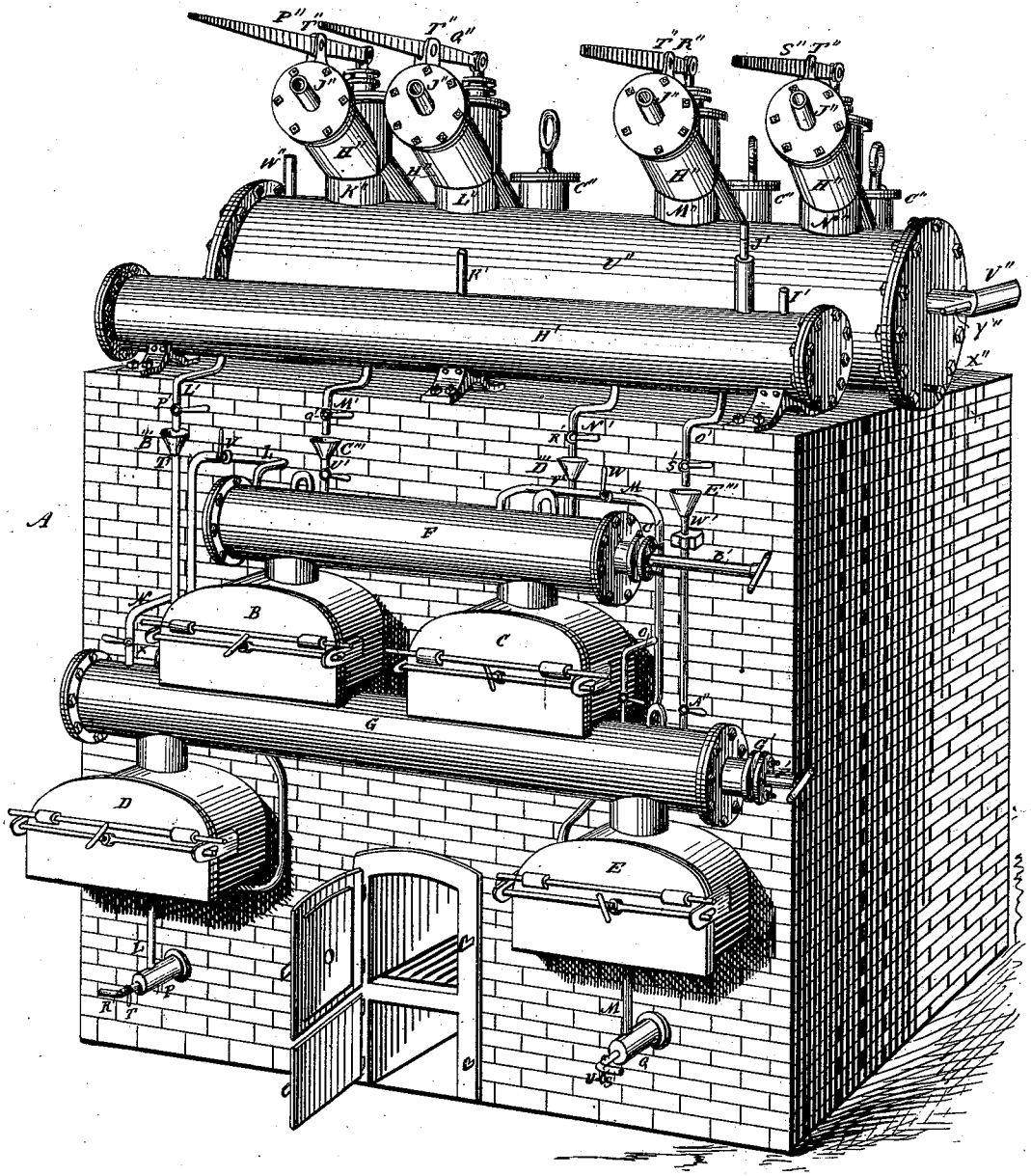
4 Sheets—Sheet 1.

H. W. ADAMS.

Apparatus and Process for Manufacturing Illuminating Gas.

No. 204,181. **Patented May 28, 1878.**

Fig. 1



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Apparatus and Process for Manufacturing Illuminating Gas.

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Fig. 2

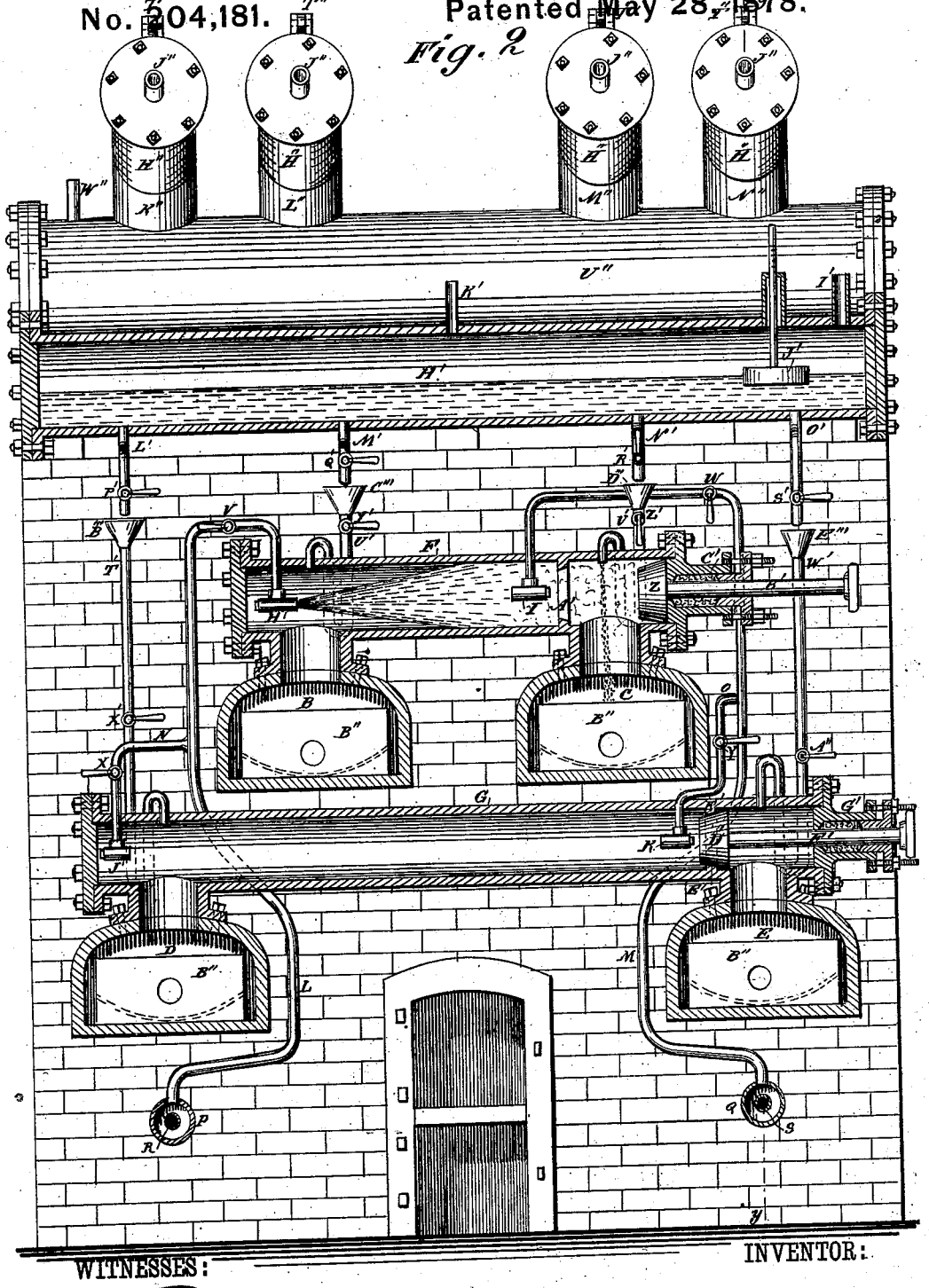

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Fig. 3

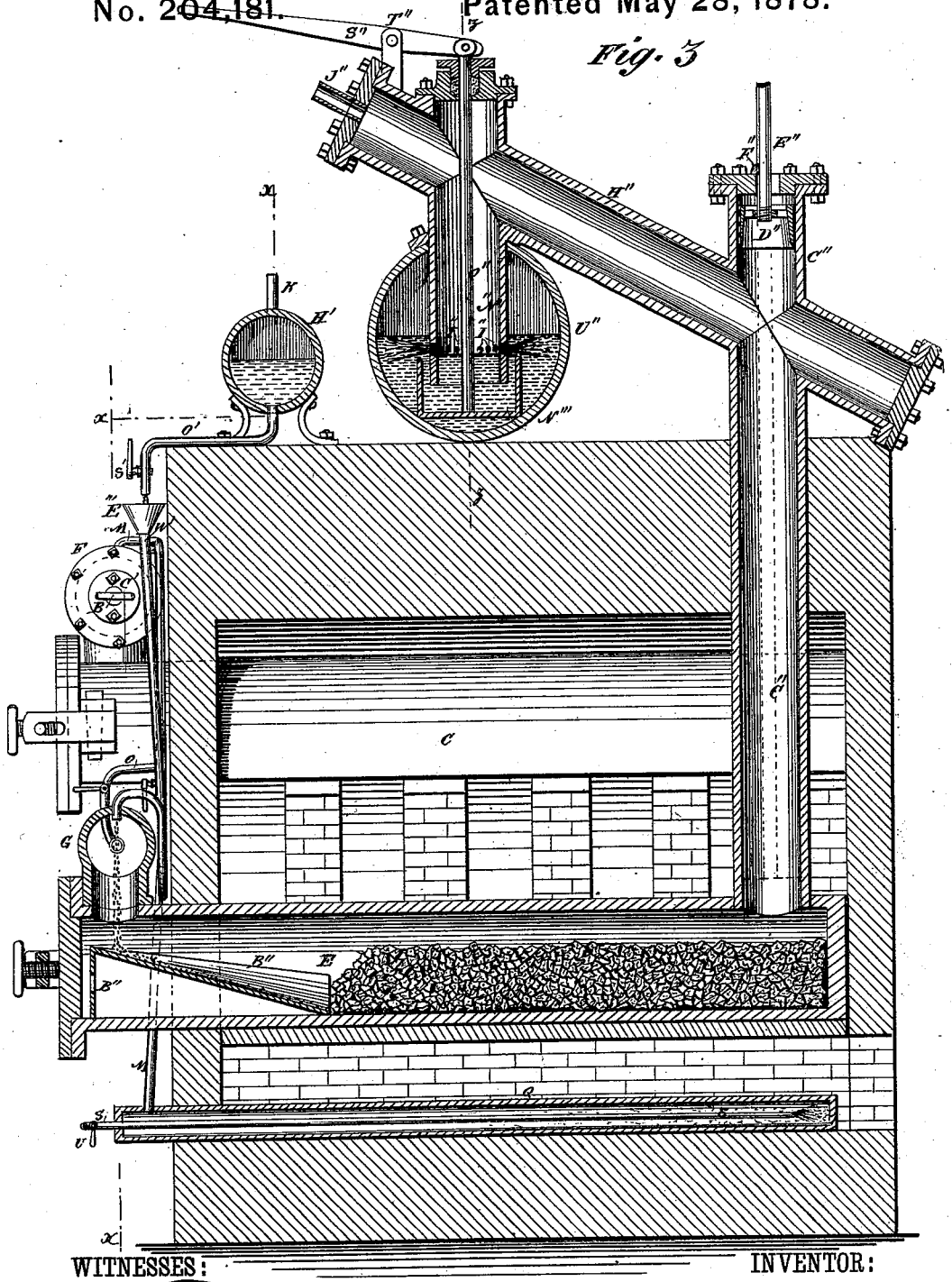

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Fig. 4

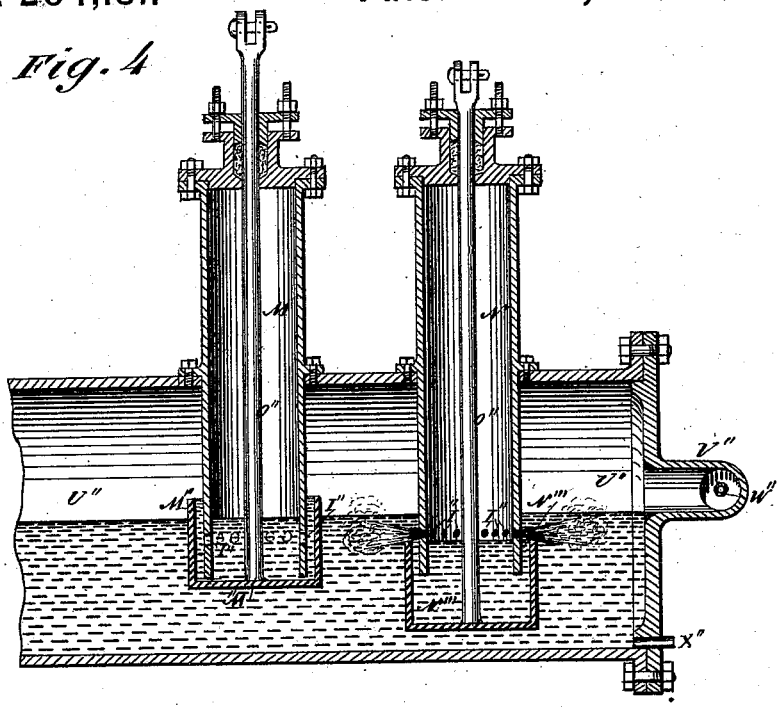


Fig. 5

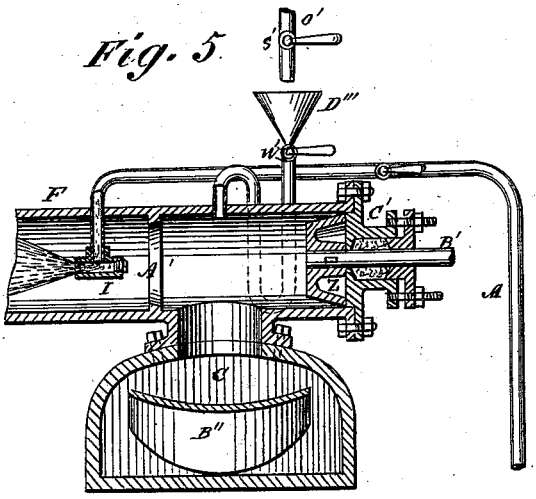


Fig. 7

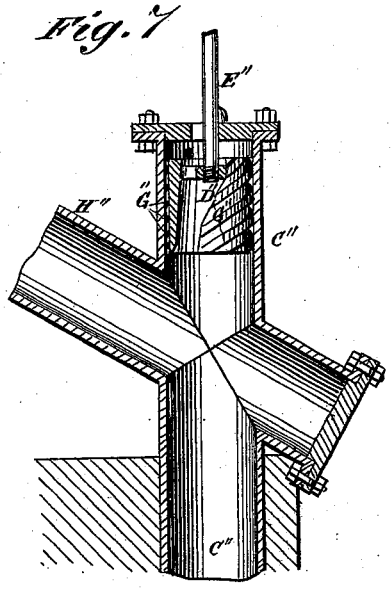
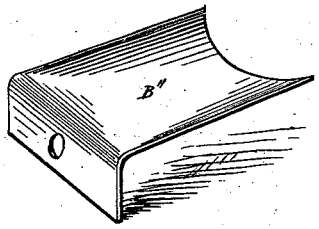


Fig. 6



WITNESSES:

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UNITED STATES PATENT OFFICE.

HENRY W. ADAMS, OF PHILADELPHIA, PENNSYLVANIA.

IMPROVEMENT IN APPARATUS AND PROCESSES FOR MANUFACTURING ILLUMINATING-GAS.

Specification forming part of Letters Patent No. **204,181**, dated May 28, 1878; application filed May 7, 1878.

To all whom it may concern:

Be it known that I, HENRY W. ADAMS, of the city and county of Philadelphia, and State of Pennsylvania, have invented an Improved Apparatus and Process for Manufacturing Illuminating-Gas from coal, petroleum, and steam, and mixing and combining together the gases generated from these and similar materials into one compound fixed gas of superior illuminating power, in the same retort, by means of the same heat, and in the same time usually allowed for the distillation of a similar charge of coal alone.

The object of my invention is to make a larger quantity of gas from coal and other similar materials than has heretofore been done, and to increase and cheapen this production still further by the use of gas generated from water or steam, and enriched by oil or other oleaginous matter. To do this, I subject gas-yielding coal, wood, peat, turf, or any other suitable gas-making and coke-producing materials to destructive distillation in close retorts, in such a manner as to make no tar nor ammoniacal liquor, as is now the case, or, at least, so trifling a quantity as practically to amount to none, and by this means to increase very largely the production of gas from coal, wood, peat, turf, or any other similar bodies capable of being resolved into gas, tar, and coke.

The retorts now in common use are open at one end and closed at the other. The standpipe for the escape of the gas from the retort is placed on its upper side, near its open end, which projects from the front side of the bench by means of a cast-iron neck, secured to the retort proper by a flange and bolts. When a charge of gas-coal is put in the retort is usually at a cherry-red heat, while the coal is cold. The first effect is that the coal is heated up to the temperature of boiling water, which causes a distillation of the water or moisture in the coal. As the heat of the coal is not sufficient to decompose the steam thus generated into oxygen and hydrogen gases, it escapes directly by the cool standpipe, and condenses in the hydraulic main and cooler. When the heat is sufficient some nitrogen unites with hydrogen and forms ammonia, which is dissolved in the water, and ammoniacal liquor is produced. When the coal rises to a heat sufficient to distill off its bitumen, but not to decompose it to permanent gas, this vapor of gas-tar passes directly out of the retort through a cool stand-pipe, and condenses also in the hydraulic main and cooler. This process of making tar and ammoniacal liquor from a fresh charge of coal undergoing destructive distillation in the common coal-gas retort goes on until the coal in the retort is raised to a red heat, when the bituminous matter in it is decomposed and converted into several fixed gases, which, when purified, are stored in gasometers for illuminating purposes.

Each of the aforesaid secondary products amounts to twelve gallons of tar and twelve gallons of ammoniacal water, or more, to the ton of coal. The average production of gas from a ton of coal is not far from four and one-quarter feet to the pound of coal, or eight thousand five hundred feet to twenty hundred pounds.

The large amount of ammoniacal liquor—over twelve gallons to the ton of coal—consisting of nearly all water, is capable of being decomposed into oxygen and hydrogen gases. The oxygen combines with the carbon of the red-hot coal and produces carbonic-acid and carbonic-oxide gases, the latter of which, with the hydrogen generated, produces a very large volume of combustible gas, but poor in illuminating quality. The tar—the richest product of carbonaceous matter yielded by the coal, and the most valuable part for gas-making—is capable of being decomposed and converted into a gas excessively rich in carbon, and possessing a very high degree of illuminating power. When the former poor gas and the latter rich gas are made in the same retort and at the same time, they unite in a nascent state, and compose a fixed gas of excellent quality. The quantity of gas is thus very largely increased from the same charge of coal. This increase amounts to about one-third of the present volume of gas obtained from a given charge of coal, distilled in the ordinary coal-gas retorts, having stand-pipes on their front ends. To effect an object so desirable, I locate the coal to be distilled in the distilling apparatus, so that the first vapors of tar and moisture, which start out of the first charge of coal at too low a heat to be de-

composed, shall be compelled to pass over and through a considerable body of red-hot coke, or partially-distilled coal, or other decomposing surfaces, for a considerable distance before they reach the stand-pipes, and thus be converted entirely into fixed gas. This I do most effectually by the means hereinafter more fully described.

Another object of my invention is to take advantage of the red-hot surfaces of the coals or other coke-yielding substances undergoing destructive distillation in my retorts, to decompose oil, petroleum, naphtha, or any other suitable oleaginous matter, and conjunctively therewith to decompose water—preferably superheated steam—in order to increase the quantity and diminish the cost without impoverishing the quality of coal-gas produced from a given charge of coal or other similar material. During the latter part of the period of distillation the gas from the coal undergoing such distillation grows poorer in carbon and richer in hydrogen. Its illuminating power is thus lessened, and, moreover, its quantity is very considerably diminished below the amount yielded during the first period of distillation. By supplying a stream of oil, petroleum, naphtha, or other oleaginous body to the retort whose charge of coal has been partially distilled and converted into red-hot coke, in conjunction with superheated steam, the yield of gas from the coal is re-enforced by the large volumes now generated in the same retort and by means of the same heat, and in the same time, from the oil and steam, of superior brilliancy, with no other cost or trouble except the expense incurred for the fluid gas-yielding matter and the steam. A coal-gas retort is thus made to perform a triple duty, and produce a product larger in quantity and relatively cheaper.

In making gas from water, in conjunction with oil, petroleum, napththa, or other similar gas-yielding fluid and oleaginous materials, and with partially-distilled charges of coal, in the same retort, and by means of the same heat, I prefer to use superheated steam, so as not to cool the retort by feeding into it water, or even common wet steam.

It is better to convert the water into steam in a boiler in the ordinary manner, and then to superheat it by any of the known methods, before it is admitted to the retort, charged with partially-distilled coal or other similar body, into which oil and other similar fluid matters are fed at the same time. Then the process goes on rapidly without detriment to the proper decomposing heat of the retort. The rich oil-gas and the poor water-gases mingle together in a nascent state, and, with the coal-gas still being generated from the coal, unite and compose a good fixed gas of excellent illuminating power.

Having stated the objects of my invention, I will now show how these objects may be fully realized in practice.

The drawings which accompany this specification, and which are made a part of it, show one mode of carrying out my invention.

Similar letters with similar primes represent similar parts in all the drawings.

Figure 1 represents a working bench of four retorts, coupled together in reciprocating pairs, with all their connections in perspective. Fig. 2 is a vertical section through the line *x x* of Fig. 3, showing a front elevation of the bench. Fig. 3 is a vertical section on the line *y y* of Fig. 2, showing a section of one retort and its various connections. Fig. 4 is a section through the hydraulic main, showing a section of the dip-pipes, provided with a ring of holes above their lower ends, for causing the gas to shoot through them into the fluid which seals them in horizontal jets, and to be washed from lamp-black, also showing the sealing-buckets in relation thereto, drawn through the line *z z*. Fig. 5 is an enlarged vertical section drawn through the line *x x*, showing the method of introducing steam and petroleum or other oil into a mixing-pipe, and drawing the tarry and aqueous vapors and gas from a reciprocating retort, and mixing all these products together—namely the tarry and aqueous vapors and gases coming from a retort containing a fresh charge of coal or other similar material, together with a stream of oil, petroleum, naphtha, or any other suitable gas-making fluid and steam—and injecting them together, in a mingled and heated condition, into a retort charged with red-hot coke or partially-distilled coal or other equivalent material, and dispersing them through the same, to be decomposed and recomposed into fixed illuminating-gas. Fig. 6 is a perspective view of the inclined apron or oil-gutter placed in the mouths of all the retorts, when charged with coal, to receive the inflowing stream of oil, petroleum, naphtha, or other fluid oleaginous matter, and conduct them back into the interior of the retort and onto the red-hot coke or partially-distilled coal, and prevent them from forming a puddle in the cooler necks of the retorts. Fig. 7 is an enlarged section on the line *y y*, showing a tubular cutter in all the stand-pipes, for keeping them clear of any deposition of carbon.

A shows a bench of four gas-retorts set in a furnace, and provided with all the connections for operating them. B C D E are four retorts, set in a furnace in the common method, and are connected together, so as to be operated in reciprocating pairs, for generating coal, oil, and water-gas in conjunction in each retort. F shows a pipe connecting together the retorts B C, and G shows a pipe connecting together the two retorts D E. These pipes are also used for mixing together the tarry and aqueous vapors and gases coming from a fresh charge of coal or other gas-making and coke-yielding material in one retort, with oil, petroleum, naphtha, or other suitable fluid matter and steam, and delivering them in a mingled and heated condition into the other retort, when charged with red-hot coke

or partially-distilled coal, or its equivalent, to oe fully decomposed and recomposed into a fixed illuminating-gas. In these two cross-pipes F and G are placed, near their opposite ends, steam nozzles or tees, opening toward each other, and being intended to deliver jets of steam. These nozzles in F are shown by H I, and in G by J K. They are respectively connected to the steam-pipes L M and branches N O, which steam-pipes are also connected with the superheaters P Q. These are cast-iron pipes, about a foot in diameter and about eight feet long, and are placed in the lower flues of the furnace, through which the furnace discharges all its utilized gases into the stack. Here they get red-hot without robbing the retorts of their needful heat. Both ends of these superheaters are closed. R is a steam-pipe, about half an inch in diameter, more or less, which enters the superheater P at its outer end, which projects from the front of the furnace, and passes through its interior in a parallel direction and to within a few inches of its rear end. Its end is open, so as to deliver steam from a steam-boiler, with which this pipe is supposed to be connected, into the rear of P, in order that it may have to travel back to the front end and be superheated by contact with the interior sides of the red-hot pipe P. S is a similar steam-pipe, and similarly situated in the superheater Q, and is intended to fulfill a similar office. T U are cocks on R S, to let steam into them from the boiler and to shut it off. V is a cock on the steam-pipe L, to let steam onto or shut it off from the retort C; and W is a cock on M, to let steam onto or shut it off from the retort B. X is a cock on the steam-pipe N, to let on steam or shut it off from the retort E; and Y is a cock on the branch-pipe O, to let on steam or shut it off from the retort D. Z shows a valve in the cross-pipe F. A′ is its seat. B′ is the handle. C′ is the stuffing-box on F, through which the handle B′ works. D′ is a similar valve on the pipe G. E′ is its seat. F′ is its handle, working through the stuffing-box G′. These rods are one inch and a quarter in diameter, and are provided with auger-handles on their ends, for pulling them out or pushing them in.

The cross-pipes F and G are about six inches in diameter. The valves Z and D′ are round and beveled, so that that they will pass through and wedge in a ring of metal cast in the inside of the cross-pipes F and G, which ring is smaller in diameter than the interior of the said pipes. These valves, pushed into their seats or pulled out from them, either close the communication between the retorts B and C and between D and E, or open it, as the case may be. The object of these valves is to shut the connection between the retorts when charging one, so as not to lose the gas from the other.

H′ is a reservoir for holding oil, petroleum, naphtha, or any fluid gas-yielding material. It may be of any desired size. It should be made of boiler-iron, and be perfectly tight. I′ is a pipe for filling it by means of a pump. J is a float for indicating the quantity of oil in the reservoir. K′ is a safety-tube for allowing any vapor to escape. It should be long enough to pass up through the roof of the retort-house. Its top may have a light safety-valve. L′ M′ N′ O′ are pipes, which enter the under side of H′, for the purpose of drawing oil out of it. P′ Q′ R′ S′ are valves for opening and shutting these pipes. T′ U′ V′ W′ are four pipes for conducting oil, petroleum, naphtha, or any other oleaginous matter to the cross-pipes F and G, and from thence to the retorts B C D E. These pipes are provided with bends about one foot long, in the form of the letter U, for the purpose of preventing the gas in the retorts from blowing out. They are also provided with valves X′ Y′ Z′ A″, situated on one of the legs of the respective bends. They are also provided with funnels B‴ C‴ D‴ E‴ for receiving the oil, petroleum, naphtha, or other similar fluid, which is to be fed into the cross-pipes F G. The stream of oil or other fluid gas-producing material, when flowing through these pipes, falls through the cross-pipes F and G, mixed with and heated by the superheated steam, and by the hot vapors coming from the fresh-charged retort into the retorts B C D E, and what is not vaporized and blown forward onto the red-hot coals by the steam-jets falls onto an inclined apron or gutter, which is placed in the mouth of each retort when charged with coal or other similar body, for the purpose of causing any such liquid to flow back into the hotter part of the retort, and be delivered onto the red-hot and partially-distilled coal, and be converted into gas. This apron is represented by B″. It is made of sheet-iron. A hole is punched through one end, so that a hook can be run into it to pull it out of the retorts easily and quickly when the doors are removed, for the purpose of charging them.

C″ C″ C″ C″ represent the four stand-pipes, which are connected with the four retorts B C D E at their rear ends. These stand-pipes are one foot in internal diameter, so that they may not be liable to choke up with carbon. The back ends of the retorts are always red hot, while their front ends are never so. It is better, therefore, to allow the gas to escape from the back ends of the retorts, which are always the hot ends, and which will cause a much more effectual decomposition of the tar vapors in the gas than to take it from the cold ends in front, as is the case with ordinary coal-gas works. Besides, in all such works the tar-charged vapors and moisture distilled from the front ends of their charges, lacking the proper heat to decompose them to gas, pass directly into the cooler necks of the retorts in front, and ascend the still cooler stand-pipes, and condense abundantly in the hydraulic main, and cause a great loss of gas. By compelling the gas-tar and aqueous vapors now formed in the front ends of the charges to pass

through the red-hot ends of the retorts and escape from red-hot stand-pipes, much less tar and much more gas can be made from a given charge of coal. This is the reason why I place my stand-pipes in the rear ends of the retorts. I make them very large in diameter to protect them from filling up with carbon.

As another protection against the choking of these stand-pipes with hard carbon at their mouths, I remove them from the direct action of the fire by placing them in the extreme rear end of the retorts, and then incasing them with the stand-pipes in the brick-work of the rear end of the furnace, so that they are partially shielded from the more intense heat of the fire. The effect of this arrangement is that while they are quite hot they do not burn the gas and deposit its rich carbonaceous portion in solid layers on the inside of these pipes. Only a small quantity will form in their mouths, and to prevent the accumulation of this I employ a tubular cutter having nearly the same diameter as the stand-pipes, and operate it by an attached rod passing through a slot in the flanges or plugs at their tops. These slots are oblong, so as to allow lugs on the rods of the cutters to pass through them and rest on the tops of the flanges, and so hold up the cutters in the tops of the stand-pipes when not in use. The joints are made sufficiently tight by stiff pug or putty. This cutter is shown by D″, and the rod by E″, and the lug by F″.

At any time, when desired, the engineer can go to the tops of the stand-pipes and turn the rods one-quarter round, so that the lugs on the rods will pass through the oblong slots in the flanges, and thrust the cutters down the stand-pipes and into the retorts, and assure himself that they are open. This is a very great convenience. The large diameters of these pipes and the tubular cutters with which they are provided give ample security to the gas-engineer that these important and most exposed pipes will occasion no trouble. The outsides of these cutters are armed with teeth or spiral cutting-edges, so as to aid in removing any hard deposit which may from time to time accumulate, from neglect, on the insides of these pipes near and round their mouths and junctions with the retorts. G″ shows these teeth or spiral cutting-edges.

By putting the cross-pipes F and G on the front ends of the retorts outside of the furnace, so that their valves and pipes cannot be harmed by the fire, and so that they can be easily got at and opened and repaired, and by keeping forcible jets of steam shooting through them, so that they cannot choke up, and by compelling the gas to escape from the red-hot ends of the retorts in the rear, and through red-hot stand-pipes, by which means the tar and aqueous vapors, hitherto so imperfectly distilled and decomposed, which are discharged from the coal in the front ends of the retorts are much more effectually and thoroughly converted into gas, I believe I have effected a decided improvement in the destructive distillation of coal for illuminating purposes.

H″ H″ H″ H″ show the four saddle-pipes, provided with steam-pipes J″ J″ J″ J″, attached to their upper ends, for the purpose of blowing steam through them to clean them.

K″ L″ M″ N″ show the four dip-pipes. Both the saddle-pipes and dip-pipes are twelve inches in internal diameter.

My process makes gas so fast that the common sizes of these pipes are not sufficient.

Gas, as it issues from the retort, is always loaded with fine particles of carbon, which it is necessary to remove. This is now done by causing the gas to bubble through the tar, which seals the dip-pipes in the hydraulic main; but the gas escapes from the lower ends of the dip-pipes in such large volumes as to prevent proper contact with the sealing-tar, and the result is that much of the fine carbon is carried by the gas into the coolers, lime-purifiers, and gas-holders. In fact, any one can notice it burning in every gas-light in little sparks just above the tops of the burners. To cause, therefore, a more thorough cleaning of the gas from this fine carbon in the hydraulic main, I bore a ring of holes, about three-fourths of an inch in diameter and about half an inch apart, round and through the dip-pipes, about one inch above their bottom ends. I then fill the hydraulic main with a fluid, hereinafter to be described, so that these holes in the dip-pipes shall be one inch (more or less) below the level of the fluid in the hydraulic main, and their bottom ends be two and three-quarter inches below the top surface of the sealing-fluid. The effect is that the gas generated in the retorts presses the fluid, whether it be tar or any other proper liquid, down in the dip-pipes until it comes to the ring of three-quarter-inch holes bored through their sides, and then escapes in divided and horizontal streams, shooting out in a ring of jets, presenting more gaseous surface to the fluid, going farther, and remaining longer in it, and being more effectually stripped and washed from its fine carbonaceous impurities.

I″ I″ I″ show these holes, as before described, through the sides and one inch above the bottom ends of the dip-pipes. The buckets under the dip-pipes in the hydraulic main are fifteen inches in internal diameter. They rest on the bottom of the main. Their tops are just high enough to be on a horizontal line with the lower sides of the rings of holes through the dip-pipes, one inch above their bottom ends. The effect of this arrangement is that the dip-pipes extend down into the buckets one inch. The buckets cannot therefore get out of position, as they rest on the bottom of the main, while their tops, being one and three-quarter inch below the surface of the fluid in the main, allow the gas to shoot out through the ring of holes in the dip-pipes and pass over the tops of the buckets and through the superincumbent fluid. These

buckets are indicated by M‴ N‴. By raising them until their bottoms touch the bottoms of the dip-pipes, or until the seal is deep enough, the fluid, which they carry up in them, seals the holes in their sides still deeper. This device enables me to turn the gas generated in one of the reciprocating retorts into the other, as will hereinafter be shown.

To operate these buckets, iron rods three-fourths of an inch in diameter are made fast to their bottoms, and extend up centrally through the dip pipes, and pass through the flanges and stuffing-boxes on their tops. These rods are indicated by O″ O″ O″ O″. To the tops of these rods the levers P″ Q″ R″ S″, provided with fulcrums T″ T″ T″ T″, are attached. By elevating or lowering the long arms of the levers the buckets are raised or lowered accordingly. The hydraulic main is shown by U″, and V″ is an overflow-pipe, which carries off the gas, and also the liquid accumulations. The level of the fluid in the main is flush with the bottom side of this discharge-pipe. W″ is a pipe for pumping any liquid into the main. X″ shows a pipe for drawing off the contents of the main. Y″ is a steam pipe, through which steam from a steam-boiler is delivered in a forcible jet into the pipe V″, for the purpose of making an exhauster to pump the gas from the retorts and to prevent the damaging effect of pressure of gas in them.

In the ordinary process of manufacturing coal-gas from coal, such a large quantity of tar and ammoniacal water are made that the constant overflow of these products from the discharge-pipe attached to the hydraulic main carries off with it the fine carbon mixed with the tar, and thus keeps the main free from its accumulations. This is not the case with my process. If I commence to make gas with my main filled with tar or some other fluid, in a few days the liquid in the main will become so thick and viscid with the admixture of fine carbon injected into it by the gas from the retorts that the flow of gas through the dip-pipes is obstructed, until finally the main has to be cleaned out and refilled. Nor can pure water be used in the hydraulic main in place of tar, because the dry and hot lamp-black or minutely-divided carbon which the gas brings abundantly out of the retorts in all gas-works flies through the water without being moistened by it and penetrated, and consequently without being entangled in it and held back by it. To provide against this contingency, I therefore mix water with soap, gelatine, gum, alkali, or some similar matters, by which an emulsion or a gelatinous or mucilaginous or soapy fluid is prepared, in which pulverized charcoal will readily mix, and pump this into the main as occasion requires, to keep it free from obstructions from this source and to wash the gas from this impurity. In preparing this fluid to fill my main the rule to go by is this: Take a given quantity of water and mix with it enough soap, gelatine, glue, gum, soda, potash, or oil, tar, or heavy petroleum, in which enough soda or potash has been mixed to form an emulsion with water, and prepare a liquid with which pulverized charcoal will readily mix into a wet and pasty mass. Such a fluid will answer well for the hydraulic main of any gas-works, and will cleanse the gas from its lamp-black in a satisfactory manner.

Having described the objects of my invention, and one form of apparatus for the accomplishment of these objects, I will now show what I deem to be the best method of operating it. It is understood that my observations now refer to a bench of four retorts, as shown in my drawings, and described in this specification. In the first place, I fill the hydraulic main with a fluid, prepared as before described, up to a level with the discharge-pipe V″. I then kindle a fire in the furnace under the retorts B, C, D, and E, and heat them up to a high cherry-red heat. I then take off the doors of the retorts B and D, and charge them, in the first instance, with coke. I then shut them up, and wait about one hour and a half to let the coke in the retorts become red hot, in order to be in a suitable condition to decompose the tarry and aqueous vapors from the charge of gas-coal with which the reciprocating retorts C and E are to be charged. It is understood that all the valves between the retorts and the hydraulic main are now open. I now charge these last-mentioned retorts with two hundred pounds of gas-coal in each. I draw out the valve Z by the handle B′ in the cross-pipe F, which opens a communication between the retorts B and C. I also draw out the valve D′ by the handle F′ in the cross-pipe G, which opens a communication between the retorts D and E. I also pull down the levers R″ S″, which raises the buckets M‴ N‴ and seals the dip-pipes M″ N″, which communicate with the retorts C and E, so deeply that the gas coming off from the two fresh charges put into them passes into the cross-pipes F and G, and through them into the two retorts B and D, which are charged with red-hot coke. By passing over and through it, the tarry and aqueous vapors which are expelled from the coal in C and E while it is heating up to a red heat are decomposed into fixed gas. The tar-gas and the water-gas from the coal, being generated together, recombine in a nascent state, and compose an illuminating-gas of rare brilliancy. The gas passes into the stand-pipes and through the saddle-pipes and dip-pipes K″ L″, which are in communication with the retorts B and D, and escapes through holes in the said dip-pipes, whose buckets are down, and whose rings of holes, therefore, have a less seal than the rings of holes in the two dip-pipes M″ N″, whose buckets M‴ N‴ are up. At the same time I open the oil-valves X′ Y′ in the feed-pipes T′ U′, which enter the cross-pipes F and G over the retorts B and D. I also open the two valves P′ Q′ in the pipes L′ M′. This causes oil, petroleum, naphtha, or any other fluid gas-yielding material to descend into the two retorts B D, charged with

red-hot coke, and to fall onto the inclined aprons B″ B″, which conduct it back into the red-hot coke, where it is vaporized and decomposed into gas during its passage through those retorts. At the same time I open the steam-valve U, and let steam from the boiler into the pipe S in the superheater Q. I then open the steam-valve W in the steam-pipe M and the valve Y in the branch steam-pipe O. This lets jets of superheated steam escape from the nozzles or tees I K in the cross-pipes F and G. The superheated steam-jets, shooting from these nozzles, expand and make an exhauster in the mixing-pipes F G, and draw out the tarry and aqueous vapors and gases from the fresh charges of coal in the retorts C and E, and mix with them and with the streams of oil falling into the pipes F G from the pipes T″ U″, and inject them together into the retorts B and D. These retorts, charged with red-hot coke, are now in a suitable condition to receive these mixed products and decompose them, and recombine them into a fixed gas of extraordinary illuminating power. The steam is also let into the pipe Y″, to make a pump in the overflow-pipe V″ and remove the pressure from the hydraulic main and draw the gas out of the retorts as soon as it is generated.

The retorts are to be kept up to a very high red heat, varying into an incipient white. By giving them constant supplies of gas-yielding material a higher degree of heat may be carried on the retorts and gas be generated more abundantly than with a low heat. This operation goes on steadily for two hours, (more or less,) or until the charges of coal in the retorts C and E have been distilled for one-half the period of time allotted to their distillation. The gas is cooled, purified by lime, measured, and stored in gas-holders in the usual way. At this period I begin to prepare to draw the coke in the retorts B and D, and to charge them with gas-coal. I first shut the valves P′ Q′ in the oil-pipes L′ M′ and the valves X′ Y′ in the siphon feed-pipes T′ U′. I then shut the steam-valves Y′ and W′ and push up the levers R″ and S″, which lowers the buckets M‴ and N‴ and diminishes the seal of the dip-pipes M″ and N″. I then pull down the levers P″ and Q″, which lifts up their buckets and increases the seal of the dip-pipes K″ and L″. After this I shut the valves Z and D′. This closes the communication between the retorts B and C and between D and E, and prevents the gas escaping from C and E while B and D are being charged. I now loosen the doors on the retorts B and D and set fire to the escaping gas to prevent a "rap." I then pull out the aprons B″ B″ and plunge them into water to cool them. I then draw the coke from these retorts and charge them with about two hundred pounds of gas-coal in each, put in the aprons B″ B″, and close the doors. I then immediately open the two valves Z and D′ and the steam-valve Y, and let steam from the boiler into the pipe R in the superheater P. I then open the two steam-valves V and X in the steam-pipe L and the oil-valves R′ S′ and Z′ A″. This causes streams of oil, petroleum, naphtha, or any other oleaginous fluid which may be employed to fall into the mixing-pipes F and G, and also jets of superheated steam to shoot from the nozzles H and J, directed toward these streams of oil and heating them, which steam-jets also expand and impinge against the interior sides of F and G, and tend to create a vacuum in the rear of these points of impingement, and therefore to draw by suction the tarry and aqueous vapors and gases from the fresh charges of coal in the retorts B and D into the mixing-pipes F and G, and inject them, with the oil streams, into the retorts C and E, to be dispersed through and over their red-hot charges of partially-distilled coal, and to be decomposed conjunctively with the steam, and their elements, together with gas still being generated from the partially-distilled charges of coal in these retorts, are recombined in their nascent state into a fixed gas of high illuminating power, and passed through the red-hot stand-pipes of these retorts into the hydraulic main.

It is to be here observed that the course of the gas is now reversed. I wish it also to be distinctly understood that the great novelty and utility of my invention are now and here completely unfolded and shown in this operation, as distinguished from all processes of gas-making hitherto known by me, and as constituting the life of my invention, namely, that the fixed gas thus manufactured is a combination, in one retort at the same time and by means of the same heat, of the gaseous elements derived from four distinct and separate sources, namely, from the tarry and aqueous vapors and gases coming from the fresh charges of coal in the reciprocating retorts B D, and the superheated steam-jets escaping from the nozzles H and J, and the streams of oil, petroleum, naphtha, or any other suitable oleaginous matter from the pipes V′ W′, and the gas generated from the partially-distilled charges of coal in the retorts C and E. The poor gases generated from the steam combined in a nascent state with enough of the excessively-rich carbonaceous matter of the oil, petroleum, naphtha, or other similar body to make a good compound illuminating-gas, while the coal-tar and ammoniacal water, now secondary and unutilized products in the ordinary coal-gas works, being decomposed together by my process, so recombine as to produce a rich and permanent gas.

So effectually do I decompose this coal-tar and ammoniacal water that I do not make one drop of either when proper care is taken to maintain the heat of the retorts at the proper degree. When it is considered that a ton of gas-coal, distilled in the method now commonly practiced, produces not generally less than twelve gallons of coal-tar, and often more than this quantity of ammoniacal water, thus making together twenty-four gallons or more

of liquid gas-yielding products, which, when decomposed in conjunction and combined together, make a good fixed illuminating-gas, there can be no good ground left for marvel at the assertion which I here make that my process of distilling coal produces at least one-third more gas of superior quality from a ton of coal than the mode in common use by coal-gas companies. I do not get tar enough to seal my dip-pipes in my hydraulic main. To meet this deficiency I am obliged to prepare water, as heretofore explained, to seal them. Besides, by supplying oil and steam to my retorts in graduated and constant streams during the latter part of the period of distillation, when their charges of coal are red hot and are partially converted into coke, and in a suitable condition to receive a re-enforcement of gas-yielding material, I keep up a flow of gas from my retorts, uniform in quantity and quality, to the very end of the period of distillation. By this means I confidently assert that I get as much gas and as good gas out of one retort, and by the same heat, as can be obtained from two retorts charged with coal alone, and distilled for the same length of time.

This fact develops another economical value of my invention. Only about one-half the number of retorts are required to manufacture a given quantity of gas by my process compared with the number needed to produce an equal amount of gas by the process now universally in use by coal-gas companies. The expenses for labor and material are correspondingly reduced.

I have shown one form of apparatus for carrying out my invention. Other plans may be devised to do the same thing, and therefore I shall claim, broadly, independently of any apparatus, the process of making fixed gas for illuminating and heating purposes, substantially as hereinbefore set forth.

I have shown how my reciprocating retorts are charged and operated. These operations are to be continued, as stated, charging each retort every four hours, and reversing the gas and the oil and steam feed into the reciprocating retort at the same time, and charging each retort two hours apart. This process requires that the charge of coal, wood, peat, turf, or any other gas-yielding and coke-producing material shall be distilled for two hours in one retort before the products of the other retort, together with the oil and steam, are turned into it and the course of the gas reversed. This course is to be pursued when the period of distillation of each charge of coal or other similar materials is limited to four hours; but a longer or shorter period may be practiced, provided that the middle of the period of distillation, or thereabout, of one retort shall be the time when the other reciprocating retort shall be charged and the course of the gas be reversed, and the products of the fresh charge, together with the oil and steam feed, be turned into the retort whose charge is red hot and partially distilled.

The forcible jets of steam, shooting first in one direction and then in the opposite direction from the steam-nozzles H I in F and from J K in G, perform four different functions. They keep the pipes F and G clean by preventing in them the deposition or accumulation of tar or hard carbon. They make an exhauster to draw out the tarry and aqueous vapors and gases from the retorts when freshly charged and inject them into the reciprocating retorts, and they act as carriers and force-pumps to push and disperse the oils, vapors, and gases through these last retorts, and discharge the gas finally from them. They furnish, by decomposition, large volumes of gas to combine with the richer carbonaceous vapors and gases, and to increase the production of good illuminating-gas.

Having shown the objects of my invention and one method of accomplishing them, and having described its construction and operation in a full, clear, and exact manner, what I now claim, and desire to secure by Letters Patent, is as follows:

1. In a bench of gas-retorts, A, the retorts B C and D E, connected together in reciprocating pairs by the cross-pipes F and G, placed on their front ends, which project outside of the furnace, and which pipes are provided with valves Z and D′, steam-connections L M N O, and nozzles H I and J K, and pipes T′ U′ V′ W′ for feeding oil, naphtha, or similar fluid matter into them, the said retorts having their stand-pipes placed on their rear ends, substantially in the manner and for the purposes shown and described.

2. The nozzles H I and J K, in combination with the pipes F and G and the retorts B C and D E, substantially in the manner and for the purposes indicated and described.

3. The reciprocating retorts, in combination with connecting-pipes, having steam-nozzles at each end and opening toward each other, for injecting steam alternately and in opposite directions, as vehicles to carry the products of a freshly-charged retort into a reciprocating one, the charge of which is red hot and partially or wholly distilled, substantially as described.

4. The steam-pipes L M, in combination with the superheaters P and Q and with the nozzles H I in the pipe F, and the branch steam-pipes N O, in combination with the nozzles J K in the pipe G, all provided with valves V W X Y, substantially in the manner and for the purposes described.

5. The oil-reservoir H′, provided with the pipe I for filling it, the float J for indicating the quantity of oil in it, the safety-pipe K′, and the attached feed-pipes L′ M′ N′ O′ and valves P′ Q′ R′ S′, constructed substantially in the manner and for the purposes indicated.

6. The stand-pipes C″ C″ C″ C″, in combination with and placed at the rear end of the retorts B C D E, and inclosed by the back wall of the furnace, which protects them from the direct action of the fire, and prevents the

more intense heat of the furnace from filling them up with solid carbon, as set forth.

7. The dip-pipes K″ L″ M″ N″, having a circle of holes, I″ I″ I″ I″, about one inch above their lower and open ends, in combination with the sealing-buckets K‴ L‴ M‴ N‴, which, when resting on the bottom of the hydraulic main U″, will project at their upper edges up to about the level of the series of holes in the dip-pipes, and which are provided with attached rods O″ O″ O″ O″ and levers P″ Q″ R″ S″ and fulcrums T″ T″ T″ T″, to raise and lower them at pleasure, and to reverse the gas from one reciprocating retort to the other, all constructed substantially in the manner and for the purposes set forth.

8. The hydraulic main U″ and dip-pipes K″ L″ M″ N″, in combination with a sealing-fluid, such as soft soap, an emulsion, or mucilage, or liquid gelatine, which, by virtue of its plastic and adhesive nature, has the characteristics of gas-tar in cleansing fresh-made gas, substantially as and for the purpose described.

9. The tubular cutters D″, provided with external teeth or spiral cutting-edges G″, and attached rods E″, having lugs on them, F″, to hold them up in the tops of the stand-pipes, when not in use, by resting on the tops of their flanges, through which they are passed by means of oblong holes, in combination with the stand-pipes C″, substantially in the manner and for the purpose set forth.

10. The combination of the steam-pipes J″ with the saddle-pipes H″, for the purpose of injecting them into jets of steam to clean them, substantially as shown and described.

11. The process of manufacturing illuminating-gas, which consists in passing the tarry and aqueous vapors and gases distilled from a fresh charge of coal, wood, peat, turf, or other similar materials undergoing destructive distillation in one retort, in conjunction with oil, petroleum, naphtha, or any suitable oleaginous matter, together with steam, (preferably superheated,) as an injecting, carrying, and gas-yielding agent, into a reciprocating retort charged with red-hot coke or partially-distilled coal, wood, peat, turf, or other suitable substance, to be decomposed conjunctively in the same into fixed gas, and continuing this operation until the said fresh charge is partially distilled, and then shutting off the oil and steam feed, and drawing the spent charge from this retort and charging it with a fresh charge of coal, wood, peat, turf, or other similar material, and reversing the course of the gas and turning it from the retort last charged with its tarry and aqueous vapors and gases, in conjunction with a stream of oil, petroleum, naphtha, or any other oleaginous matter, together with steam, as an injecting, carrying, and gas-yielding agent, into the other reciprocating retort, whose charge is now red hot and partially distilled, to be decomposed together in the same into fixed gas, and continuing this operation until the last fresh charge is partially distilled, and then shutting off the oil and steam feed, and drawing and charging this last retort again, and reversing the gas, as before, and turning its tarry and aqueous vapors and gases, with the oil and steam feed, into the other retort, and so continuing this alternating process, thus generating, mixing, and combining the gaseous elements of coal, petroleum, and water in the same retort in a nascent state, and during the usual period of distillation, into a fixed gas of high illuminating power.

HENRY W. ADAMS.

Witnesses:
A. E. BEACH,
C. SEDGWICK.