3 Sheets—Sheet 1.

T. S. STEWART.

GAS GENERATOR.

No. 190,163. Patented May 1, 1877.

Fig. 1.

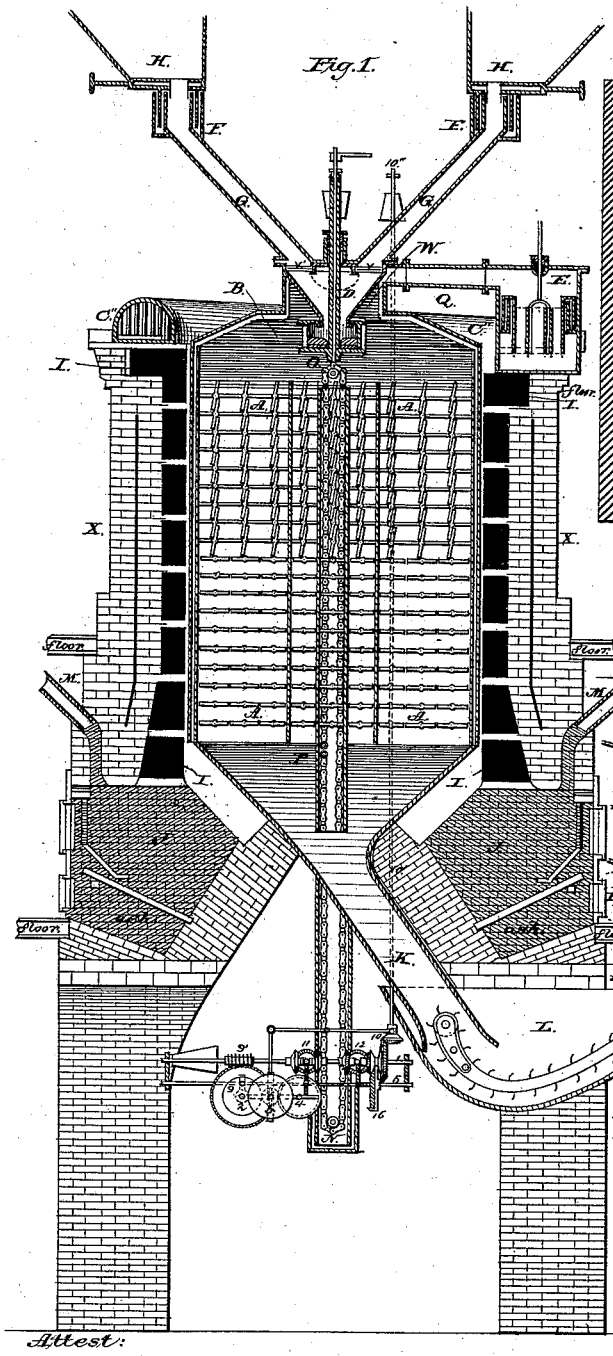


Fig. 2.

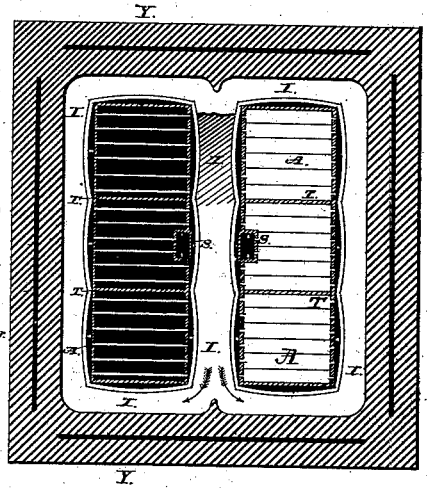
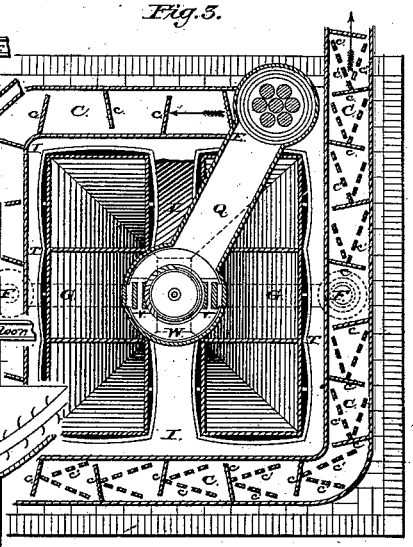


Fig. 3.



Attest:

Richard L. Gardiner

Harry Smith

Inventor:

Thomas S. Stewart

3 Sheets—Sheet 2.

T. S. STEWART.

GAS GENERATOR.

No. 190,163. Patented May 1, 1877.

Fig. 4.

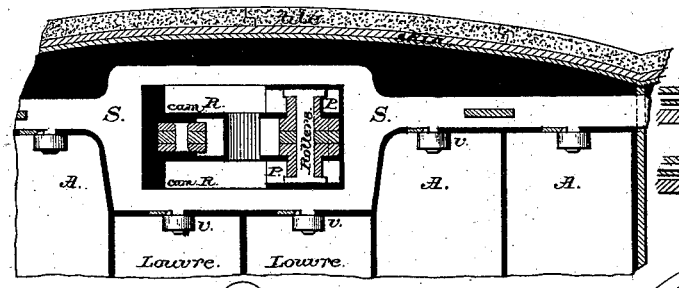


Fig. 6.

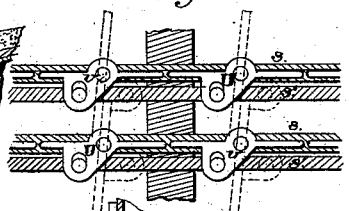


Fig. 5.

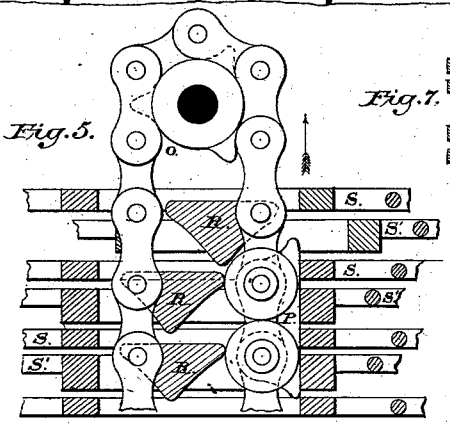


Fig. 7.

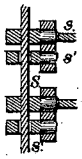


Fig. 8.

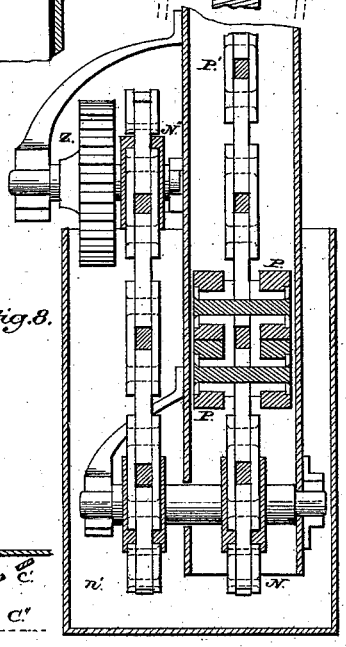


Fig. 9.

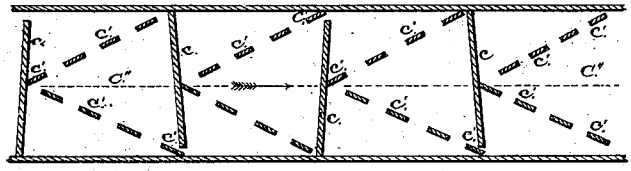


Fig. 10.

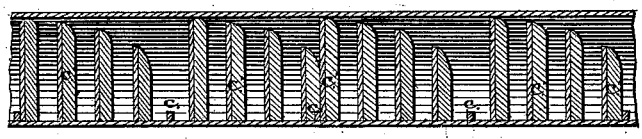
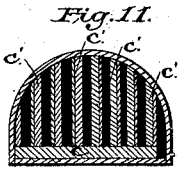


Fig. 11.



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3 Sheets—Sheet 3.

T. S. STEWART
GAS GENERATOR.

No. 190,163. Patented May 1, 1877.

Fig. 12.

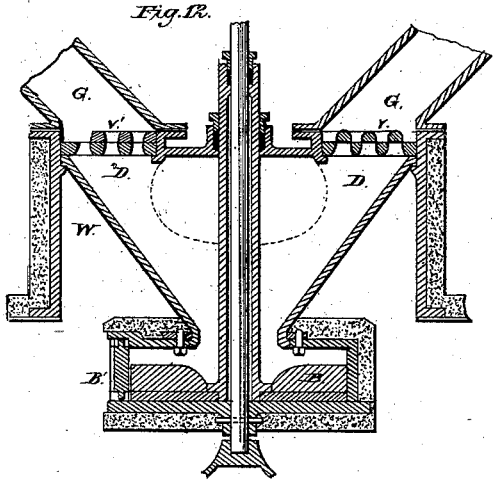


Fig. 13.

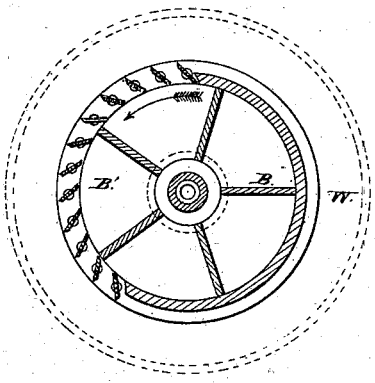


Fig. 14.

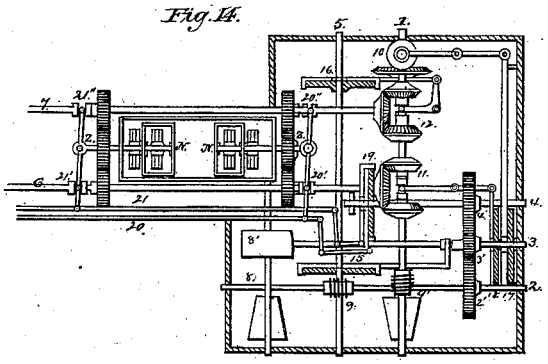


Fig. 15.

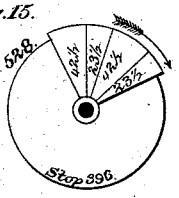


Fig. 16.

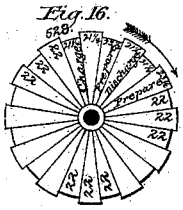


Fig. 17.

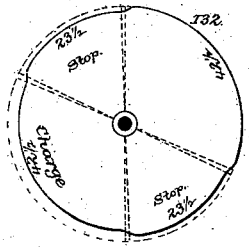


Fig. 18.

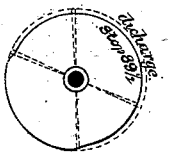
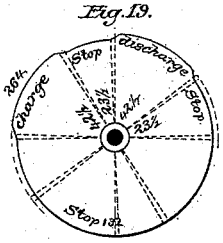


Fig. 19.



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UNITED STATES PATENT OFFICE.

THOMAS S. STEWART, OF PHILADELPHIA, PENNSYLVANIA.

IMPROVEMENT IN GAS-GENERATORS.

Specification forming part of Letters Patent No. **190,163**, dated May 1, 1877; application filed June 13, 1876.

To all whom it may concern:

Be it known that I, THOMAS S. STEWART, of Philadelphia city and county, State of Pennsylvania, have invented a self-acting Gas-Generator, being a new and improved apparatus for generating and distilling carbureted-hydrogen gas from coal or other carbonaceous materials, of which the following is a specification:

It is well known that a thin layer of coal submitted to "low heats" produces an illuminant of superior candle-power in abundant quantity, and that low heats secure prolonged durability of the apparatus. An inspection of the drawings herewith submitted as part of this specification of my invention will show a contemplated radical change in the practical working process of the present or any previous methods applied in the distillation of coal for the production of gas, which make it requisite to explain its intended functions and general applicability before entering into a description in detail.

Figure 1 is a vertical section of the generator, and Fig. 2 is a horizontal sectional plan of a pair, as combined in working, except that only twenty-two generating-beds are represented, to prevent confusion, while the size is that for forty-four beds. Each bed is nine and three-tenths feet by three feet, giving an aggregate generating-surface of one thousand two hundred and twenty-seven and six-tenths square feet, capable of distilling one thousand nine hundred and eighteen pounds of coal per charge in fifteen minutes' time, or one hundred and eighty-four thousand one hundred and forty-two pounds in the twenty-four hours, submitted in layers three-eighths of an inch thick, thus giving to the pair of generators of the size represented distilling power equal to three hundred and fifty-one common retorts working at four hours' charges.

The coal is first prepared by breaking and screening to the required size, and by elevators deposited in coal-stores situated on top of the building. Thence it passes by gravity into weighing-bins, from thence into the distributer, (Figs. 1, 12, and 13,) the function of which part of the apparatus is to charge and spread the coal in even layers, of thickness required, in and upon each of the distilling-beds of the generator in succession, beginning with the lowest one. After fifteen minutes' time, for a charge of three-eighths inch, or twenty for a half-inch, layer, the coke is discharged from the beds, and passes by gravity down the conduit K into the water-seal L, from which it is carried by a rake-formed bucketed elevator into coke-bins, for distribution by gravity.

After the lapse of half the time of the duration of the charge given to the first generator the distributer is turned half-way round, and a charge delivered upon the beds of the second of the pair, when a full and a free intermingling of the products of distillation takes place between the half-carbonized and that of the new charge, spaces being provided for the free passage and intermingling of the gases of each generator.

The products pass up into the drum W, and thence by outlet-pipes Q through the main O″.

In this main are placed the condensers and the evaporators, Figs. 1, 9, 10, and 11, whereby the crude products of distillation are condensed, and forced to give up the tar, and liberate any enveloped globules of gas or hydrocarbon vapors by a series of deflecting condensers, upon which the flowing volume of gas impinges in its passage to the washers, while the tar and volatile hydrocarbons carried down into it are redistilled by being forced to pass over a surface forty feet in length, heated to the proper degree for the distilling purposes, while the gas and vapors given off are mixed and combined with the large volume of the flowing hot gas. The whole process, throughout its various parts, is operated and worked by application of mechanical movements. The only manual labor required is with regard to firing and the attendance to continuous working of the machinery. The weighing of the charges is self acting and registering, only requiring a sheet of paper to be placed on the cylinder of a registering apparatus, somewhat like to a gas-pressure indicator in arrangement.

Fig. 1 represents a vertical section of a single generator, taken on the line Y Y of Fig. 2; and Fig. 2, a horizontal section of a pair of generators taken on the line X X, Fig. 1, as arranged and combined in practical working,

showing the brick-work, manner of settings, &c.; J, fire-places; I, hot-air flues; G, conducts for the coal; D, hopper; B, the distributer; A, the generator-beds; K, coke-outlet conduits.

Fig. 3 represents a horizontal sectional plan of the pair, the top cover being removed, showing the form of the external casing; T, stays and inverted pyramidical form of the bottom of the case; G, plan of coal-conducts; F, plan of hydraulic seals; V, inlet-valves; W, drum; Q, outlet-pipe; E, hydraulic valve; C, section of main with the series of inclosed condensers and evaporators.

Fig. 4 represents an enlarged sectional plan of part of the louvers forming the generating-beds A; S S, plan of part of a pivot-rail and yoke, inclosing a section of chain and connected rollers, P; also, the cams R, fixed one on each of the inner sides of the chain-frames. These frames, when in position, form the chain-passage.

Fig. 5 is a vertical section through the cam-frame S S, Fig. 4; O, upper chain-pulley and chain; *s*, pivot-rails; *s'*, crank-levers; R, cams; P, chain-rollers, a pair of which is attached on each side of the chain, having a carriage-frame with friction-rollers abutting against the inner ends of the chain-frames. Fig. 6 is a vertical section of four louvers; U, the crank and pivot-eyes; S, pivot-rail; S', crank-lever.

Fig. 7 is a vertical transverse section of Fig 6, with a part of an upright support and guide.

The generator beds or floors A are formed by horizontal ranges of plates of iron in the form of pivoted louvers combined in vertical tiers, forming compartments, surmounted above each other to any required height or size, or of any required horizontal sectional form. Each range is turned and adjusted through means of crank U and levers S', actuated by mechanical movements, opening the louvers, as represented on the upper end of Fig. 1, and by the dotted lines on Fig. 6, to discharge the coke, and closing them, as represented on the lower parts, preparatory to receiving the new charge, always beginning with the bottom range. The chain, in passing from the bottom to the top, carries with it the rollers P, which, acting on the cams R, slide the levers S', by means of the cranks, and studs on levers turn the louvers. After the rollers have passed the upper range their movement is reversed, the rollers are caused to pass down the opening thus made, and around the lower chain-pulley N, thence up the other side of the chain-passage, and again acting on the cams R restore the louvers to the former position.

The yokes formed in the middle of pivot-rails and crank levers when combined make a nearly-inclosed rectangular tube, by an increased width given to the crank-lever yokes, as represented on Fig. 5. From the yokes a perfectly tight tube is continued down into the hydraulic seal, at bottom of the chain, as at P' N, Fig. 1. The louvers have cranks and levers operating at one end only, the other having a single eye turning upon short studs or pins made on the rail. All the crank-levers slide on friction-rollers. This method for swinging the louvers has the advantage of preventing the coal when charging from getting in between the ends of the louvers and the case; but any equivalent is applicable.

The drawings represent a generator of the size of forty-four beds of louvers; but, in order to obtain distinctness, half the number only are represented. The distance of the beds apart must be more than half the width of the louver, in order to clear when turned up. The louver-beds of each generator are inclosed by strong open frame-work of which the pivot-rails form the longitudinal ties, which, together with transverse end returns, are supported by uprights. This frame and inclosed louvers should be constructed in vertical sections of such weight as will suit convenient handling. This frame is again inclosed by an outer case, made of boiler-plate iron, gas-tight, formed, by preference, in segments of a circle, as represented on Fig. 3, secured at the springings by strong abutting stays, as at points T T, to counteract any inward movements upon the louvers that might occur from bulging in, expansion, or warping; but flat surfaces may be used, provided a sufficient number of wide angle-irons are riveted vertically on the outside of the sheets, and a space left between the case and the frame, or any other equivalently safe manner.

This outer case is to be protected from the cutting effects of the heat-currents by fire-clay tiles, let in at the top and bottom to the flue-tile, leaving clear space between the iron and the tiles, for expansion. The two ends and outer sides of each generator are continued down at an angle of not less than forty-five degrees and united to form the bottom, leaving an opening for outlet of coke. The space for the center flue is inclosed, as under I I, Fig. 3. K, the coke-conduit, is continued down from the opening into the seal L. An endless chain, with rake-formed buckets upon it, convey the coke into the bins located in story X, from which it passes by gravity down conduits M M into fire-places J J. The heated air passes up through the flues I I. The flues are continuous inclined planes, of the pitch of two flues to each revolution.

When large generators are required, pulverized-coal fuel, with hot-blast, is intended to be used, as auxiliary to the fires.

Three ranges in height of draft-dampers will be required to each generator setting, and valves for cleaning out the flues are to be placed at each corner of each range of flues, vertically over each other, with a dust-conduit from the bottom flue, down through the piers, to a receptacle. The center flue is stopped off at O, Fig. 1, by a ∧-shaped coping, to prevent the coal lying on it, and the

outer sides and ends are sloped up, as represented on Fig. 1, to form the top, having a drum-formed receptacle, W, about forty inches in diameter, placed on the center. The top and drum are lined with a non-conductor of heat.

Q is the outlet-pipe from the drum W to the hydraulic valve E. The dotted elliptical figure represents the position of opening behind the hopper D.

Fig. 1—N O is an endless chain; P, a pair of rollers and frame, fixed to the chain, by the passing of which upon each side the louvers are turned.

Fig. 8 is an enlarged vertical section of the part of the chain turned edgewise, with a section of the rollers, the hydraulic seal N, method of transferring the mechanical movements to the chain, &c. As before stated, the rectangular chain-frames form a nearly-inclosed chain-pass through the beds of generators, so as to exclude lumps of coal or coke when charging or discharging. This pass is continued from the lower lever S′ down into the hydraulic seal N′ N″, Fig. 8, by the tube P′ N, made of plate-iron, gas-tight. The endless chain N O works freely in this pass. One side, between the cams R and the other, having the pair of rollers P P on each face, (same thickness as the cams,) in passing up by the rotation of chain-pulley O N, acts upon the cams R, sliding the levers a distance equal to the throw of the cranks *l l*, Fig. 6, thereby turning the louvers one-fourth around. When the rollers have passed the upper cam the actuating motion is reversed; the chain and rollers pass down the now open side of the pass, through the water of the hydraulic seal N′ N″, by which it and the chain are cooled; thence up the other side of pass; now obstructed by the changed position of the cams R, upon which the rollers again act, but on their opposite edge, thereby sliding the levers and turning the louvers into their former position. The rollers P, Fig. 8, are attached to one link of the chain by forming of hollow studs upon each of the outer plates, over which the rollers pass, secured in place by a bolt passed through them and the chain-link. Near the lower end of the chain-pass is placed the chain-pulley and axle N. Another, the same as it, N′, is placed on the same axle, outside of the pass-case, and above this, a sufficient distance to allow of depth of seal, a like pulley, N″, is placed vertically over N′. The axle of this works in a box fixed on outside of chain-pass, having a spur-gear, Z, on the outer end. An endless chain passes over pulleys N′ N″, by which motion given to spur-gear is transferrred to N O. The two chain-passes are inclosed by the one outer case, forming the seal for the pair of generators, as represented on plan at N N, Fig. 14. This case is to be clear from all attachment of other parts.

D, the feed-hopper, is suspended by a projection on the inside of the drum.

A range of coal-bins is placed against the wall on each side of the building, leaving a sufficient space between them for clearance in hoisting, for putting in or getting out sections of the generators. Two bins are required to supply a pair, one to feed on coal, while the other is being replenished. Each bin rests entirely upon the frame of a self-registering weighing apparatus, showing upon a dial the weight of coal drawn off by each charge, and making an automatic register of the same, the time of the charge, and of that between the charges. It is arranged somewhat like the gas-pressure indicator. Above these weighing-bins are placed large coal-stores, resting upon the walls of the building, forming part of the roof. G G are coal-conductors from the weighing-bins to the feed-hopper; H H, the weighing-bins; F F, hydraulic unions, with slide stop-valves placed over each. Like connections and valves are made between the bins and coal-stores. The object of this form of connection is to allow of the free movement of the bins upon the weighing apparatus, and the ready removal of the conduits when required.

V V′ are slide-valves, by which the supply of coal to the hopper and distributer is regulated. The coal is prepared by breaking, and passed through screens, the meshes of which are four to the square inch; then, by means of elevators, it is put into the coal-stores, from which it passes down by gravity as required.

The object of this part of my invention is to form within a large gas-tight retort numerous compact sub-retorts or compartments, so combined and arranged as to produce large carbonizing areas, with minimum use of material and space, whereby a large amount of coal can be submitted to any required degree of heat, and carbonized in comparatively very thin layers with facility and speed, combined with automatic charging and discharging of each sub-retort, and with efficient ingress for the coal and egress of the coke.

These functions, combined with that of other parts hereafter described, are operated by mechanical movements alone, forming a new and useful combined apparatus, by which time, material, and labor will be most effectually utilized, and a superior article of great commercial importance produced at a reduced cost.

B, the distributer, in Fig. 1, is shown in position for operation. Fig. 12 is an enlarged vertical section; B, distributer; D, hopper; W, drum; V V′, feed-regulating valves; G G, coal-conduits. Fig. 13 represents a horizontal section of the same.

On the lower end of the hopper is formed a flange, upon which the distributer is suspended and revolves freely. It consists of a horizontal rotating disk or throwing-wheel, B, having radial blades fixed equidistant upon its upper surface, and is attached to the lower end of a hollow vertical shaft, having a speed-pulley fixed upon its upper end.

This disk-wheel is fitted into a horizontal case or box of a circular form, turning freely

upon a vertical spindle passing up through the hollow shaft, and is continued down through a collar in center of bottom plate of case sufficiently to rest in a step, upon which the case may freely turn. This spindle has a lever attached to the upper end, by which the case is turned round, after charging the first generator, to give a charge to the second one. Ten-seventeenth parts of the circumference of the case is inclosed, the remaining seven-seventeenth parts B′ is formed by a segmental range of vertical pivot-louvers set at a radial angle of forty-five degrees, forming chutes or directors of the flow of coal thrown off the rotating disk-wheel by the action of centrifugal force. For generators of a full circular horizontal form, the louvers of the distributer form a full circle—viz., the whole circumference of case.

The angle of inclination of the louvers varies to some extent between the ends and center of the segment, and, also, to the proportional width to the length of the generator-beds for which it may be required. Therefore the exact pitch is to be ascertained by trial upon a bed of the size and form (except circular) to which it is to be applied, and the louvers fixed at the pitch thus obtained. The same pitch will always suit the like size and form of generator-bed. To the case is attached an outside lining of a non-conducting material, with a covering-shield of the same arranged to slide over the louvers.

The object of this part of my invention is a machine wherewith to utilize and apply centrifugal force, and to divide and direct the flow of coal received through the hopper, to distribute and spread it in even layers upon either oblong, circular, or other sectional-formed generator-beds in combination with the before-described parts.

C″, Fig. 1, is the hydraulic main in situation, and E is a sectional elevation of the hydraulic seal, also in situation.

On Fig. 3 is represented a sectional plan of the parts as located.

Fig. 9 represents an enlarged sectional plan of part of the main and inclosed condenser and evaporator. Fig. 10 is a vertical longitudinal section of the same, and Fig. 11 represents a transverse section.

C″, the main; C′, the condensers; C, the evaporators.

The hydraulic main is **D**-formed in cross-section, the flat side set downward. It is continued around on the top of the four walls of the generator upon an independent hot-air flue, through which heat from the upper generator-flue is caused to pass, in quantity, at will, regulated by valves and dampers. The main is to have an inclined ascent from the hydraulic valve-inlet of about one and one-quarter inch in each ten feet; E, the hydraulic valve. It is formed by an outer cylinder of about thirty-two inches diameter, with flat top and bottom, having a "cup" formed around the inside, taking up about one-third of the length between top and bottom. It drops seven inches below the range of the bottom of hydraulic main. The bottom of the main slopes down to meet that of the cylinder, thus extending the tar-reservoir, the outlet for which is, of course, seven inches above cylinder-bottom.

The inner and moving cylinder is without top or bottom. It has seven short dip-pipes suspended within its area, equidistant apart, having their lower end in same plane with that of the inner cylinder. The inverted cup is formed at the upper end on outside, the cylinder being of sufficient length to dip, say four inches. It is raised or lowered by a rod connected to an outside lever and counterpoise, retaining it up unsealed, except when the generator is being put in or out of service, or in case of back pressure from the works, and when in service the dip can be made as light as required.

The evaporator is formed upon the bottom plate of the hydraulic main; and consists in a series of horizontal check-ribs, C, projecting one and a half inch above the bottom surface, continued throughout the length of the main, about two feet apart, having a slight lateral descent, alternately, with that of the main, each rib to have an opening of one and a half inch between its lowest end and the side of the main, or at the alternate ends, the other end and lower edge to be fixed with tar-tight joints.

In combination with this evaporator is a condenser, also formed on the inside of the main by a series of thin plates, C′, about two and one half inches wide, placed three inches apart, in two diverging lines of about twenty-nine degrees to the center line of the main, in form of the letter **V**, with the points toward the hydraulic valve E. Each leg of the angular-formed figure is to be kept about half an inch off from the sides of the main. The plates C′ are fixed vertical, extending from the bottom to top of the main, the first of the series of **V**-formed figures of vertical plates to be placed three or four feet back from the hydraulic valve E, thence, to be continued throughout the length of the main, in the order, and as represented, on Figs. 3, 9, and 10.

The crude products of distillation from the generator-beds rise into the drum W, passing through the outlet-pipe Q, and valve E, into the main C″ in its course to the washers. But, in continuing this course, the flow impinges upon the oblique upright plates, and is deflected, striking the sides of the main obliquely, is again deflected upon the next of the series of oblique plates, and so on, throughout the length of the main, thereby causing condensation and deposit of the tar upon the plates and sides, also a breaking up and disintegrating any globules containing gas or hydrocarbon vapors. This tarry matter, falling upon the flat bottom of the inclined main, is caused to flow back toward the valve E, but is obstructed in its course by

the projecting check-ribs, and caused to spread out over the bottom in a thin, broad sheet, over an extended heated surface, whereby it is distilled, at any required degree of temperature, the hydrocarbon vapors evaporated or distilled into permanent gas, intermingling and uniting with the large passing flow, thereby enriching and increasing its volume.

The object of this part of my invention is an apparatus, combined with those before described, wherewith to recover and redistil any enriching hydrocarbon oils, &c., carried down, by causing the crude flowing gas, before reaching the washers, to strike upon numerous plates of metal, whereby the mechanically-contained globules and particles of tar and hydrocarbon vapors are condensed and fall down, flowing with the tar along a wide heated surface for forty feet, where it is fractionally evaporated at suitable limited and regulated degrees of temperature.

The main should be continued around the inside of the buiding for, say, one hundred and fifty or two hundred feet, with a regular descent for the tar to that part in which the evaporators are fixed.

Mechanical movements: On Fig. 1 is represented a vertical elevation of the mechanical movements, and Fig. 14 is a horizontal plan. One revolution of pulley N passes six links of the chain. Each link is three and a quarter inches long—the distance apart of the lower beds; hence, one-sixth of a revolution given to spur-gear Z will move the chain N O, with the rollers P, the distance of one link, and actuate the crank-lever S′ to turn one range of louvers.

Two spur-gears, like to and with the same number of teeth as Z, are placed on shaft 6 in gear with Z and Z, turning loose; also, two more of the same, turning loose on shaft 7, in gear with Z and Z. Each of the four have clutch-boxes sliding on feathers. A miter-gear is fixed on the end of shafts 6 and 7.

Shaft one (1) is at right angles to, and in the same plane with, 6 and 7. On it are two loose mutilated miter-wheels, 11, in gear with the wheel on end of shaft 6, with only one-sixth the number of teeth of that in the fixed wheel, giving an intermittent motion of one to six. Shaft 1 also carries two loose miter-gears, 12, in gear with the fixed wheel on end of shaft 7, all having the same number of teeth. These two pairs of loose wheels have double clutch-boxes sliding on the feathers between each pair, as the means of producing reversing motions to shafts 6 and 7.

On shaft 1 is also fixed a worm, 9′, in gear with a worm-wheel fixed on shaft 2, having sixty-six teeth, giving it sixty-six revolutions to one of shaft 1; also, on shaft 2 is fixed a worm, 9, in gear with a worm-wheel, having eight teeth, fixed on shaft 5, giving this shaft five hundred and twenty-eight revolutions to one of shaft 1, this being the number of revolutions required from the beginning of charging one generator to the time for charging another of each pair. On shaft 2 is the fixed spur-wheel 2′, in gear with the pinion 3′, turning loose on shaft 3, having a clutch and feather, with only half the number of teeth of 2′. This again is in gear with the fixed spur-wheel 4′ on shaft 4, having the same number of teeth as the first.

Figs. 15, 16, 17, 18, and 19 represent the special forms given the edge of the cams. The figures marked on the divisions represent the number of revolutions of shaft 1, and the lettering the function of that division.

Cam 15 is fixed on shaft 5. A rod and lever connect its yoke with the clutch on shaft 3. It regulates the movements imparted by spur-gear 2′. For three hundred and ninety-six revolutions the cam retains the clutch disengaged, the pinion turning loose, but is engaged for the remaining one hundred and thirty-two revolutions, of which pinion 3′ transfers sixty-six to spur-gear 4′. Cams 17 and 18 are fixed on shaft 3. A rod and lever connect the yokes of cam 17 with the double clutch between the gears 11, and regulate the movements of the mutilated gears by alternate engagement, imparting the movement to shaft 6, thence, by spur-gear Z Z, to the pulley and chain N O. Cam 18 regulates the movements of the distributer B, feed-valves V′ V, &c., by actuating the cluch engaging the beveled pinion 10, turning loose on lower end of vertical shaft 10′ 10″. The pinion is in gear with and receives its motion from the beveled wheel fixed on shaft 1, possessing double its number of teeth. The cam engages the clutch 10, and actuates the distributer during charging only, or for forty-two and a half revolutions. It is set so as to act at one-sixth of a revolution later than cam 17. A chain-belt connects the speed-pulleys on shaft 10′ and hollow shaft of distributer, imparting a rotary motion to the disk-wheel B. Cam 18 also actuates the feed-valves V′ V by means of a connecting-rod and bell-crank lever, opening and closing them one-half a revolution in advance of the cam, so as to fill the hopper D in time for charge, and leave it empty after the last louver is turned to receive its charge.

Cam 16 is fixed on shaft 5, requiring, for one revolution, five hundred and twenty-eight of shaft 1. The six divisions marked "prepare discharge, prepare charge," require one hundred and thirty-two revolutions, the other eighteen divisions twenty-two each. The cam actuates the double clutch between the miter-wheels 12 through means of a bell-crank lever connected with its yoke, and, by engaging one or the other of the gear, give a reversed motion to shaft 7 of the duration of the number of revolutions of each division, as marked on cam.

Cam 19, represented on Fig. 19, is fixed on shaft 4, requiring, for one revolution, one hundred and thirty-two of shaft 1. It actuates two movements at the same time, one at each opposite point of its diameter. Its function is to regulate the motions of the clutches slid-

ing on feathers on shafts 6 and 7 through movements of the oscillating levers 20′ and 20″ and 21′ 21″, connected, by rods and bell-crank levers 20 and 21, to the cam-yoke.

For working any number of pairs of generators in a range, the lines of shafting 6 and 7, &c., are supposed to be continued out to transmit the movement.

While the division marked on cam 19—"23½ stop"—is passing its yoke-roller, say at point 19, the like divisions of cams 16 and 17 are also passing their respective yoke-rollers preparatory to discharging alternate generator of each pair.

Cam 16, acting on clutch of gear 12, imparts motion to shaft 7, transferred by spur-gear Z to chain N O, which is caused to turn until the expiration of the twenty-three and a half revolutions, when the chain-rollers will be in the position P, Fig. 1; then the cam reverses the motion of gear 12, which would convey the chain-roller back again for twenty-one and a quarter revolutions, were it not that division-discharge 42½ of cam 19, at the same time acts on its yoke-roller, causing also a reverse movement of the oscillating lever with the attached clutches 20′ and 20″, to the position represented on Fig. 14, clutch 20′ being engaged and 20″ disengaged, whereas, if in the former position, all the spur-gears on shaft 7 would have been engaged and retained in motion, and all on shaft 6 would be disengaged and loose; but by the reversing of each alternate oscillating lever each alternate clutch is disengaged, permitting the gears to turn loose on shaft 7, while by the same movement the opposite gears on shaft 6 become engaged with their respective clutches, and are thus prepared to impart the intermittent motion through Z to the chain.

While the division-stop 23½ of cam 17 is passing its yoke-roller there is no motion, the clutch of mutilated gear 11 being disengaged at both ends; but as division-discharge 42½ passes gear 11, it imparts the intermittent motion to shaft 6, thence by spur-gear Z engaged with clutch 20′ to chain N O, also with the chain of each alternate generator of a range. By this motion the chain-rollers P, Fig. 1, are continued up, acting upon the cams R R, &c., thereby shifting the crank-levers S′ S′, &c., and so turn up the louvers forming the bed of the generator, until forty-four are so turned up, when the cam 17 reverses the motion of shaft 6, by passing the next division of stop 23½, or preparatory to charging, during which no motion is given to shaft 6, but cams 16 and 19 are at this time also entering the like division; cam 19, by its action, again reverses the position of the oscillating levers and attached cams 20′ and 20″, disengaging clutch 21′ and engaging 21″, and so on for each alternate oscillating lever. This action again engages all the clutches on shaft 7, and disengages all on shaft 6, while cam 16, after passing two changes of chain of twenty-one and one-fourth turns each, again actuates clutch of gear 12 on a reverse motion of twenty-three and one-half revolutions of shaft 7, which is transferred by the now all engaged clutches to the chain, causing the chain-rollers that had been, by cam 17, carried above forty-four generating beds in discharging, to be transferred again to the position P, Fig. 1, but on the opposite side of the chain to which it was for the discharge. Then a reversed motion of twenty-one and one-fourth revolutions again takes place; but, as before, cams 17 and 19, at the same time, reverse the respective clutches under their control, cam 19 again reverses the oscillating levers, engages clutch 20′, and disengages 20″, so that the motion of shaft 7 cannot act further on the chains engaged in operating the charge; and cam 17, by actuating gear 11, transmits the intermitted motion through the now engaged clutch on shaft 6, thence by gear Z to the pulley N, chain and rollers N O, Fig. 1, which is continued in its upward motion by an impulse of one-sixth of a revolution of pulley P, acting against cam R, shifting the crank-lever S′ to its former position, thus turning down a range of louvers forming the first or bottom generating-bed. An intermission of five-sixths of a revolution of chain-pulley P now takes place, during which the charge of coal is distributed in upon the bed, by action of the distributer, and spread in an even equal layer, before another range of louvers is turned down, and so continues until the forty-four ranges are turned down, and each has received its charge of coal.

At the end of charging, cam 15, Fig. 15, disengages the clutch from spur-pinion 3′, having passed four divisions, aggregating one hundred and thirty-two revolutions, and stops for the time of three hundred and ninety-six revolutions; the pinion, therefore, runs loose, stopping the motions of shafts 3 and 4, and their fixed cams 17, 18, and 19, also during three hundred and ninety-six revolutions of shaft 1, all, after having passed the division-charges reverse the motions by entering again upon the division-stops 23½ on cams 17, 18, and 19, upon division-stop 132. This cam, on entering this division, again actuates each alternate oscillating lever and attached clutches, disengaging 20′ and engaging 20″, and so on, whereby all the clutches on shaft 7 become engaged, while cam 16, taking its motion from shaft 5, continues to actuate gears 12 for eighteen changes of the chain, each requiring twenty-two (22) turns of shaft 1, when it is again ready to enter the preparatory division of twenty-three and one-half turns. The beginning of a charge to the other generator of the pair, half the time for the duration of a charge to the first generator, having expired with one revolution of this cam, the distributer-case is turned half round.

For discharging and charging the second generator of the pair the same movements of the respective parts take place, as herein explained, except that the four parts marked

"discharge," "charge," and "stop" on cam 19, actuate the movements while passing the lower yoke-roller at the point of the diameter opposite to 19. On shaft 1 is a fixed speed-cone, and another similar one is fixed on shaft 8, together with the driving-pulley 8′. These cones are formed in the proportion of $10\frac{278}{1000}$ inches at one end to $7\frac{721}{1000}$ inches at the other. The movements are calculated at five hundred and twenty-eight revolutions of shaft 1 for half charge, in so many seconds of time, or 1056 for the average charge in 1056 seconds. The difference in diameter between the two ends of the speed-cone equals 300 revolutions; therefore 1056 less 150 is 906 revolutions, or fifteen minutes of time for a charge of three-eighth-inch layer of coal; and 1056 plus 150 is 1206 revolutions, or twenty minutes for a charge of half-inch layer of coal.

Having thus described and explained my invention and methods of operating, what is claimed as new, and desired to be secured by Letters Patent, is—

1. The gas-generating beds or floors A, &c., formed by combination of ranges of pivoted louvers U, &c., placed in vertical tiers surmounted above each other, forming compartments of any required size, number of tiers, or of any horizontal sectional form, inclosed in an outer gas-tight case or retort, T, with mechanism for operating the same, substantially as hereinbefore described and shown, for the purposes set forth.

2. The adjustable chutes or directors of the flow of coal, formed by the pivoted vertical louvers B′, placed around the circumference of the horizontal revolving box or case B, whether operated with the full circle of louvers, or of any segmental part thereof, substantially as hereinbefore described and shown, for the purposes set forth.

3. The combination of the adjustable chutes or directors B′, with the revolving box, inclosed horizontal revolving disk-wheel B (Figs. 12 and 13) hopper D, coal feed-regulating valves V, with mechanism for operating the same, substantially as hereinbefore described and shown, for the purposes set forth.

4. The series of projecting check-ribs forming the evaporators C, fixed in inversely-inclined order upon the bottom plate inside of the inclined hydraulic main C″, substantially as hereinbefore described.

5. The oblique vertical deflecting condensers C′, formed and arranged in V-shaped series on the inside of the hydraulic main C, substantially as hereinbefore described.

6. The combination of generating-beds A, distributer B, feed-valves V, conduits G, hydraulic connections F, weighing-bins H, with the mechanism for operating and effecting the self-charging and discharging of each louver-formed generating-bed in succession, substantially as hereinbefore described and shown, for the purposes set forth.

7. The combination of numerous ranges of louver formed carbonizing-bed A, automatically worked within the sealed gas-tight case or retort T, receiving their charge of coal and discharging it when coked without opening said retort, or the admittance of atmospheric air, with mechanism for operating the same, substantially as hereinbefore described and shown, for the purposes set forth.

8. The combination, throughout the interior of the inclined hydraulic main C″, placed over and heated by the hot-air flues I, of a series of condensers, C′, and evaporators C, for the recovery by distillation and evaporization of the liquid hydrocarbons condensed and carried down by the tar, &c., substantially as hereinbefore described and shown, for the purposes set forth.

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