No. 617,226. Patented Jan. 3, 1899.

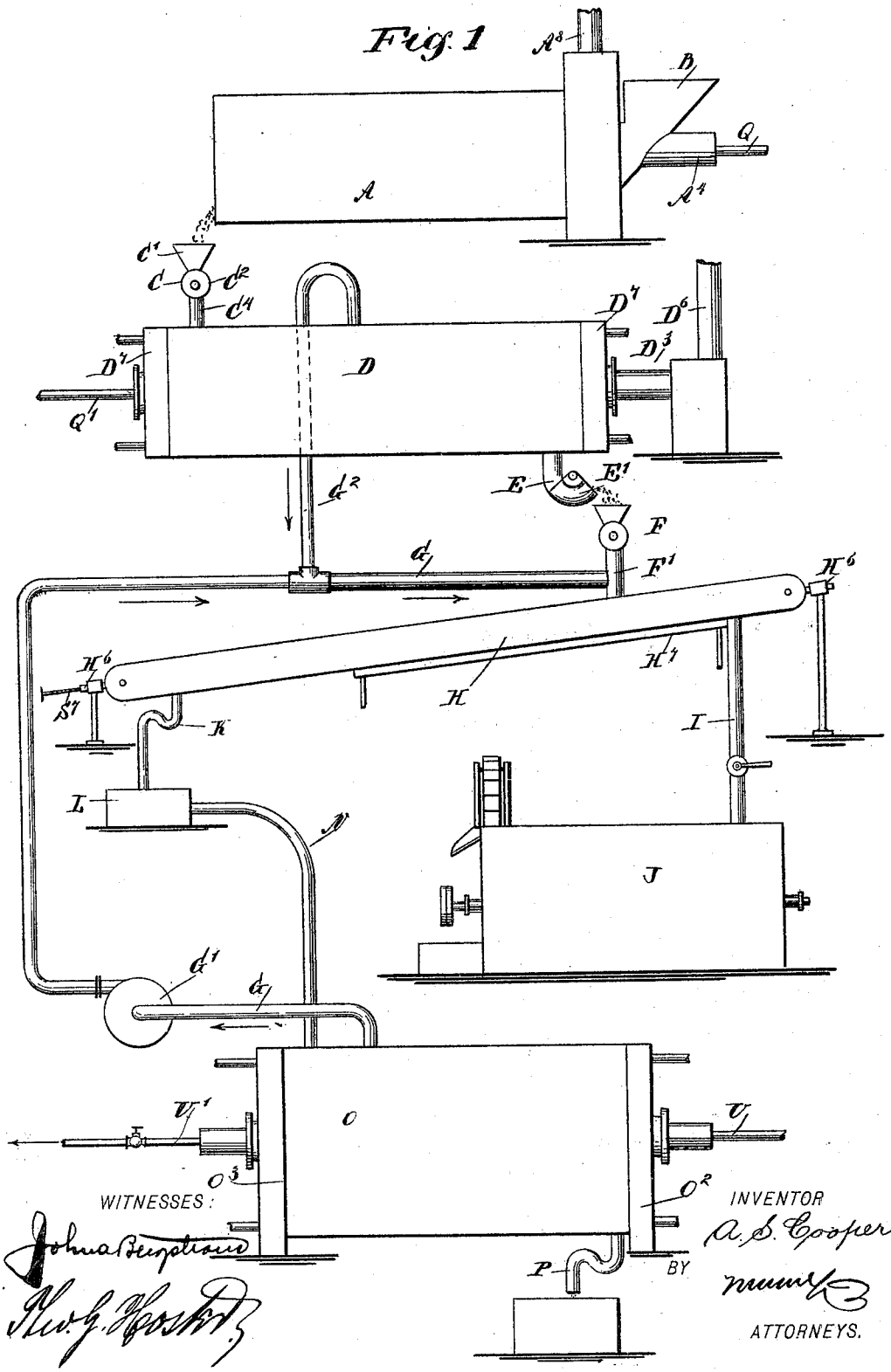
A. S. COOPER.

METHOD OF AND APPARATUS FOR EXTRACTING BITUMEN FROM SAND.

(Application filed Nov. 19, 1897.)

(No Model.) 7 Sheets—Sheet 1.

Fig. 1



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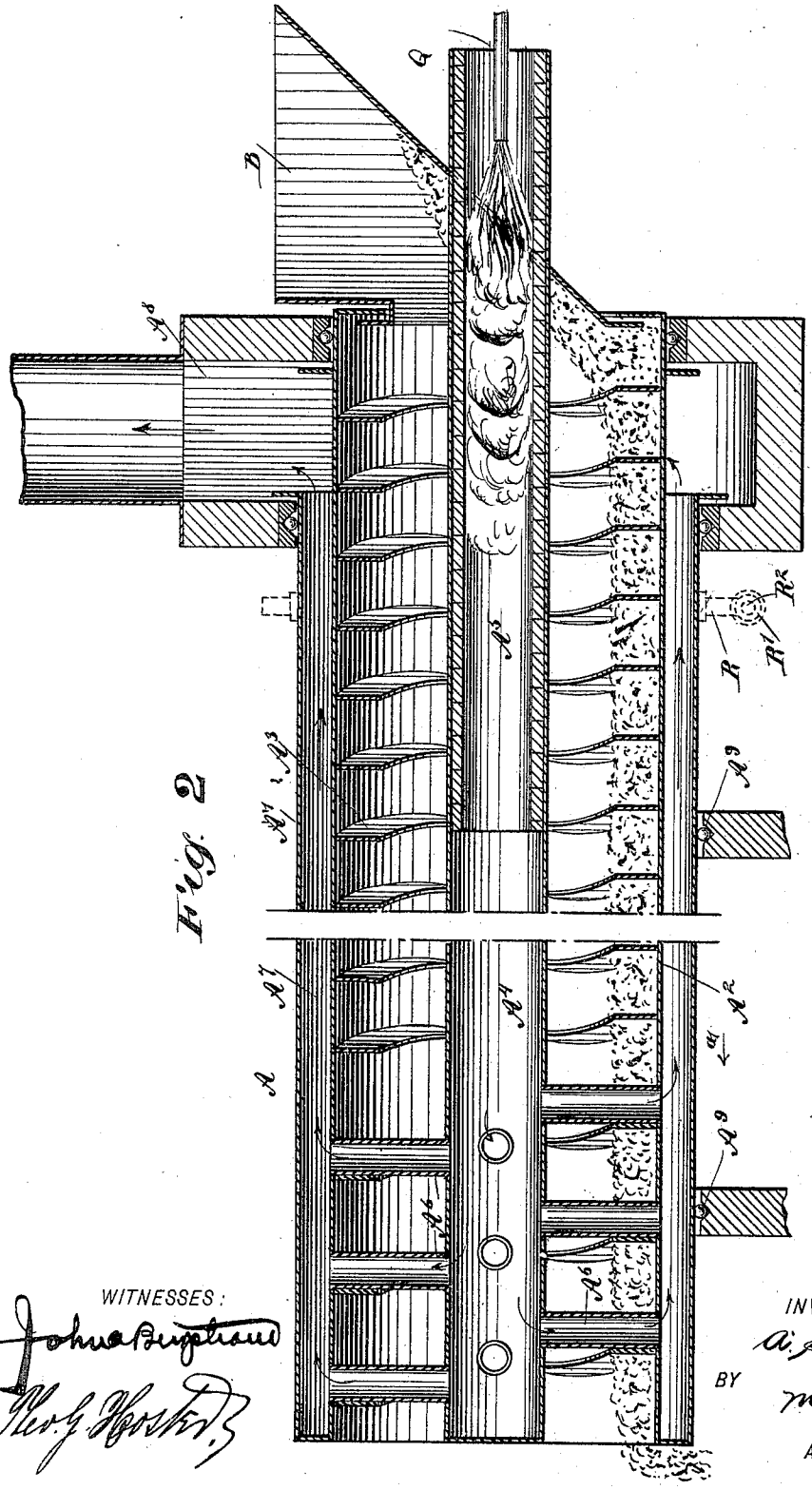


Fig. 2.

WITNESSES:

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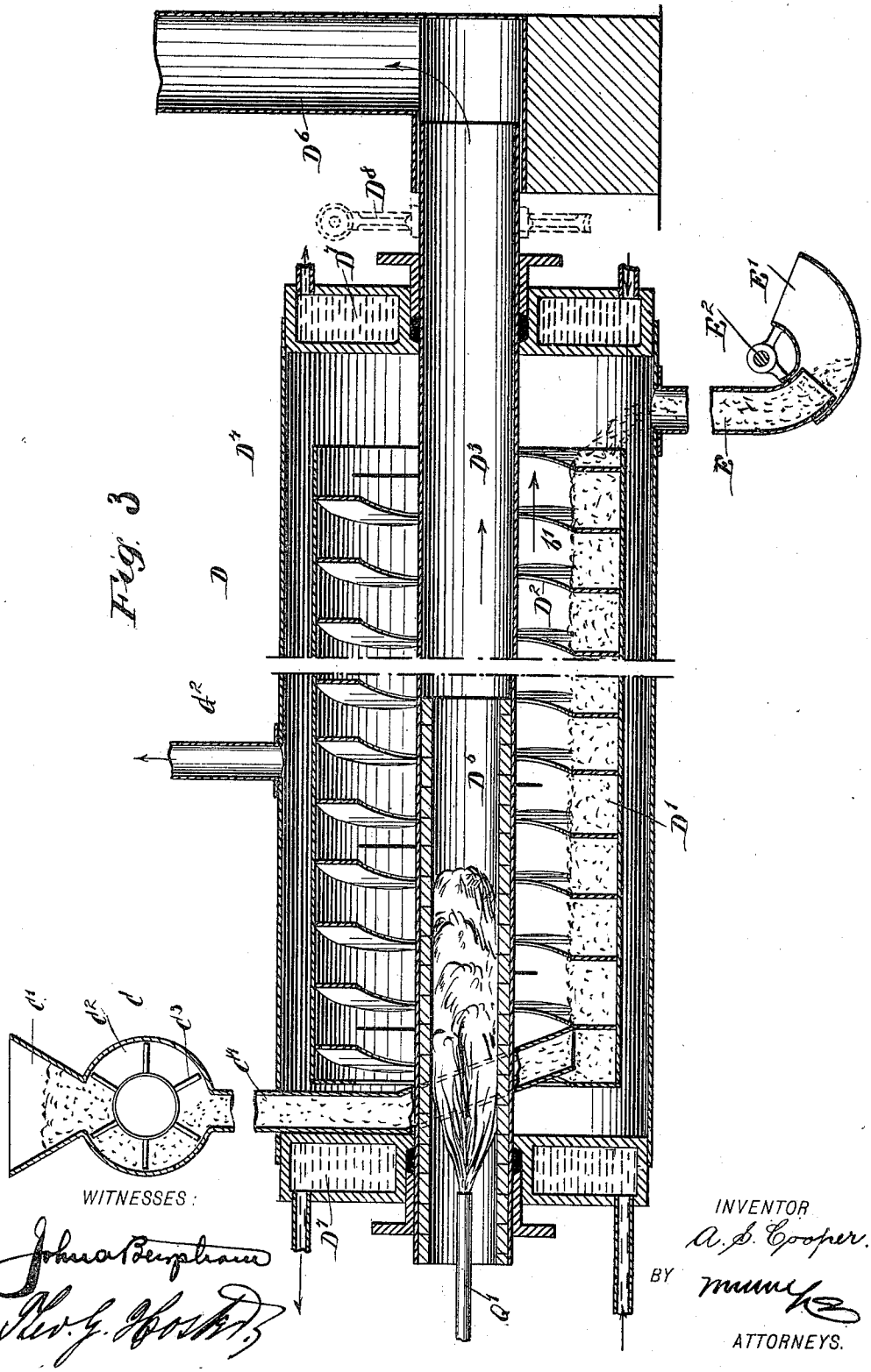
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METHOD OF AND APPARATUS FOR EXTRACTING BITUMEN FROM SAND.

(Application filed Nov. 19, 1897.)

(No Model.) 7 Sheets—Sheet 3.

Fig. 3



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METHOD OF AND APPARATUS FOR EXTRACTING BITUMEN FROM SAND.

(Application filed Nov. 19, 1897.)

(No Model.) 7 Sheets—Sheet 4.

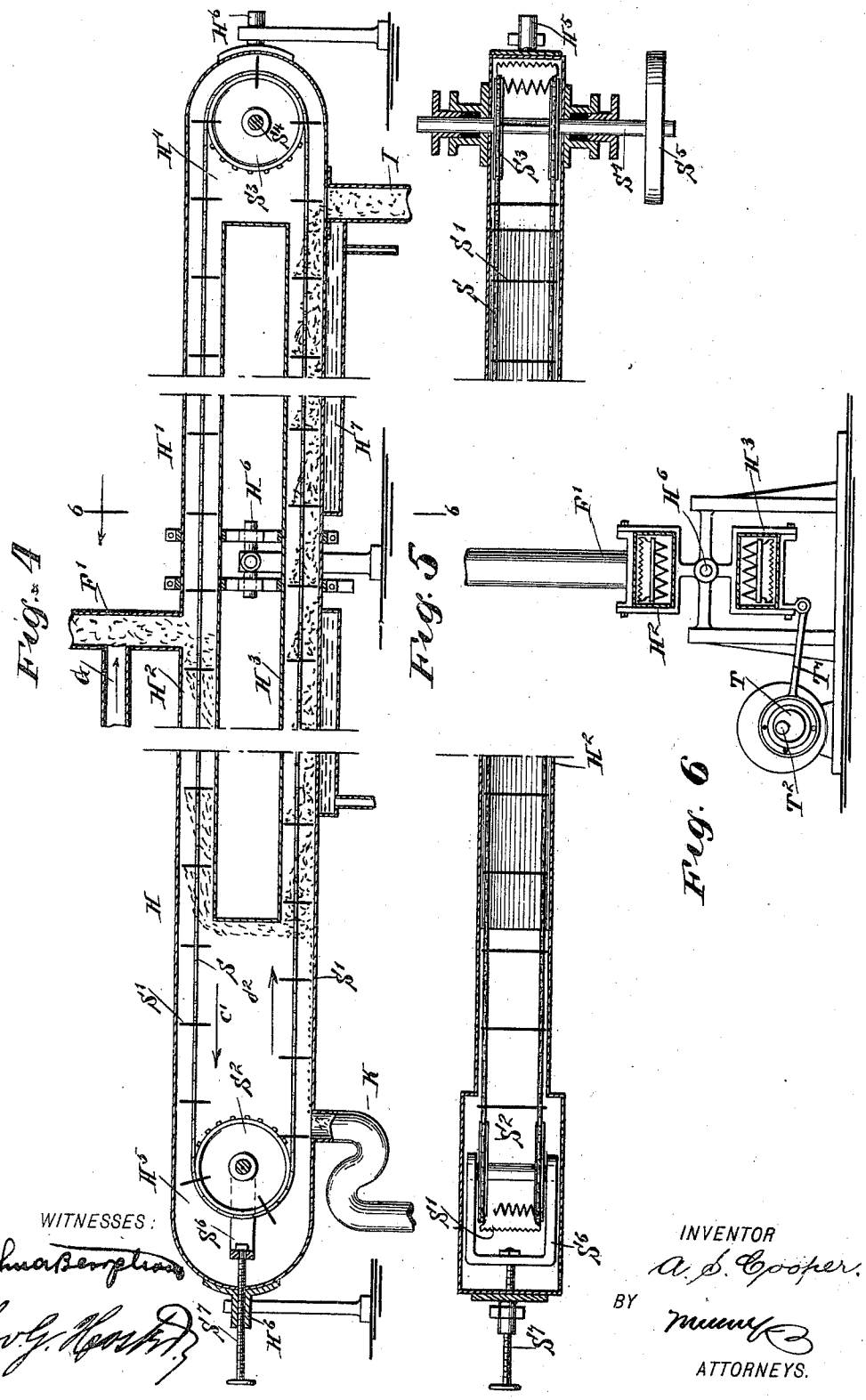


Fig. 4

Fig. 5

Fig. 6

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METHOD OF AND APPARATUS FOR EXTRACTING BITUMEN FROM SAND.

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(No Model.) 7 Sheets—Sheet 5.

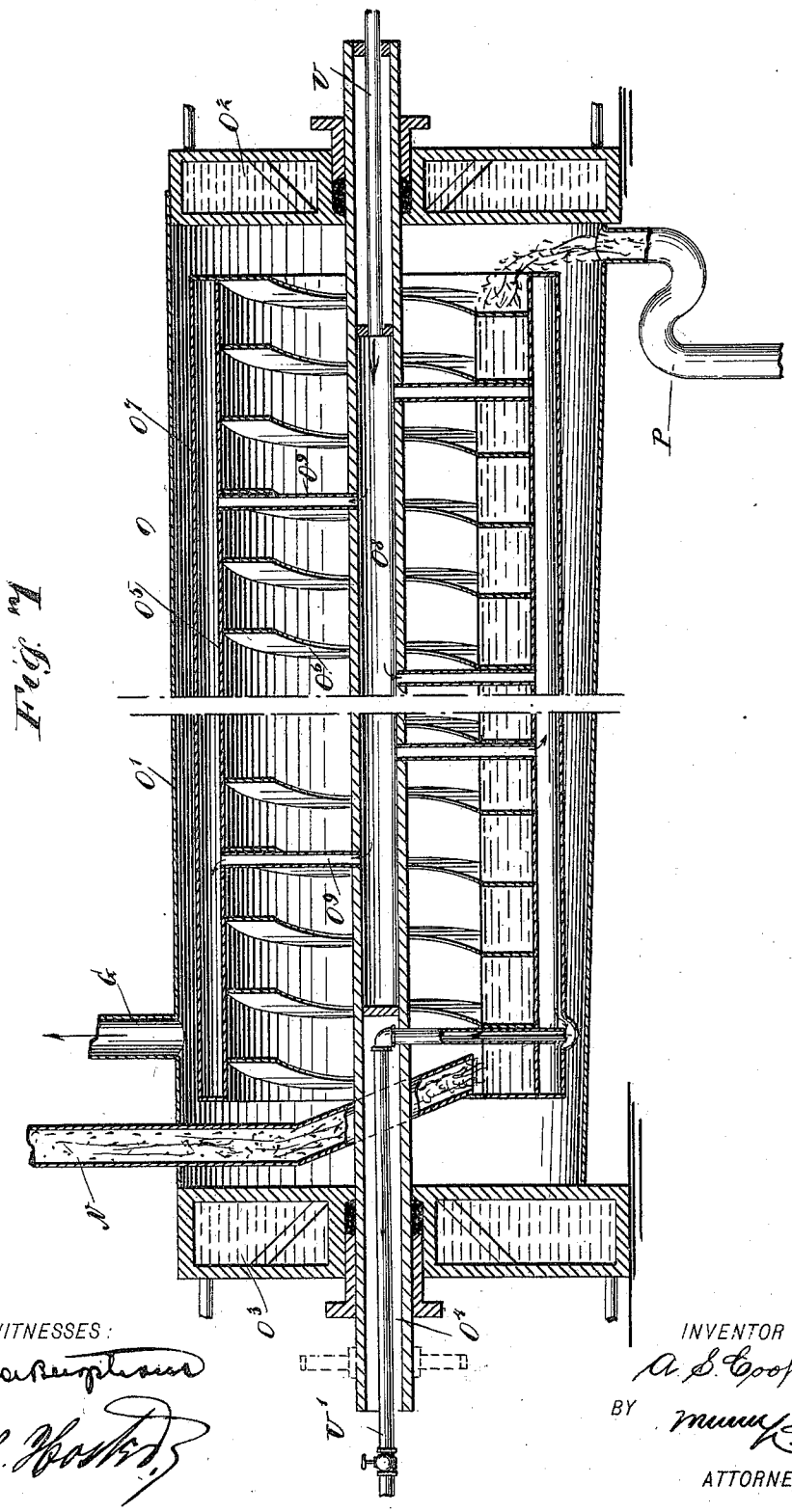


Fig. 1.

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METHOD OF AND APPARATUS FOR EXTRACTING BITUMEN FROM SAND.

(Application filed Nov. 19, 1897.)

(No Model.) 7 Sheets—Sheet 6.

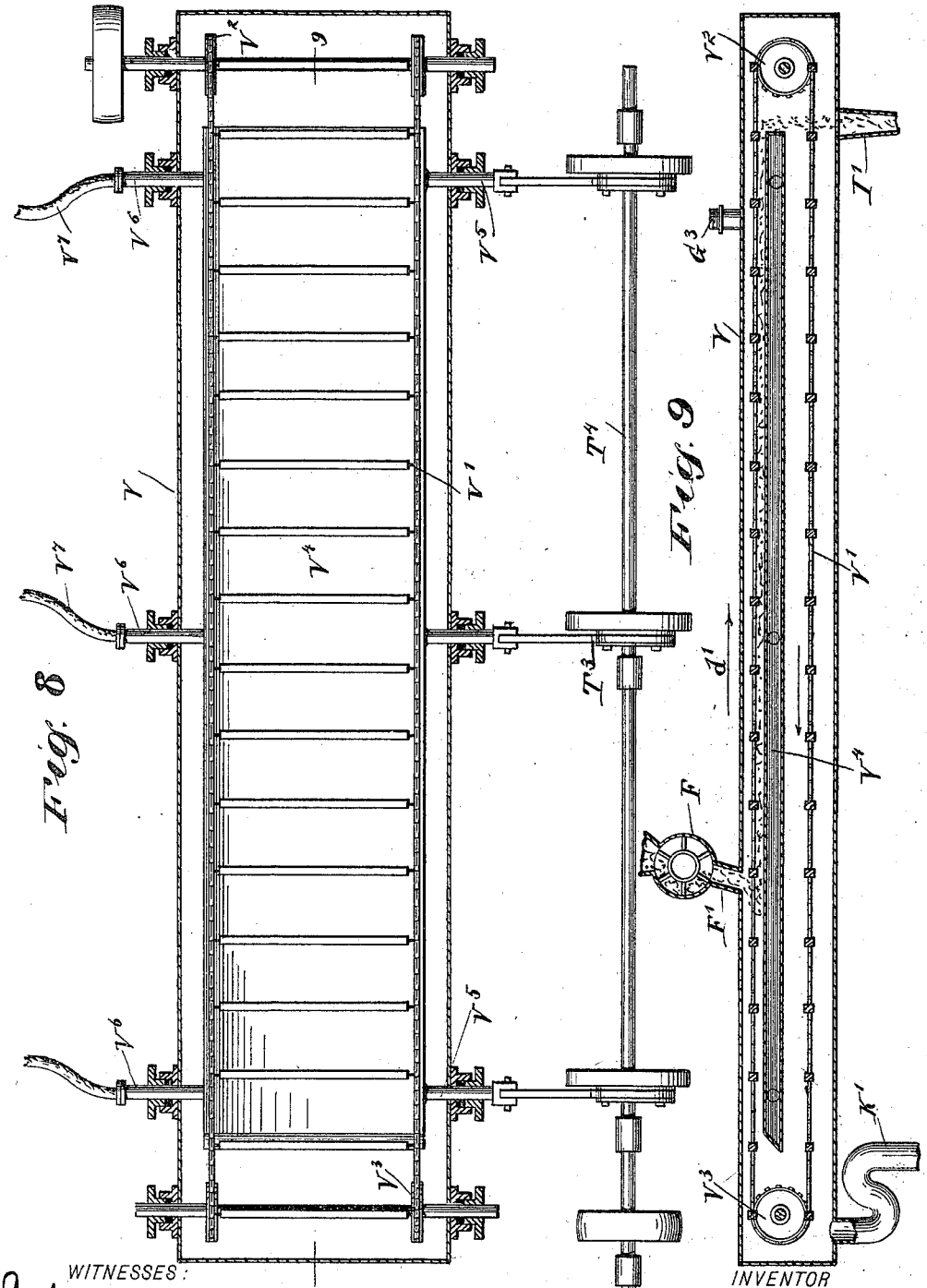


Fig. 8

Fig. 9

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No. 617,226. Patented Jan. 3, 1899.

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METHOD OF AND APPARATUS FOR EXTRACTING BITUMEN FROM SAND.

(Application filed Nov. 19, 1897.)

(No Model.) 7 Sheets—Sheet 7.

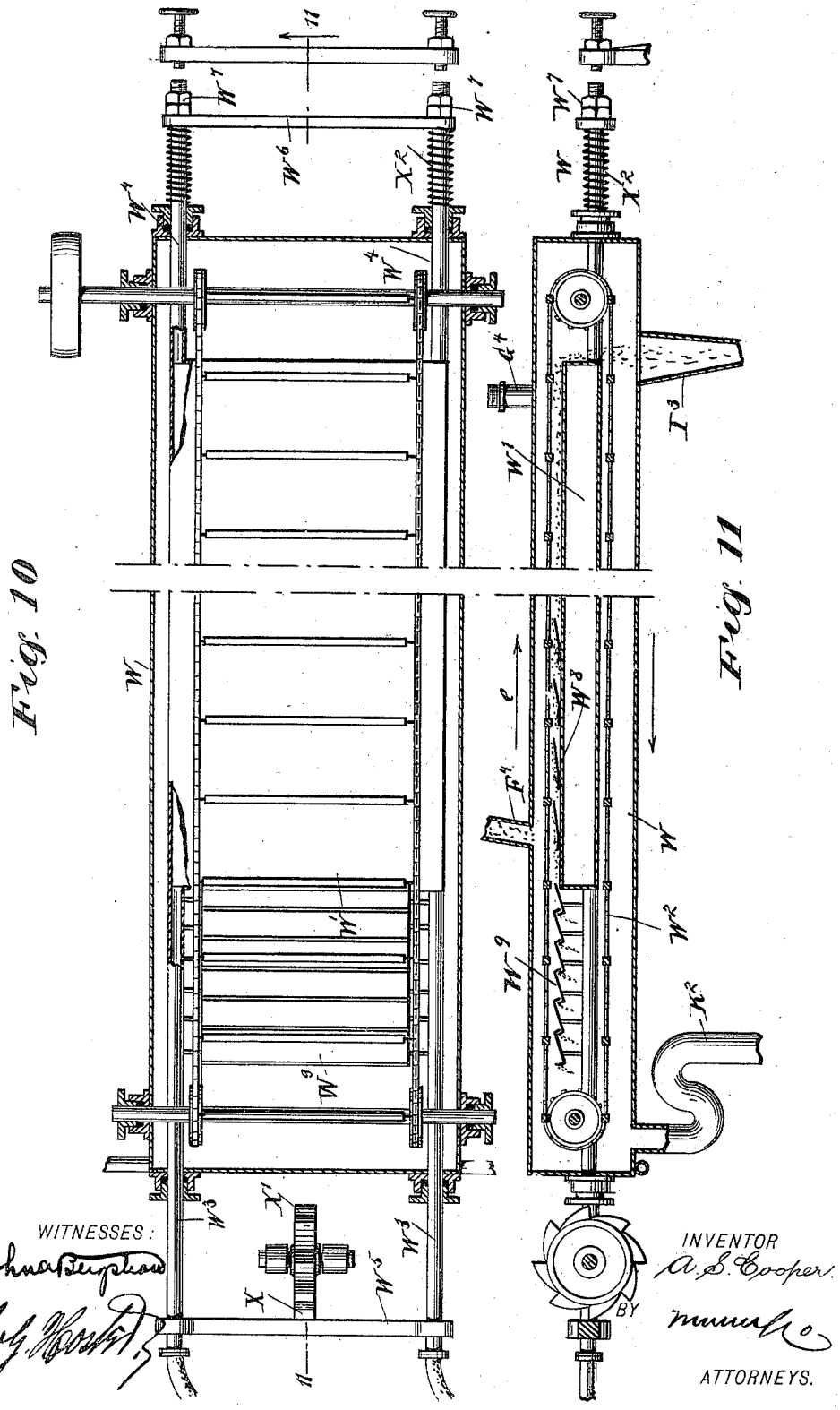


Fig. 10

Fig. 11

WITNESSES:

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UNITED STATES PATENT OFFICE.

AUGUSTUS STEIGER COOPER, OF SAN FRANCISCO, CALIFORNIA.

METHOD OF AND APPARATUS FOR EXTRACTING BITUMEN FROM SAND.

SPECIFICATION forming part of Letters Patent No. 617,226, dated January 3, 1899.

Application filed November 19, 1897. Serial No. 659,120. (No model.)

To all whom it may concern:

Be it known that I, AUGUSTUS STEIGER COOPER, of San Francisco, in the county of San Francisco and State of California, have invented a new and Improved Method of and Apparatus for Extracting Bitumen from Sand, of which the following is a clear and exact description.

The object of the invention is to provide a new and improved method of and apparatus for extracting bitumen from sand in a very simple and economical manner.

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

Figure 1 is a side elevation of an apparatus for carrying the method into effect. Fig. 2 is an enlarged sectional side elevation of the disintegrator. Fig. 3 is a similar view of the device for mixing crude petroleum-oil with the granulated mass of bituminous sand. Fig. 4 is a like view of the extractor. Fig. 5 is a sectional plan view of the same. Fig. 6 is a transverse section of the same on the line 6 6 of Fig. 4. Fig. 7 is an enlarged side elevation of the evaporator. Fig. 8 is a sectional plan view of a modified form of extractor arranged for immersing or steeping the bituminous sand in the solvent. Fig. 9 is a sectional side elevation of the same on the line 9 9 of Fig. 8. Fig. 10 is a sectional plan view of another modified form of the extractor arranged for the solvent to flow through the bituminous sand, and Fig. 11 is a sectional side elevation of the same on the line 11 11 of Fig. 10.

In various parts of the United States are found large quantities of sand the grains of which are cemented together by bitumen, which fills the spaces between the grains, the bitumen contained in such sand ranging from ten to fifteen per cent. of the sand. The principal object of this invention is to obtain the bitumen free from impurities and at comparatively low cost, principally by the use of a solvent which is used over and over again, as hereinafter more fully described.

The entire apparatus is shown in outline in Fig. 1, and consists principally of a disintegrator A, provided with a hopper B, through which the bituminous sand is introduced into the disintegrator A, in which the material is heated to a temperature of about 212° Fahrenheit, so that the bitumen is softened and the bituminous sand falls in a granulated mass, which is discharged into a feeder C, arranged for periodically delivering the granulated mass into a mixing apparatus D, crude petroleum-oil being introduced into the feeder C to pass with the granulated mass into the mixing apparatus D.

Any petroleum-oil will answer the purpose; but the California oil is preferable, as it has an asphalt base—*i. e.*, the solid portions of said oil are asphalt in contradistinction to the base or solid portion of the Pennsylvania petroleum, which is paraffin. The asphalt contained in such oil makes a good flux to temper the harder asphalts. Consequently the harder asphalts are not injured by the employment of crude oil, and hence the oil is effectively used for separating the asphalt from impurities. The oil and the bituminous sand are thoroughly mixed in the mixing apparatus D, which is provided with a discharge-pipe E for delivering the disintegrated and oiled bituminous sand into a feed-hopper F, having its normally-closed outlet F′ connected by a pipe G with a suitable source for supplying a solvent, which passes with the said material from the feeder into an extractor H. In the latter the solvent takes up the bitumen to form a liquid separated from the sand, which latter is delivered by an outlet-pipe I to an apparatus J for further treatment of the spent sand, the apparatus being such, for instance, as shown and described in the Letters Patent of the United States, No. 507,885, granted to me on October 31, 1893. The solution containing the bitumen, oil, and solvent passes through a pipe K into a settling-tank L for the silt to settle in the bottom of the tank, the liquid being withdrawn therefrom by a pipe N into an evaporator O, arranged to separate the solvent from the bitumen, the latter passing through a discharge-pipe P to the outside of the evaporator, while the vaporized solvent is exhausted in the pipe G, previously mentioned, preferably by the aid of an exhaust-fan G′, as indicated in Fig. 1.

The disintegrator A (shown in detail in Fig. 2) is provided with a drum formed by two concentric shells A' A^2, connected with each other at one end, the inner shell A^2 being

provided with a spiral blade A^3 for moving the material discharged by the hopper B into the inner shell forward along the same to the opposite end in the direction of the arrow a'. Within the inner shell A^2 extends a hollow shaft or pipe A^4, partly lined with fire-brick A^5 and extending through the hopper B, as is plainly shown, to receive at its end a hydrocarbon-burner Q for burning crude petroleum-oil in the fire-brick-lined portion of the pipe A^4. The unlined end of the pipe A^4 is connected near the outer closed end of the said pipe by branch pipes A^6 with an annular heating-chamber A^7 formed between the two shells, so that heat travels along the said chamber toward the open end of the shell A' to finally discharge the smoke and gases into a chimney A^8, arranged at this end of the apparatus. Now it is evident that the heat from the burning crude petroleum thoroughly heats the material moving forward in the shell A^2, so that this material is readily disintegrated, and the bituminized sand falls in a granular mass and is discharged at the end of said shell into the feeder C, as previously explained.

The drum, consisting of the shell A' and the shell A^2, as well as the pipe A^4, is mounted to rotate on suitable bearings A^9, and said shell A' is provided with a suitable gear-wheel R, in mesh with a worm R', secured on a shaft R^2, connected with suitable machinery for imparting a rotary motion to the shaft, so that the worm R' rotates the gear-wheel R, and consequently the drum and the parts carried thereby.

The granulated mass after leaving the disintegrator A falls into a hopper C', forming part of the feeder C, arranged on the mixing apparatus D. The hopper C' opens at its lower end into a cylindrical casing C^2, (see Fig. 3,) containing a feed-wheel C^3, having its wings so arranged as to feed a certain quantity of the granulated mass to the pipe C^4 whenever motion is given to the said wheel C^3. The pipe C^4 discharges into a revoluble drum D', forming part of the mixing device D and containing a spiral blade D^2 and secured on a revoluble hollow shaft or pipe D^3, provided at one end with a fire-brick lining D^5 and opening at its other end into a chimney D^6. The shaft or pipe D^3 is journaled in suitable stuffing-boxes held in water-jacketed heads D^7 of a casing D^4, inclosing the conveyer-drum D' and the principal portion of the pipe D^3. A hydrocarbon-burner Q' extends into the fire-brick-lined end D^5 of the pipe D^3 to permit of burning crude petroleum in said pipe to heat the material moved forward in the direction of the arrow b' by the spiral blade D^2 within the conveyer-drum D', it being understood that a rotary motion is given to the pipe D^3 and the said conveyer-drum by a suitable gear-wheel D^8, secured on the pipe and connected with a suitable driving mechanism similar to the one above described in reference to the shell A'.

As above mentioned, a desired amount of oil having as its base asphalt is passed through the material into the hopper C' to be mixed in the conveyer-drum D' during the rotation thereof and during the forward movement of the material, caused by the action of the spiral blade D^2. Thus the oil and the bituminous sand become thoroughly mixed and heated, and any benzin-vapors arising within the casing D^4 and the drum D' pass from the latter into the casing D^4 and from said casing by the pipe G^2 to the pipe G for use in the extractor H as a solvent. The material discharged from the conveyer-drum D' falls into the outlet-pipe E, attached to the casing D^4, and the said pipe is provided with a receiving-hopper E', preferably made segmental and mounted to swing on a shaft E^2 to allow the hopper to receive a measured quantity of material for delivery to the feeder F, similar in construction to the feeder C, so that further description thereof is not deemed necessary. The outlet-pipe F' of the feeder F is connected with the solvent-supply pipe G and opens into the extractor H, as plainly shown in Figs. 4 and 6, the material now being disintegrated and composed of an admixture of bituminous sand, petroleum-oil, and a solvent in the form of benzin-vapors.

The extractor H is provided with a gas-tight casing H', formed with two legs H^2 H^3, placed one above the other and opening at their ends into heads H^4 H^5, of which the head H^4 is provided in its bottom with an outlet-pipe I, discharging into the purifying apparatus J, as previously explained, and the other head H^5 is connected at its bottom with an outlet-pipe K for discharging the liquid solution, consisting of the bitumen, the solvent, and the oil, into the settling-tank L. The casing H' is provided with longitudinally-extending trunnions H^6, journaled in suitable bearings to permit of rocking the casing, as hereinafter more fully explained. All pipes entering or leaving the extractor have for a short distance a piece of flexible hose, so as to permit the oscillation of the extractor.

Within the casing H' is arranged a conveyer-belt comprising sprocket-chains S, scrapers, plows, or similar agitating devices S', passing through the legs H^2 and H^3 in the direction of the arrows c' and c^2. (Indicated in Fig. 4.) The devices S' move the material from the pipe F' to the head H^5, into which the material drops to the next leg H^3 to be carried in the direction of the arrow c^2 through the said leg, so that the spent sand finally reaches the discharge-pipe I. The sprocket-chains S pass over sprocket-wheels S^2 and S^3, arranged in the heads H^5 H^4, respectively, and the sprocket-wheels S^3 are secured on a shaft S^4, provided on its outer end with a pulley S^5, Fig. 5, connected with other machinery for imparting a rotary motion to the shaft S^4 to cause a traveling of the conveyer-chain within the casing in the direction previously indicated. The other sprocket-wheels

S^2 are journaled in a bearing S^6, held on a screw-rod S^7, screwing in the trunnion H^6 for the head H^5 to permit of drawing the chains S sufficiently tight to insure a proper movement of the material within the casing H', as above explained.

On the bottom of the lower leg H^3 is arranged a condenser H^7, Fig. 4, in the form of a jacket or cooling-chamber, through which water is circulated for condensing the vapors passing through this leg to the outlet-pipe K. The lower leg H^2 is also connected with a transversely-extending eccentric-rod T', Fig. 6, of an eccentric T, adjustably held on the fly-wheel of a shaft T^2, adapted to be driven by suitable machinery, so that the eccentric imparts a rocking motion to the casing H' and the parts contained therein to insure an agitation of the material and allow the solvent to properly act on the bitumen. By making the eccentric adjustable more or less throw can be given to the casing.

The solvent, in the shape of hot vapors, in passing with the material into the casing H' is brought in contact with the bitumen, and the surfaces of the latter exert an attraction on the molecules of the vapor with which they are in contact to such an extent that they become covered with a more or less thick layer of gas condensed to liquidity. The liquefied gas and partly-liquefied bitumen are susceptible of mixing, and when brought in contact they are gradually intermingled according to a law somewhat resembling that which governs the diffusion of gases, forming a solution. The vapors upon reaching the lower leg H^3 over the condenser H^7 are condensed and, as the casing is inclined, the solution flows down the leg H^3 in the opposite direction to that in which the material is moving, so that the solvent comes in contact with all the particles of bitumen to separate the latter from the sand. It is understood that the material in the leg H^2 moves downward, and in the leg H^3 it moves upward against the solvent, so that the freshly-condensed solvent first meets the sand which has been most washed, and when it leaves the sand at the lower end of the leg H^3 it leaves that portion which has been the least washed. During the traveling of the bituminized sand against the flow of the solvent it is constantly agitated by the oscillation of the casing H'. The solution passes through the pipe K into the settling-tank L to allow the silt to settle, and the solution is passed from the tank, by the pipe N, to an evaporator O, presently to be described.

The evaporator O, Fig. 7, is provided with a casing O', having water-jacketed heads O^2 and O^3, in which is mounted to revolve a drum consisting of a hollow pipe O^4, supporting a shell O^5, containing at its inside a spiral blade O^6 and supporting at its outer end a second shell O^7, forming, with the other shell O^5, a steam-chamber compartment for the passage of steam for heating the solution during its forward movement in the shell O^5 by the action of the blade O^6, it being understood that the lower end of the pipe N passes through the casing O' and discharges into the inner shell O^5 near the head O^3. The pipe O^4 is provided at its middle with a separate compartment O^8, into which opens a steam-supply pipe U and from which lead branch pipes or hollow spokes O^9 to the steam-chamber between the shells O^5 and O^7. A pipe N' extends through the other end of the pipe O^4 and opens into the space between the shells O^5 and O^7 to draw out any water of condensation that may accumulate in the said space, the water of condensation being forced out by the pressure of steam. Now it is evident that the solution during its passage through the shell O^5 is thoroughly heated to separate the bitumen from the solvent, the latter passing in the form of benzin-vapors from the open ends of the shell O^5 into the casing O' to finally pass through the pipe G back to the pipe F' for reuse in the extractor, as previously explained. The bitumen flows to the lower end of the inclined bottom of the casing O' and through the pipe P to a suitable receptacle for receiving the bitumen.

As above described, the solvent is used in the form of vapors; but it is evident that the solvent may be differently used to obtain the same result by immersing or steeping the bituminous sand in the solvent by the apparatus shown in Figs. 8 and 9 or by causing the solvent to drip, trickle, or flow with the mass by the apparatus shown in Figs. 10 and 11.

In the apparatus shown in Figs. 8 and 9 the extractor is provided with a vapor-tight casing V, containing a conveyer-belt V', passing over sprocket-wheels V^2 and V^3, of which the former is driven by a suitable outside source. Within the casing V is arranged a condenser in the form of a hollow bed V^4, onto which the material is discharged through the pipe F' from the feeder F, and this material is moved forward in the direction of the arrow *d'* on the top of the bed by the wings or flights of the conveyer-belt V'. The casing V is preferably inclined, so that the solvent readily flows toward the outlet-pipe K', while the spent sand passes into the pipe I' for delivery to the purifying apparatus J. A lateral shaking motion is given to the hollow bed V^4 from an outside source, the said bed being provided for this purpose with rods V^5 and pipes V^6, fitted to slide in suitable bearings in the sides of the casing V, the rods V^5 being connected with suitable eccentrics T^3 on a driven shaft T^4, as is plainly indicated in Fig. 8. The pipes V^6 are in the form of tubes and are connected by hose V^7 to a suitable source of cold-water supply for cooling the interior of the bed V^4 and the material passing over the same as well as condensing the solvent vapors. The disintegrated and oiled bitumenized sand is evenly distributed on the bed V^4 and is agitated by the flights of the conveyer-chain as well as by the lateral shaking motion given to the said

bed. The hot vapors in this case pass from the material through the pipe G^3 into the casing near the upper end of the bed V^4, and as the vapors come in contact with the cooled material and the cooled bed they are readily condensed and flow down on the top of the bed through the advancing material. The solution formed by the bitumen, oil, and solvent finally passes to the pipe K′, while the spent sand is discharged, as above mentioned.

In the extractor shown in Figs. 10 and 11 a casing W is provided containing a condenser in the form of a bed W′, onto which passes the material from the feed-pipe F^4. A conveyer-belt W^2 is mounted in the said casing for moving the material over the bed in the direction of the arrow *e* to come in contact with the hot solvent vapors passing into the casing by a pipe G^4 near the upper end of the bed W′. An outlet-pipe I^3 for the sand is arranged near the upper end of the casing, and an outlet-pipe K^2 for the solution leads from the lower end of the said casing. A longitudinal concussion is given to the bed W′, and for this purpose the latter is mounted on rods W^3, Fig. 10, and W^4, extending through suitable stuffing-boxes in the ends of the casing W. The rods W^3 are connected with each other and with hose connected with a water-supply for circulating water through the bed W′. A connecting-bar W^5 for the rods W^3 carries a tappet X, engaged by a cam X′, for moving the bar W^5, the rods W^3, and the bed W′ in one direction against the tension of springs X^2, held on the other rods W^4, connected with each other by a cross-bar W^6. The tension of the springs can be regulated by adjusting the bar W^6 accordingly by suitable nuts W^7, as indicated in the drawings. The movement of the flights passing over the bed W′ stirs and mixes the bituminized sand with the solvent, the flights also serving to carry the sand up the bed W′. The hot petroleum-vapors introduced readily condense to a solvent on the upper surface of the said bed W′, and this solvent in flowing through the bituminous mass readily takes up the bitumen to form the solution. The upper surface of the bed is formed or provided with riffles W^8 for breaking the downward flow of the solution and for making pockets for catching the solvent to insure a proper washing of the bitumen from the sand. The sand is carried up the bed from one riffle to another by the percussion given to the bed by the action of the cam, tappet, and the springs. Below the lower end of the bed W′ are arranged V-shaped riffles W^9, supported by the shafts W^3 and moving with the same and the bed. The riffles serve to drain the dissolved bitumen from the sand as the bitumen will flow through them. The gravity of the sand keeps it from going through. Thus it will be seen that in the case described the solvent percolates through the bituminized sand to insure the formation of a solution containing the bitumen.

In referring to the vaporized solvent I have in my specification designated it as a "benzin;" but I would have it understood that I mean to designate under the head of "benzin" solvents any and all of the series of light and more easily volatilized products of distillation of crude petroleum.

In pointing out more clearly the distinctive features of my method, which reside largely in the use of the heavy crude petroleum-oils, I would state that asphaltum consists of two principles which can be separated by solvents—viz., petrolene and asphaltene. Heavy petroleum-oils dissolve both petrolene and asphaltene, whereas the lighter portions of petroleum-oil—to wit, benzin—only dissolve petrolene. Consequently when benzin alone is employed as a solvent the petrolene only will be extracted from the bituminous rock; but if, as in my invention, the asphaltene and petrolene are first dissolved in heavy petroleum-oil benzin will then dissolve the solution of asphaltum and heavy petroleum-oil. It is well known that when two liquids which dissolve one another only partially are mixed with a third liquid which enters into solution with them both in all proportions then a perfect and homogeneous solution results. These conditions are fulfilled in my invention, in which the heavy petroleum-oil mixes in all proportions with both the benzin and the asphalt and overcomes the imperfect solution of the asphalt in benzin alone. I would also state that it is of importance to use the volatile solvent in the form of a vapor, first, because it may be directly returned from the drying-chamber without condensation, which is a saving of time and apparatus, and, secondly, because in this vaporized form it is hot and it settles upon and enters into a more intimate union with the asphalt sands, and in the act of liquefying thereupon greatly facilitates the solution and separation.

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

1. The herein-described method for separating bitumen from sand, consisting in subjecting the material to the action of crude petroleum-oil to soften and dissolve the bitumen contained in the sand, and then subjecting the mass to the action of a benzin solvent for the bitumen, mechanically agitating the mass, separating the solution from the sand, evaporating the solvent from the asphalt, and returning the solvent in vaporized form to fresh portions of the oiled sands, as set forth.

2. The herein-described method for separating bitumen from sand, consisting in first heating the material to disintegrate the material and to form a granular mass, then subjecting the mass to the action of crude petroleum-oil, having an asphalt base to partly dissolve the bitumen contained in the sand, subjecting the mass to the action of a benzin solvent, separating the liquid bitumen

from the sand, and finally evaporating and returning the solvent in vaporized form to fresh portions of the oiled sand, substantially as described.

3. In an apparatus for extracting bitumen from sand, an inclined extractor having an inlet for the material and the solvent, means for advancing the material within the extractor, an outlet for the spent sand, a discharge for the solution, and a water bed or jacket located between the outlets for the sand and the solution for condensing the vapors within the extractor, substantially as shown and described.

4. In an apparatus for extracting bitumen from sand, an extractor comprising an inclined casing, a traveling conveyer-belt within the said casing, for moving the material along one portion of the casing, and in an opposite direction along another portion of the casing, an inlet for the material and the solvent, outlets for the sand and solution and a water bed or jacket located between said outlets for condensing the vapors in the said casing, substantially as shown and described.

5. In an apparatus for extracting bitumen from sand, an extractor comprising an inclined casing formed with two conduits, and chambers at the ends of the conduits, each chamber having an outlet, a conveyer-belt within the casing, one run passing up one conduit, and the other run passing down the other conduit, and a water bed or jacket for the casing, arranged between its end chambers for condensing the vapors therein, substantially as shown and described.

6. In an apparatus for extracting bitumen from sand, an extractor comprising an inclined casing, a traveling conveyer-belt within the said casing, for moving the material along one portion of the casing and in an opposite direction along another portion of the casing, an inlet for the material and solvent, outlets for the sand and solution, a water bed or jacket for condensing the vapors in the said casing between said outlets, and means for oscillating the said casing, substantially as shown and described.

7. In an apparatus for extracting bitumen from sand, a disintegrator comprising a revoluble drum an attached concentric and external heating-chamber opening into a chimney, a hollow shaft or pipe for the said drum, with hot-blast connection at one end and branch pipes connecting the hollow shaft with the heating-chamber, and a spiral conveying-blade inside of the said drum, and turning with the same to move the material, substantially as shown and described.

8. In an apparatus for extracting bitumen from sand, a disintegrator comprising a revoluble drum, an attached concentric and external heating-chamber opening into a chimney, a hollow shaft or pipe for the said drum with hot-blast connection at one end and branch pipes connecting the hollow shaft with the heating-chamber, a spiral conveyer-blade inside of the said drum, and turning with the same to move the material, and a feed-hopper opening into the upper end of the said drum for feeding the material into the drum, substantially as shown and described.

9. In an apparatus for extracting bitumen from sand, the separator or evaporator for the solvent comprising a stationary casing, a revoluble drum within the casing, provided with an annular concentric steam-chamber, a spiral conveying-blade on the inside of the drum, and a hollow supporting-shaft for the drum connected with a steam-supply and having branch pipes opening into the said annular steam-chamber, for supplying the latter with steam, substantially as shown and described.

10. In an apparatus for extracting bitumen from sand, the separator or evaporator for the solvent comprising a stationary casing, a revoluble drum within the casing, provided with an annular concentric steam-chamber, a spiral conveying-blade on the inside of the drum, a hollow supporting-shaft for the drum connected with a steam-supply and having branch pipes opening into the said annular steam-chamber, for supplying the latter with steam, an outlet-pipe for the concentrated bitumen from the casing, and a discharge-pipe for the solvent vapors leading from the top of the casing, substantially as shown and described.

11. In an apparatus for extracting bitumen from sand, an extractor having an inlet for the material and the vapor solvent, an outlet for the spent sand, an outlet for the solution, and a vapor-condenser; in combination with an evaporator provided with a stationary casing connected with the said inlet for the vapor solvent, and a heated drum revoluble in the said casing, and connected with the said outlet for the solution, substantially as shown and described.

AUGUSTUS STEIGER COOPER.

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