and sand settling to the bottom of the amalgamating-tank into a narrow return-passage, as D^7, the energy of the pump and the area of the return-passage being such that the motion of the water will carry with it the auriferous sand, which sand is thus collected as it settles to the bottom of the tank and thrown again to the top thereof.

In the construction shown in Figs. 1 to 8 I have illustrated a pump which I have found to give excellent results in practice. It consists of elongated spur or star wheels I' I', situated at the bottom of the tank D^1 and on each side of the mouth of the conduit D^7, these star-wheels again meshing with star-wheels I^2 I^2, situated above them and of course turning in opposite directions. Shield-plates I^3 extend from the bottom of the conduit D^7 over the periphery of the star-wheels I^2, and the bottom of tank D^1 is of course given a proper conformation, curved, as shown, to insure that the revolving wheels I' will draw

in a proper amount of water from the tank. The star-wheels are secured to shafts I^4, which pass through the end of the tank and upon which, as shown, are secured bevel-gears *i i*. O^{19} and O^{20} are bevel-gears secured to a shaft O^{18}, upon the end of which is a sprocket-wheel O^{17}, which is driven by a chain O^{16}, which passes over a sprocket-wheel O^4 on the driving-shaft O^2. This gearing will drive either the upper or lower star-wheels, the other pair being conveniently actuated by spur-gearing connecting the shafts with those above or below. Considered as a pump this device is familiar to those skilled in the art, but has a peculiar value in my apparatus because the star-wheels not only serve to create a current of water of the necessary violence, but also serve on occasion as scrapers well adapted to carry up any sand which may settle in considerable volume to the bottom of the tank, and they are also advantageous because they are not liable to be clogged or injured by sand getting between the engaging teeth.

At the top of the conduit D^7 it is advisable to have some deflecting or distributing apparatus by which the water and sand issuing from the conduit will be thrown out over the top of the amalgamating compartments or chambers of the tank. Such a device is indicated at J^2; but of course any convenient appliance for this purpose could be substituted for it or used with it. Thus the riffle-plates K^6 in Fig. 7 serve to spread the sand out in the tank.

In place of the construction illustrated in Figs. 1 to 7 almost any variety of pump or water-forcing device may be used to accomplish the circulation of auriferous sand in the amalgamating-tank.

In Fig. 9 I have illustrated a familiar form of conveyer by which sand settling to the bottom of the tank can be carried upward irrespective of the speed with which the device moves. In Fig. 10 I have shown at I^6 I^6 paddle-wheels placed at the top of the conduit D^7, by the rapid revolution of which, in the direction indicated by the arrows, a sufficiently-rapid current of water is, so to speak, "sucked up" through the conduit D^7. In Fig. 13 I have indicated a form of jet-pump, a water-main H^3, having a series of orifices h^3, extending up from the bottom of the tank and pointing into the conduit D^7, the effect of which will be to create the necessary upward current. In Fig. 14 I have shown at I^7 and at I^8 a modified but familiar form of pump arranged to force the water and sand upward through the return-conduits (indicated at d^7) and arranged along the sides of the tank instead of extending from the center thereof, and I have indicated in dotted lines at d^8 the obvious fact that the return-conduits need not pass through the tank at all, but simply extend from the bottom to the top thereof. In Figs. 11 and 12 I have shown a further modification in which, in place of one or more elongated return-conduits, such as those marked D^7, a series of pipes D^9 are arranged in the tank, and in the construction shown I have combined the pipes D^9 with a jet apparatus similar to that shown in Fig. 13, the nozzles h^3 projecting into nozzles I^{10}, from which passages I^9 lead to the tank and from which also extend the pipes D^9. These are only some of the various modifications which could be instanced; but in all cases precaution should be taken that the body of water in the amalgamating-compartments of the tank should not be violently agitated, as I consider it of great importance that the sand should be permitted to settle quietly and gradually among the amalgamating-plates, this insuring, in the first place, an even and thorough contact, and in the second place obviating the danger of scouring the plates, which is naturally incident to rapid and irregular motions of the sand in the tanks, and this even settling being also of considerable importance in view of the necessity for good work of subjecting each volume of sand to substantially the same treatment both in kind and duration.

In each amalgamating-compartment of the tank, be there one or more—as, for instance, in the compartments D^7 D^5, (shown in Fig. 7,)—I arrange a series of amalgamating-plates—such, for instance, as are indicated at K or at K′—or of riffle-plates, (indicated at K^6.) The arrangement illustrated in the case of the plates K is of a series of plates set longitudinally in the tank and extending one over the other, the angular inclination of the plates being regulated by the sort of material under treatment and the plates being preferably made adjustable in inclination. In the case of the plates K′ the plates are set transversely in the tank, and they are supported at the top, as shown, by shoulders or bars, (indicated at *k k*,) and an additional support is provided by a ledge K^3, extending out from the shield I^3. A longitudinally-extending bar is secured to each plate for adjusting its angular inclination, the shifting of the bar varying simultaneously the inclination of each plate. The plates come to a point, as indicated at K^4, said point being situated above the mercury-trap, which will be hereinafter described. The plates, as indicated in Figs. 6 and 7, are preferably of the corrugated or zigzag form shown, so as to create little currents, which will tend to throw the sand from one to the other.

In Fig. 7 I have shown above the amalgamating-plates K riffle-plates K^6, situated at the top of the tank and adapted to catch and retain the heavier particles of gold. In Fig. 9 I have illustrated the tank-chamber D^5 as filled entirely with riffle-plates.

The next important feature of my improved device is the means provided for shifting or feeding the sand longitudinally through the tank while it is being circulated, as above described. Considered purely as a process it is immaterial what kind of means, conveyer

or shifting mechanism, is used to effect this longitudinal feeding. I prefer, however, to effect the longitudinal feed at the same time that the circular feed is effected and to provide means for varying or adjusting said feed, and I have shown how this can be simply and efficiently done by arranging deflecting-plates set at proper angles in either the amalgamating-chamber or the return-conduit, or preferably in both. Where the deflecting-plates are used in the amalgamating-chamber, they can be made to serve both the purpose of deflecting and amalgamating plates. Thus the transversely-set amalgamating-plates K′ (best shown in Figs. 6 and 7) will obviously deliver the sand at a point nearer the delivery end of the tank than that at which the sand is fed to the plates, and the extent to which the sand is so shifted or fed can be regulated by shifting the angular inclination of the plates K′. For this purpose I have shown the shifting rod k' extending to the end of the tank (see Fig. 6) and provided with an adjusting-nut k^2; but irrespective of the kind and form of the amalgamating-plates the shifting or feeding of the sand can be accomplished by giving the return-conduits an angular inclination in the proper direction—as, for instance, in the case with pipes D^9, Figs. 11 and 12. The said pipes, as shown, have ball-and-socket joints d^9 at the bottom and are attached to the shifting rod d^{10} and are made adjustable by nut d^{11}. Substantially the same effect is produced in the long and narrow conduit D^7 by placing a series of transverse partitions or plates J inside of the conduits, and, as shown, these deflecting-plates J are pivoted at one end (see J′) and secured at the other end to an adjustable bar, which for convenience I have shown as forming a part of the deflector J^2, this deflector and shifting bar being attached to a bolt J^4 (see Fig. 5) and shifted by means of a nut J^5. It will be noticed that what I may call a "hood" (indicated at J^3) is formed at the end of the deflecting and shifting bar near the delivery end of the tank.

I have already called attention to the delivery-orifice d' of the amalgamating-tank D^4. As the height at which the water will flow out of the tank should be made adjustable for this purpose, I have shown a gate L, secured on the end of a screw-shaft l, having a hand-wheel l' for raising or lowering the gate. In the construction shown the orifice d' registers with the upper part of the return-conduit D′, and when the sand has reached the delivery end of the tank it is carried up with the water and passes out of the opening d' into a chamber, (indicated at M.) From this chamber it passes through a pipe M′ to a pump N, which pump (see Fig. 2) is driven by a rope, belt, or chain O^{14}, passing over a wheel O^1 on shaft O^2 and over a wheel O^{13} on the pump-shaft O^{15}. N′ is the delivery-conduit through which the pump forces the sand and water, and it is carried up, as indicated in Fig. 2, along the side of the conveyer G′, so that the material passing through the amalgamating-tank is forced by the pump to the refuse-pile along with the material deposited on the conveyer G.

Returning now to the amalgamating-tank it will be noticed that a trap R is shown extending in trough-like form along the inclined sides of the bottom of the tank. This is made up, as shown, of an upright plate r' and a bent plate r^2 r^3, forming a trap, as shown, which is filled with mercury and from the inside of which, covered by plates r^2 r^3, leads an opening or passage R′, which connects with an amalgam-bottle R^2. Mercury and amalgam falling from the amalgamating-plates will be intercepted by this device and caught in the bottles R^2, from which it can be drawn from time to time. This device is of importance in preventing the loss of mercury and amalgam when, as is preferable, the plates are kept well covered with mercury. The amalgamating-plates should have their edges or points from which mercury is likely to drip situated, as shown, above the trap, so that the drip will fall into the latter.

At d^2 I have indicated cocks by which the water and sand in the amalgamating-tanks can be drawn off at will. These are convenient and valuable as affording means for preventing the sand from settling and choking the pump when for any reason it becomes necessary to stop its operation.

The method by which the auriferous sand is treated and the operation of my improved apparatus in carrying this method into effect have been already sufficiently described.

In the claims I have not specifically claimed the modifications of construction indicated in Figs. 9 to 14, as they are alternative to other constructions specifically claimed, and these modifications will form the subject-matter of additional patents.

It will be understood, of course, that my process and apparatus are applicable to the treatment of all gold-bearing material of whatsoever character, and I have used the term "sand" as generally descriptive of such material whether it consists of the product of stamp-mills or natural earthy "pay-dirt."

As already stated, my improved apparatus is intended to be used both with mechanical separators and such as riffles and with the particular form of separator known as "amalgamating-plates," and where in the claims I refer to "separators" I wish to be understood as using the term in the comprehensive sense, which would include both the mechanical separators and the mercurial separators or amalgamating-plates.

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

1. An apparatus for separating precious metals from sand having in combination a tank, means for feeding sand into one end and withdrawing it from the other, one or more separators arranged in the tank, one or more

return-conduits arranged as described from front to rear of the tank and opening into it at the top and the bottom substantially throughout its length to remove the sand settling to the bottom of the tank as it settles, and means for elevating the sand through said return conduit or conduits and discharging it into the top of the tank.

2. An apparatus for separating precious metals from sand having in combination a tank with a hopper-shaped bottom extending lengthwise of the tank, one or more separators arranged in the tank, one or more return-conduits arranged as described from front to rear of the tank and opening into it at the top and bottom substantially throughout its length to remove the sand settling to the bottom of the hopper-shaped bottom of the tank as it settles, and means for elevating the sand through said return conduit or conduits and discharging it into the top of the tank.

3. An apparatus for separating precious metals from sand having in combination a tank, means for feeding sand into one end and withdrawing it from the other, one or more separators arranged in the tank, one or more return-conduits arranged as described from front to rear of the tank and opening into it at the top and bottom substantially throughout its length to remove the sand settling to the bottom of the tank as it settles, and means for drawing the water from the bottom of the tank along its length and forcing it and sand carried by it through the return conduit or conduits to the top of the tank.

4. An apparatus for separating precious metals from sand having in combination a tank with a hopper-shaped bottom extending lengthwise of the tank, one or more separators arranged in the tank, one or more return-conduits arranged as described from front to rear of the tank and opening into it at the top and bottom substantially throughout its length to remove the sand settling to the bottom of the hopper-shaped bottom of the tank as it settles, and means for drawing the water from the bottom of the tank along its length and forcing it and sand carried by it through the return conduit or conduits to the top of the tank.

5. An apparatus for separating precious metals from sand having in combination a tank with a hopper-shaped bottom extending lengthwise of the tank, one or more separators arranged in the tank, one or more return-conduits opening at top and bottom into the tank substantially throughout its length, means for elevating the sand through said return conduit or conduits as it settles in the hopper-shaped bottom of the tank and discharging it into the top thereof and regulable means for feeding the sand longitudinally through the tank as it circulates through said tank and its return-conduits.

6. An apparatus for separating precious metals from sand having in combination a tank-chamber, one or more separators situated in said chambers, a return conduit or conduits connecting with the bottom and top of said tank-chamber, said conduits being of less area than the tank-chamber, a pump arranged to force the water and sand from the bottom to the top of the tank through the return-conduits and a series of angularly-adjustable deflecting-plates arranged to move the sand along the tank as it circulates through the chamber and conduit.

7. An apparatus for separating precious metals from sand, having in combination a tank-chamber, one or more separators situated in said chamber, a series of angularly-adjustable return-conduits, connecting with the top and bottom of the tank-chamber and means for forcing sand and water from the bottom to the top of the tank through the return-conduits.

8. In an apparatus for separating precious metals from sand the combination of a tank-chamber, a narrow chamber connecting the top and bottom of the tank, a series of angularly-adjustable deflecting-plates situated in said narrow chamber, one or more separators situated in the tank-chamber and means for forcing sand and water through the narrow chamber aforesaid from the bottom to the top of the tank.

9. In an apparatus for separating precious metals from sand, the combination of a tank-chamber, a narrow chamber connecting the top and bottom of the tank, a series of angularly-adjustable deflecting-plates situated in said narrow chamber, a series of transversely-set and angularly-adjustable separating-plates situated in the tank-chamber and means for forcing sand and water through the narrow chamber aforesaid from the bottom to the top of the tank.

10. In an apparatus for separating precious metals from sand the combination of a tank-chamber, having a hopper-bottom extending from front to rear as described, one or more separators situated in said chamber, a return conduit or conduits connecting with the top and bottom thereof throughout its length, a receptacle for mercury extending along the bottom of the hopper-bottom and means for forcing sand and water from the bottom to the top of the tank through the return-conduit.

11. In an apparatus for separating precious metals from sand, the combination of a tank-chamber having a hopper-bottom extending from front to rear as described, one or more separators situated in said chamber, a return conduit or conduits connecting with the top and bottom thereof throughout its length, a receptacle for mercury extending along the bottom of the hopper-bottom, means for forcing sand and water from the bottom to the top of the tank through the return-conduit

and means for longitudinally shifting the mass of sand as it circulates through the apparatus.

12. In an apparatus for separating precious metals from sand the combination of a tank-chamber, a narrow upright return-conduit connecting the top and bottom of the tank and dividing it into two compartments, means for forcing sand and water through said conduit from the bottom to the top of the tank-compartment and a mercury-trough situated below the return-conduit.

13. In an apparatus for separating precious metals from sand, the combination of a tank-chamber, a narrow upright return-conduit connecting the top and bottom of the tank and dividing it into two compartments, means for forcing sand and water through said conduit from the bottom to the top of the tank-compartments, a mercury-trough situated below the return-conduit and means for longitudinally shifting the mass of sand as it circulates through the tank.

14. In an apparatus for separating precious metals from sand, the combination of a tank-chamber having a hopper-shaped bottom extending from front to rear, a return conduit or conduits extending lengthwise of the tank and opening into it at top and bottom, stirring and propelling mechanism as elongated spur-wheels or ribbed cylinders I′ I′ extending along the bottom of the tank below the entrance of the return-conduit and arranged to draw water and sand from the bottom of the tank throughout its length and force it into and through the return conduit or conduits and one or more separators arranged in the tank-chamber.

15. In an apparatus for separating precious metals from sand the combination of a tank-chamber having a hopper-shaped bottom, a return conduit or conduits reaching from near the bottom of the tank, upward stirring and propelling mechanism, as elongated spur-wheels or ribbed cylinders I′ I′, arranged at the bottom of the tank below the entrance of the return-conduit, for the purpose of forcing water and sand through said conduit, a series of adjustable deflecting-plates arranged as described to give longitudinal movement to the same and a series of separators arranged in the tank-chamber.

16. In an apparatus for separating precious metals from sand, the combination of a tank chamber or chambers containing separating-plates, a return conduit or conduits leading from the bottom to the top thereof, means for forcing water and sand through said conduits and a protecting-grating *q* arranged as described to protect the return-conduit and forcing mechanism.

17. An amalgamating apparatus having in combination a tank-chamber, a series of amalgamating-plates situated in said chamber, a return conduit or conduits connecting with the bottom and top of said tank-chamber, said conduits being of less area than the tank-chamber, a pump arranged to force the water and sand from the bottom to the top of the tank through the return-conduits and a series of angularly-adjustable deflecting-plates arranged to move the sand along the tank as it circulates through the chamber and conduit.

18. An amalgamating apparatus having in combination a tank-chamber, a series of amalgamating-plates situated in said chamber, a series of angularly-adjustable return-conduits, connecting with the top and bottom of the tank-chamber and means for forcing sand and water from the bottom to the top of the tank through the return-conduits.

19. In an amalgamating apparatus the combination of a tank-chamber, a narrow chamber connecting the top and bottom of the tank, a series of angularly-adjustable deflecting-plates situated in said narrow chamber, a series of amalgamating-plates situated in the tank-chamber and means for forcing sand and water through the narrow chamber aforesaid from the bottom to the top of the tank.

20. In an amalgamating apparatus the combination of a tank-chamber, a narrow chamber connecting the top and bottom of the tank, a series of angularly-adjustable deflecting-plates situated in said narrow chamber, a series of transversely-set and angularly-adjustable amalgamating-plates situated in the tank-chamber and means for forcing sand and water through the narrow chamber aforesaid from the bottom to the top of the tank.

21. In an amalgamating apparatus the combination of a tank-chamber, a narrow chamber connecting the top and bottom of the tank, a series of transversely-set angularly-adjustable amalgamating-plates situated in the tank-chamber and means for forcing sand and water through the narrow chamber aforesaid from the bottom to the top of the tank.

22. In an amalgamating apparatus the combination of a tank-chamber, a narrow upright return-conduit connecting the top and bottom of the tank and dividing it into two compartments, means for forcing sand and water through said conduit from the bottom to the top of the tank-compartments, a mercury-trough situated below the return-conduit and means for longitudinally shifting the mass of sand as it circulates through the tank.

23. In an amalgamating apparatus the combination of a tank having a hopper-shaped bottom, a return conduit or conduits connecting the top and bottom of the tank substantially throughout its length, means for forcing sand and water through said conduit, a mercury-trap set along the inclined side or sides of the tank, and amalgamating-plates set in the tank so that mercury or amalgam falling therefrom will be intercepted in the trap.

24. In an amalgamating apparatus the combination of a tank having a hopper-shaped

bottom, a return conduit or conduits connecting the top and bottom of the tank, means for forcing sand and water through said conduit, a mercury-trap set along the inclined side or sides of the tank, and consisting of a retaining-plate r', a bent cover-plate $r^2 r^3$ and a bottle R^2 connected therewith, and a series of amalgamating-plates set in the tank so that mercury or amalgam falling therefrom will be intercepted in the trap.

25. In an amalgamating apparatus the combination of a tank-chamber having a hopper-shaped bottom, a return conduit or conduits reaching from near the bottom of the tank, upward stirring and propelling mechanism as elongated spur-wheels I′ I′ arranged at the bottom of the tank below the entrance of the return-conduit for the purpose of forcing water and sand through said conduit, a series of adjustable deflecting-plates arranged as described to give longitudinal movement to the same and a series of amalgamating-plates arranged in the tank-chamber.

26. In an amalgamating apparatus the combination of a tank-chamber having a hopper-shaped bottom, a return conduit or conduits reaching from near the bottom of the tank, upward stirring and propelling mechanism as elongated spur-wheels I′ I′ arranged at the bottom of the tank below the entrance of the return-conduit for the purpose of forcing water and sand through said conduit, a mercury-trough set between the spur-wheels, a series of adjustable deflecting-plates arranged as described to give longitudinal movement to the sand, and a series of amalgamating-plates arranged in the tank-chamber.

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