No. 781,380. PATENTED JAN. 31, 1905.

J. C. H. STUT.

PROCESS OF MANUFACTURING ILLUMINATING GAS.

APPLICATION FILED OCT. 13, 1903.

3 SHEETS—SHEET 1.

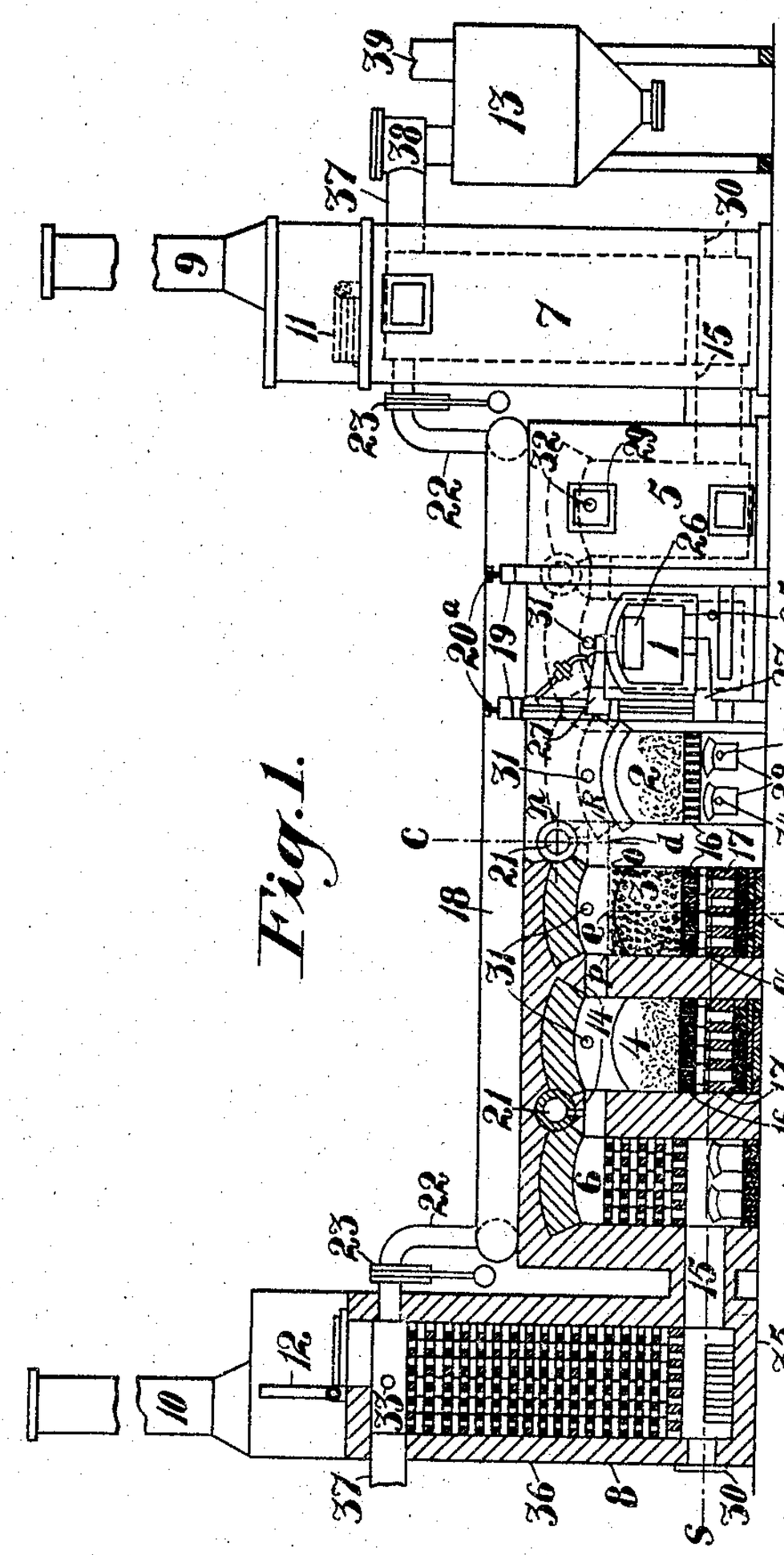

Fig. 1.

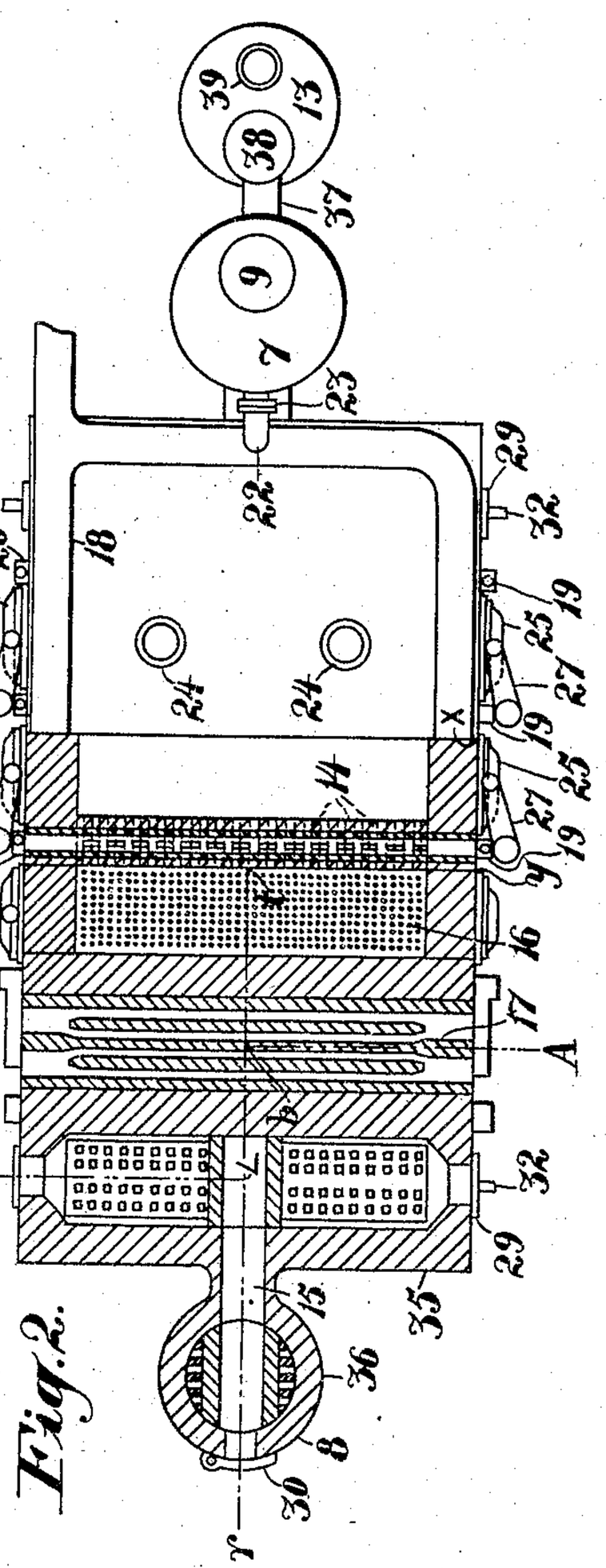

Fig. 2.

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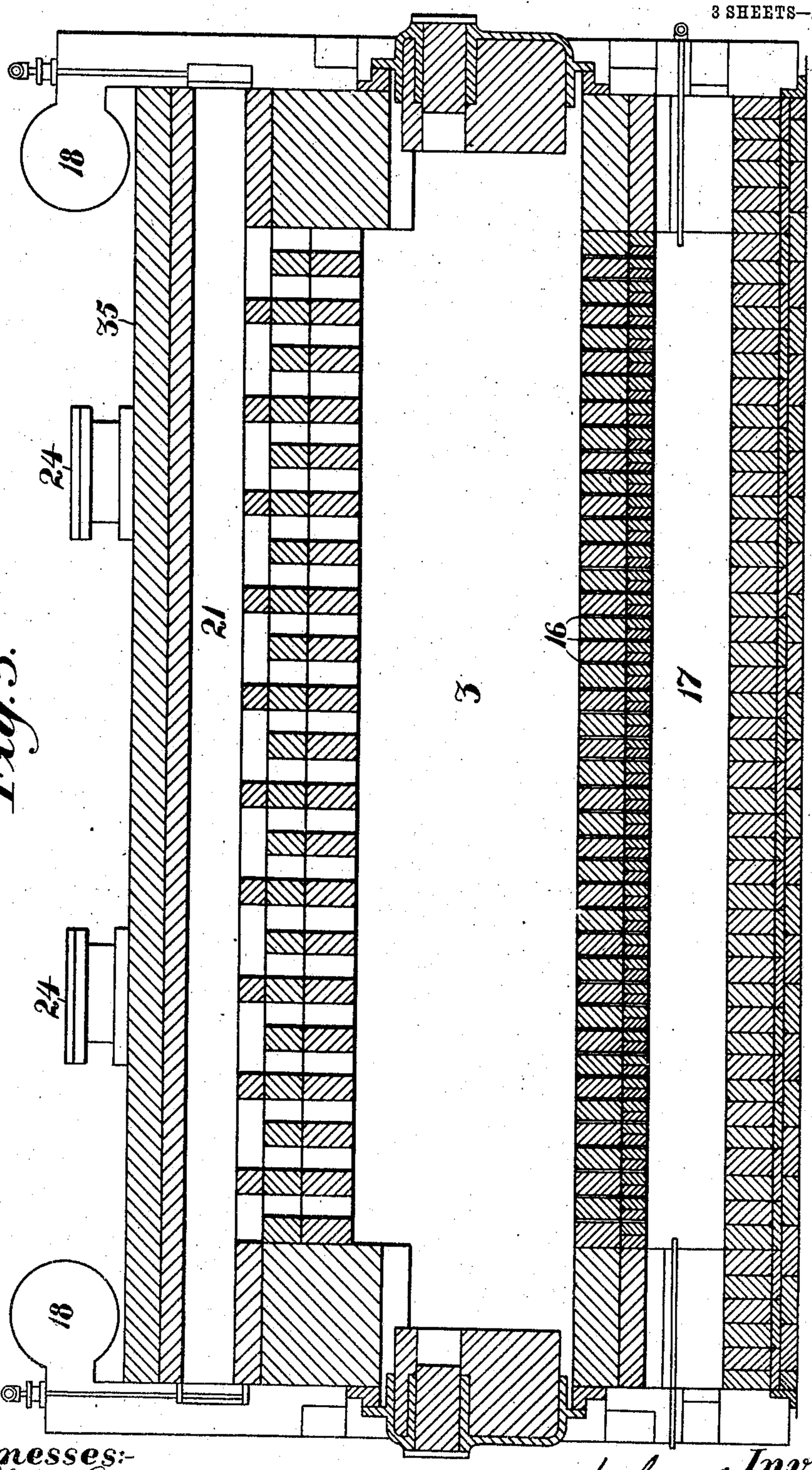
3 SHEETS—SHEET 2.

Fig. 3.



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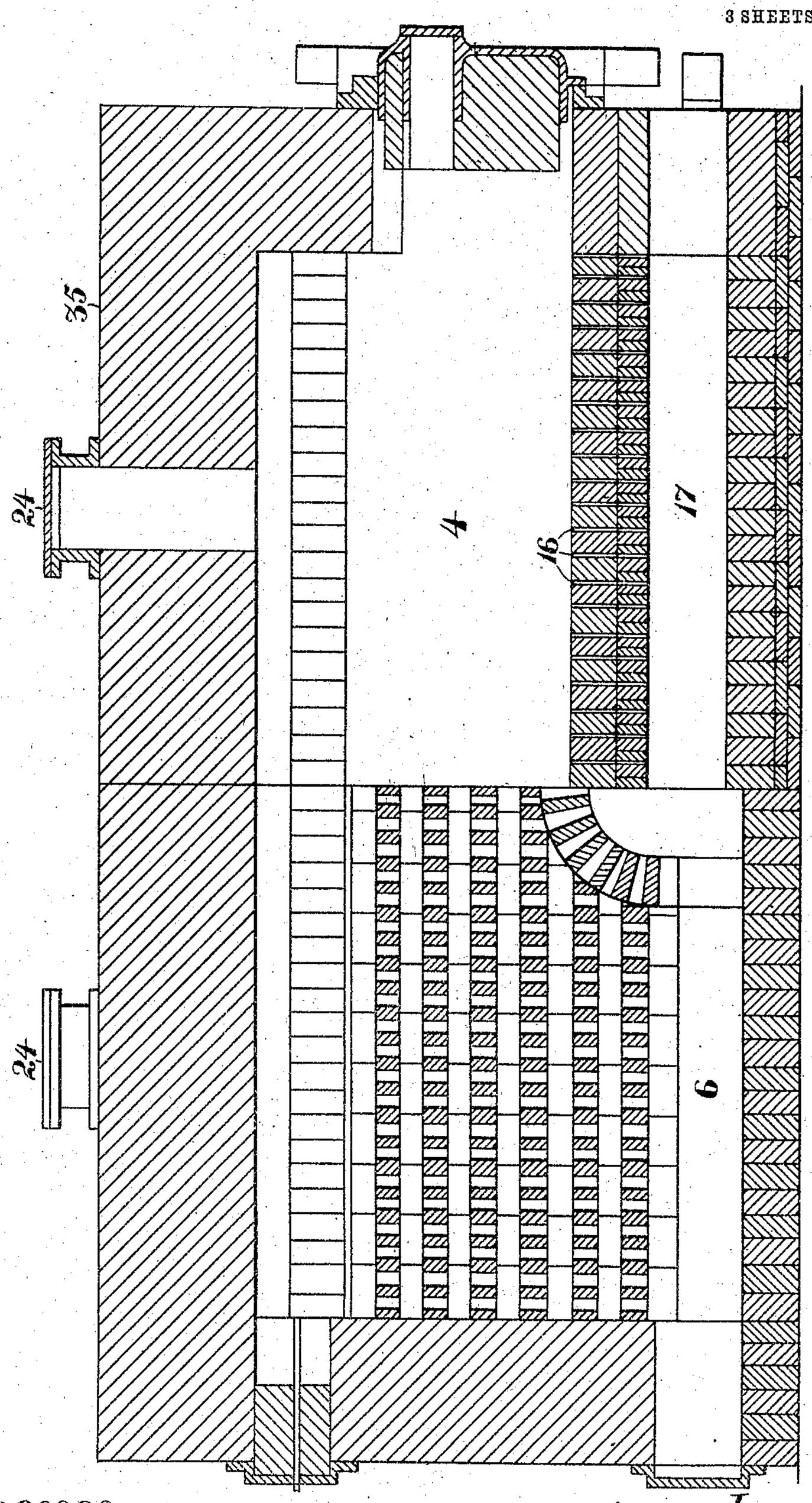
3 SHEETS—SHEET 3.

Fig. 4.



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No. 781,380. Patented January 31, 1905.

UNITED STATES PATENT OFFICE.

JOHN C. H. STUT, OF OAKLAND, CALIFORNIA.

PROCESS OF MANUFACTURING ILLUMINATING-GAS.

SPECIFICATION forming part of Letters Patent No. 781,380, dated January 31, 1905.

Application filed October 13, 1903. Serial No. 176,815.

To all whom it may concern:

Be it known that I, JOHN C. H. STUT, a citizen of the United States, residing at Oakland, in the county of Alameda and State of California, have invented new and useful Improvements in Processes of Manufacturing Illuminating-Gas, of which the following is a specification.

My invention relates to an improved process for manufacturing illuminating-gas.

The object of the present invention is to devise a system of heating the ovens and manipulating the fuel-supply so as to get the fullest efficiency from the ovens and to produce in one apparatus and in practically the same period of time an economical and high-power illuminating-gas from coal, oil, and steam. This object is obtainable by an apparatus wherein there is added to the general structure previously indicated means for introducing air or steam, also from the bottom of the furnaces, whereby it may pass upwardly through the body of incandescent coal, and by observing certain conditions in the attention of the ovens and the government of the air, steam, and fuel supply, as will be more fully explained hereinafter, having reference to the accompanying drawings, in which—

Figure 1 is a view showing a partial side elevation and exterior view, a partial section on line *x y* of Fig. 2, and partial section on line *t b l r* of Fig. 2. Fig. 2 is a view showing a plan of the left portion, a section adjacent thereto on lines R *n o p* of Fig. 1, and the remainder on lines *q s* of Fig. 1. Fig. 3 is a transverse section on lines *f e d c* of Fig. 1. Fig. 4 is a horizontal section, one portion being taken on line A *b* and the remainder to the right of section *l m* of Fig. 2.

For the purpose of illustration I have shown here a series of four ovens, (marked 1, 2, 3, and 4,) though it is obvious this number may be varied in practice, if desired.

5 and 6 are the carbureters or superheaters, located at each side of the oven series, and 7 and 8 are regenerators located beyond the carbureters at each end and surmounted by respective stacks 9 10, having the respective dampers 11 12.

13 represents a washer, of which there is one at each end of the apparatus, although but one is here shown.

In the present case the ovens, carbureters, and regenerators are shown arranged side by side and the ovens separated from each other by walls of fire-brick. The upper parts of the ovens and carbureters are connected by passages 14, and the bottoms of the carbureters and regenerators are connected by passage 15. In the present invention the ovens are provided with hearths, perforated as at 16, up through which air or steam may pass from each end of the flues 17, which extend lengthwise of each oven.

18 is a main air-supply pipe extending over the top and outside of the ovens, from which air may be supplied to the ovens both above and below the fuel by means of the branch pipes 19 20, which open, respectively, into the flued passages 21 above and between the ovens and into the ends of the flues 17. The pipes 19 20 are provided with suitable controlling-valves, (indicated at 20ª.) The regenerators have also branch air-pipes 22 leading from the air-main 18, and the passage of air through them is controlled by valves 23. Coal fuel may be admitted to the ovens as needed through the top doors 24.

The ends of the ovens are closed by the main doors 25, provided with the smaller doors 26 to allow the operator to have access to spread a fresh charge of coal over the ovens. The main doors are hung on swinging arms 27, as shown. Below the hearths are the doors 28, which allow for the cleaning of the space beneath the hearths. The carbureters and regenerators are provided with respective doors 29 and 30. The carbureters and regenerators have formed within them a checker-work of brick or the like, so laid as to form tortuous passages through which the gases from the ovens and the air admitted from pipes 22 are caused to pass. Oil may be sprayed into the ovens upon the incandescent body of coal through pipes 31. 32 represents similar oil-inlets opening into the upper part of the carbureters. Steam may be admitted alternately to the top of the regenerators through pipes 33, passing down through the checker-work in one regenerator, up through the checker-

work in the corresponding carbureter, and thence traversing the oven-space to mingle with the evolving gases from the fuel. In the present device steam is also adapted to be admitted below each oven, as at 34, and to pass through the body of solid incandescent carbon above.

37 is the main gas-pipe leading from each regenerator to its respective washer and having a controlling-valve 38, while 39 is the outlet from the washer.

The ovens, carbureters, and regenerators are inclosed in gas and air tight iron castings, as shown at 35 and 36. These castings are well riveted together and made air-tight, braced by backstays and tie-rods in any suitable manner to resist the expansion and contraction due to the heat of the ovens. The latter are made of the very best of fire-brick.

The manufacture of gas by this apparatus contemplates two periods: first, the heating period, and, second, the gas-making period. For the heating period coal or other fuel is fed as required into the charging-holes 24. The covers of these holes are then closed. Supposing the operation be from left to right, damper 11 in stack 9 at the right will be closed and damper 12 at the left opened. Valves 38 in gas-pipes 37 and also air-valve 23 in pipe 22 at the right will be closed; but air-valve 23 at the right will be opened, as likewise will be upper valves 20^a, and if it is desired to heat up the ovens quickly lower valves 20^a will be opened, although under those ovens in which coke is to be produced no air will be admitted. It is in these coke-containing ovens that water-gas is to be made later. Air under pressure or by induced draft is introduced from the main supply-pipe 18. By "induced draft" is meant a draft which either results from high chimneys or from an exhauster that will draw the gases of combustion from the ovens by the production of a partial vacuum therein, whereas a forced draft produces a pressure within the ovens in excess of the atmospheric pressure. From the fuel the gases are now evolved, and these combine with the oxygen of the air-making gases of combustion or waste gases. The gases of combustion pass through the openings 14 from oven to oven to the top of the carbureters 6 at the left, thence passing down through the brick checker-work of this carbureter through the flue 15 into the bottom of the regenerator 8, and up through its checker-work and through the open stack-valve 12 into the smoke-stack, and thence to the atmosphere. During this time the air-valve 23 in the pipe 22 of the left-hand regenerator will remain closed; but the air-valve 23 for the right-hand regenerator has been opened. The air then introduced into the right-hand regenerator will become highly heated in passing through the hot checker-work and will burn off most of the lampblack or fine carbon that has been deposited from the previous run of gas working from right to left. During this period of heating the heat from those ovens through which air is admitted from below will be transmitted through the walls intermediate between said ovens and the contiguous coking-ovens upon each side. This produces a greater heat and also a heat upon each side as well as upon the top of the fuel, and the period necessary for coking is thus greatly reduced. Every advantage is taken of this heat radiation, as will be seen later. It will be understood that the heating-fuel may be either gaseous, liquid, or solid, and the coking material may either consist of the solid fuel, as coal, or the heavy crude petroleum-oil or residue therefrom, which also makes an excellent coke. As shown in the present drawings, the ovens 2 and 4 contain coke and the oven 1 is designed for the burning of oil or gas, while the oven 3 is filled with green coal above the fuel-level of ovens 2 and 4, so that the single apparatus may illustrate each part of the operation. It will be understood that the coal which was originally introduced into all the ovens through their openings 24 has been reduced to an incandescent mass. The fresh coal now introduced into oven 3 will give off coal-gas on account of the heat retained in the hot coal beneath and in the hot brick walls on each side and reflected from the brick arch above. The oil and air supply in oven 1 has been so regulated that coke from the residue of the oil has also been formed on the body of coke from the coal in that oven. The ovens and the materials in the ovens are now in a state to make gas, and this brings us to the gas-making period. All the air-valves to the ovens above and below and to the carbureters and regenerators and stack-valve 12 are closed and the gas-valve 37 on the right is opened. The oil-valves 31 in all the ovens will be regulated in such a way to produce the proper amount of oil-gas. The steam-valve 33 on the top of the regenerator 7 is opened and also the steam-valves under the hearths of ovens 1, 2, and 4. By opening these latter valves the steam is admitted and caused to pass through a large body of white-hot coal, coke, or other fuel, and the steam is here decomposed, so that what is termed "water-gas" is formed. A large amount of coal-gas is now evolving from oven 3 and some coal-gas from ovens 2 and 4. Any proportion of water-gas to the coal-gas can be made by regulating the amount of steam introduced through the lower part of the ovens and the depth of the hot coal above the hearth. While a small quantity of water-gas may be produced by the steam from pipes 33 coming in at the top of the regenerators and striking the hot carbon or lampblack deposited on the checker-work and passing thence over the hot ovens, still by far the main portion of water-gas is formed by the steam from pipes 34 coming from below and passing up

through the body of incandescent fuel. By introducing steam above and below the fuel in the ovens it is brought into intimate contact with all the fuel both in a gaseous and in a solid state, so that the oxygen of the steam has ample opportunity to become united with the carbon, forming thereby carbon monoxid and hydrogen or so-called "water-gas," which mixes with the other gases produced and thence passing through the highly-heated carbureters and regenerators to become fixed. As the coal and water gases rise from the ovens and pass through the openings between the ovens they may be brought into contact with oil, which is introduced over the fuel in the ovens and, if necessary, also into the carbureters. This oil also is vaporized and by its contact with the hot coal in the ovens and the passage through the hot brick checker-work in the carbureter and the regenerator the gas is fixed and rendered permanent with the other gases. The oil introduced into the carbureters is for the purpose of enriching the mixture generated in the ovens. Some lampblack or fine carbon will always be deposited from the heavier oils, and to save this deposit of carbon and also to retain the greater portion of heat that is in the illuminating-gases and in the gases of combustion formed during the heating period the regenerators are made very high and with a large amount of brick checker-work in them. This provides a large body to retain the heat and a large surface for the deposit of carbon. When the gases have passed up and through the regenerators, they discharge through the gas-valve at 38 and into the washer 11, as previously stated, and from the washers to the scrubbers, purifiers, &c., in the same manner as in other gas-works. After a certain period of operation in one direction the ovens will cool down somewhat and as soon as this occurs the gas-making will cease. At this point the heating of the ovens must be again effected, but this time the heating will take place from the opposite end, or, as at present described, from right to left, because the carbon and heat deposits are now located in the right-hand regenerator. This heating process is carried on in exactly the same manner as previously described, when the operation takes place from right to left, and it is therefore not necessary to repeat it here.

By means of the apparatus herein described I am enabled to perform several different operations with practically no change further than to observe certain conditions of fuel, air, and steam feed. Thus I may manufacture gas from coal, oil, and steam, or, secondly, I may make coke and gas from coal, oil, and steam, or, thirdly, I may make coke and water-gas from steam and crude oil, or, fourth, gas may be made from crude oil and steam without the production of coke. These results may be effected as follows:

First, and to which the present invention pertains particularly, if an operation is to be carried on for making a mixture of coal-gas, oil-gas, and water-gas only the oven 3 will contain some hot coal. On the top of this coal fresh green coal will be introduced, and this coal will give off coal-gas in the manner hereinbefore described. Of course it is understood that the air above and below has been shut off to all the ovens. Steam will be admitted over all of the ovens from pipe 33 of one or the other of the regenerators. Oven 4 will be already full of the incandescent coal, and underneath this coal steam will be introduced. This steam passing through the thick layer of hot carbon will liberate water-gas, as previously described, and crude oil being introduced on the top of this hot carbon the oil will make oil-gas. The three gases—*i. e.*, the oil-gas and water-gas of oven 4 and the coal-gas of oven 3—thus produce, combine, and passing over the hot brick checker-work in the carbureter 6 and the regenerator 8 will become a fixed gas. After a period the gas-making will cease. Reheating is then necessary, which is done in the manner hereinbefore described, whereupon a charge of fresh coal may be introduced into oven 4 to fill it up to the level of oven 3 at the beginning of the operation. During the previous gas-making period the coal in the oven 4 has been gradually consumed until the top will stand at about the same level as the hot coal in oven 3 stood at before the charge of green coal when the process commenced. The ovens once more being heated, oven 4 charged with green coal, and the air-valves closed the operation in the ovens is reversed, and steam may now be introduced under the hot coal of the oven 3 and water-gas will be produced in this oven and coal-gas will be produced from the oven 4, the oil being introduced at this stage into the oven 3, as was previously described for 4. It will thus be seen that any two ovens can be used in such a manner as to alternately make coal-gas, water-gas, and oil-gas and produce no coke, for all the carbon is consumed in the gas-making and heating process. It is evident, should it be so desired, to use also any of the ovens 2, 3, or 4 for oil or gas alone besides oven 1. It will also be evident that any proportion of the different gases can be made very easily in this one apparatus from the materials used and in a very short time. For instance, should it become desirable to have the largest percentage of coal-gas in this gas then nearly all the ovens can be so regulated with their coal-supply that a large amount of green coal is introduced just before the gas-making period, the result being a large percentage of coal-gas; or should it become desirable to have the percentage of oil-gas very large then the coal-supply is reduced in each oven and the oil-supply correspondingly increased, the re-

sult being a large percentage of oil-gas; or should it become necessary to have a large amount of water-gas then the amount of steam introduced under the incandescent coke from either crude oil or coal can be so regulated as to produce a large percentage of water-gas, and so any proportion of gas as desired can be manufactured by this process and in the one apparatus.

Second: With the ovens 3 and 4 in the condition first described—that is, the oven 4 having a small quantity of coal and the oven 3 being full of green coal—coke may be produced in the oven 4 and a mixture of coal-gas, oil-gas, and water-gas produced as follows: During the heating period the valves for the admission of air or steam under the hearth of oven 4 will be closed; but air will be admitted over all the ovens, but only under the coal in oven 3, to give a quick and strong heat. This heat will be transmitted through the wall between ovens 3 and 4, thus adding the heat through the sides of the body of coke in addition to that which is applied from above during the operation, and this very materially reduces the time necessary to produce coke. After the body of coal in oven 3 has been heated to the desired point of incandescence and air under and over both ovens cut off to discontinue combustion steam will be introduced under the oven 3 and water-gas will be made in this oven, while the oil will be delivered upon the top of the coal of the same oven to produce oil-gas. The coking of the coal in oven 4 throws off coal-gas, and these three gases become fixed in the carbureter and the regenerator, wherein the surplus carbon and heat will also be deposited. If it is desired to produce any oil-gas in addition to that which may be produced as heretofore described, it may be effected by introducing oil into either of the carbureters as required. It will thus be seen that any two alternate ovens can be used to make any proportion of the three gases and a good hard coke, because every alternate oven being charged with the highly-heated coal will produce a large amount of heat to be transmitted through and over the walls for the coking of the coal in the adjacent oven. Just as ovens 3 and 4 are used alternately to make oil-gas and water-gas in one and coal-gas in the other, so may pairs of ovens be operated—that is, ovens 3 and 1 and 4 2 may change off periodically, first one pair making water-gas and oil-gas and simultaneously the other pair making coal-gas and then reversing the order in the next gas-making period. Although oven 1 is shown and mentioned as adapted to oil fuel as well as coal, that does not affect its operation in any way, since coke is formed therein, and in order to make coal-gas it is only necessary to introduce green coal on this bed of incandescent coke, close the air-valves and stack-valve, and open the gas-valves.

Third. If the oven 4 has a small amount of solid fuel, preferably coal, which has been reduced during the previous heating period to a state of incandescence, oil may be introduced upon the top of this coal through the openings 31 at either end of the oven. This oil will liberate oil-gas, and the residue will be deposited on and percolate into the fuel, and when the coking is to take place this will form the very best hard coke. The quantity of oil residue in oven 4 that may be transformed into coke during the gas-making period depends on the regulation of the infeed of oil relative to the size of the oven and the amount of the incandescent coal-body. As long as this latter remains sufficiently hot the residue will be changed into coke. Any residue remaining uncoked at the end of the gas-making period will be coked during the subsequent heating period similarly as coal. Oven 3 having some hot coal, oil may also be introduced upon the top of this coal; but steam will also be introduced under the hearth, and water-gas and oil-gas will be formed in this oven. These gases from oven 3 mix with the oil-gas arising from oven 4 and are all transmitted to the carbureter 6 and the regenerator 8 to be fixed, as hereinbefore described, thus making water-gas and oil-gas and producing coke in the alternate oven.

The operation of making water-gas and oil-gas alone from crude oil will be carried on as just described for the third method except that all the coke formed in oven 4 from the deposition of the oil residuum will be consumed in the making of the water-gas, in which case the oil-supply will be regulated so as not to flood the oven or otherwise prevent the conversion of all the oil residuum into coke while the oven is still hot enough for water-gas-making purposes.

In all these operations where coke is to be made in some ovens and not in others I avail myself not only of the reverberated heat from the coking-ovens, but in addition thereto I use the heat that is diffused through the walls of the non-coking ovens in which an intenser heat is generated by reason of the upward draft through the fuel. The coking process is thereby greatly expedited. Since in all these operations some of the ovens are thus actively engaged both in generating gas and producing fresh heat simultaneously, the actual gas-making period of the whole apparatus is prolonged over what it would be were no air admissible at the bottom of the ovens. Consequently it is that an increased gas-making capacity is claimed for the apparatus in addition to its advantages of gas-supply control previously specified. It is to be noted that during the "heating period" air is introduced over the fuel in all the ovens, so that heat can be produced by the consumption of the gases arising from the fuel; but air is only introduced underneath those ovens that are not used

for coking purposes. During the gas-making period steam is introduced from the top of the regenerator over all the fuel in all the ovens, whereas steam is only introduced underneath those ovens that are not used for coking purposes. Thus, for example, in operation No. 3 during the heating period air was introduced over all the ovens, but only under oven 3 or ovens 3 and 1, since in oven 4 or ovens 4 and 2 coke was to be produced. During the gas-making steam was introduced under the hearth of oven 3 or ovens 3 and 1 to produce water-gas and oil-gas, but not under oven 4 or ovens 4 and 2, as the case might be where the entire battery was in operation.

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

1. The process herein described for the manufacture of coal-gas, oil-gas, and water-gas, said process consisting in charging a series of contiguous connected ovens with coal, admitting air over all the ovens and simultaneously admitting a limited quantity of air beneath the fuel, recharging some of the ovens with green coal, then shutting off the air, depositing oil upon the surface of highly-heated coal of the other ovens, and passing steam through the fuel in the latter ovens from below to form water-gas which commingled at the top with the coal-gas and oil-gas evolving from the several ovens.

2. The process of manufacturing gas consisting in first heating a body of coal contained in an oven, to incandescence, heating a body of coking-coal contained in a contiguous oven until coal-gas is evolved therefrom, then passing steam through the incandescent coal in the first-named oven, delivering a regulated amount of crude oil upon the surface of the incandescent coal to evolve a gas which unites with the water-gas arising through the body, and passing said mixed gases over the body of coking-coal in the first-named oven, from which coal-gas is being evolved whereby the three are mixed.

3. The process of manufacturing gas consisting in first raising a body of coal to incandescence within a containing-oven, delivering a regulated supply of crude oil upon the surface of said coal, passing steam from below up through said coal to produce water-gas, heating a body of coking-coal within a contiguous oven whereby coal-gas is evolved, uniting the oil and water gases with said coal-gas and passing the mixed gases through the previously-heated fixing-chamber.

4. The process of manufacturing gas from coal, oil and steam, said process consisting in alternately evolving coal-gas from masses of coal and coking-coal contained in contiguous ovens and alternately evolving water-gas and oil-gas from the other of said ovens, uniting said gases by alternately passing the water and oil gases from left to right, and from right to left over the coking-oven, and thence passing said mixed gases through fixing-chambers and alternately connecting the resulting fixed gases from opposite ends.

5. The process herein described of producing coal-gas, water-gas, and oil-gas, and in controlling the proportions of said gases in a mixture, said process consisting in raising a body of coal to incandescence, then supplying a regulated quantity of oil upon the top of said body of coal to produce oil-gas and a coke residuum, delivering a regulated quantity of steam below to pass up through said body of coal and coke to form water-gas which mixes with the oil-gas evolved at the surface, and forming coal-gas from a second body of coking-coal contained in a contiguous chamber and uniting the gases thus formed through connecting-passages and afterward conducting the mixed gases to a fixing-chamber.

6. The process of manufacturing coal-gas, oil-gas, and water-gas, and proportioning the three, consisting in reducing the coal charge in the several ovens to an incandescent state, adding green coal to certain of said ovens, introducing oil upon the incandescent surface of the intervening ovens and passing steam from below through the body of fuel in the oil-supplied ovens to form water-gas which intermingles at the top with the oil-gas and coal-gas there produced, and suitably regulating the steam so admitted.

7. The process herein described of manufacturing gas consisting in reducing the coal charge in the ovens to incandescence, and admitting steam from below through the fuel alternately as to some of the ovens, and injecting oil into those ovens into which no steam is being admitted.

8. The process of manufacturing illuminating-gas consisting in heating bodies of coal to incandescence in a plurality of contiguous connected ovens by passing air simultaneously over and through the fuel, shutting off the air, charging alternate ovens with green coal above the fuel-level of the intervening ovens, admitting oil and steam to the latter and mixing and fixing the gases evolved from the several ovens, reheating the ovens and using the former green-coal-charged ovens to make oil-gas and water-gas and making coal-gas in the other ovens.

9. The process of manufacturing gas consisting in heating bodies of coal to incandescence in a series of contiguous connected ovens, charging alternate ovens above the fuel-level of the others whereby the radiated heat of the charged ovens acts to maintain the heat in the intervening ovens, passing steam up through the said intervening ovens, and during successive gas-making periods alternating in the operation of said ovens so that the ovens which had a relatively higher fuel-level during one period will have a lower fuel-level relative to the other ovens during the next

period, and generating oil-gas and mixing it with the evolving coal-gas and water-gas.

10. The process of manufacturing illuminating-gas consisting in heating bodies of coal to incandescence in contiguous connected ovens, admitting air over all the ovens and simultaneously admitting air up through some of the ovens only, shutting off the air, and passing steam up through those ovens only through which air had been previously passed, and enriching the evolved coal and water-gases with oil-gas.

11. The process of manufacturing illuminating-gas, consisting in heating bodies of coal in two adjacent connected ovens to incandescence, charging one of said ovens with green coal above the fuel-level of the other oven, admitting steam beneath the latter oven to make water-gas, generating oil-gas, and mixing and fixing in the one apparatus the several gases.

12. The process of manufacturing illuminating-gas consisting in heating bodies of coal in contiguous connected ovens to incandescence, adding green coal to the incandescent body of one oven, admitting oil upon the incandescent body of the other oven and simultaneously passing steam up through the incandescent body of the latter oven, and mixing and fixing in the generating apparatus the evolved gases of the several ovens.

13. The process of manufacturing illuminating gas, consisting in producing incandescent carbonaceous bodies in contiguous connected ovens, adding green coal to one of said ovens whereby coal-gas is evolved, and admitting steam and oil to the other oven whereby oil-gas and water-gas are evolved, and mixing and fixing the several gases before being discharged from the generative apparatus.

14. The process of manufacturing illuminating-gas, consisting in producing incandescent carbonaceous bodies in contiguous, connected ovens, adding green coal to one of said ovens whereby coal-gas is evolved, producing water-gas in the adjacent oven, injecting oil into the ovens to produce oil-gas, mixing and fixing the evolved gases from the several ovens, and replenishing when exhausted the incandescent carbonaceous bodies of the ovens and forming coal-gas in the previous water-gas-forming oven and water-gas in the previous coal-gas-forming oven.

15. The process of manufacturing illuminating-gas consisting in forming coal-gas in one of two connected contiguous ovens, and water-gas and oil-gas in the other of said ovens, and mixing and fixing the several gases, while in the generating apparatus.

16. The process of manufacturing illuminating-gas consisting in simultaneously forming coal-gas in one of two connected contiguous ovens and water-gas and oil-gas in the other of said ovens, and then forming water-gas and oil-gas in the former coal-gas oven and coal-gas in the oven in which water-gas and oil-gas were formed, mixing and fixing the several gases during each gas-making period in the generating apparatus.

17. The process of manufacturing illuminating-gas consisting in simultaneously forming coal-gas in one of two connected contiguous ovens and water-gas in the other, introducing oil to form oil-gas, and mixing and fixing said several gases in the one apparatus, and carbureting said gases.

In testimony whereof I have hereunto set my hand in presence of two subscribng witnessess.

JOHN C. H. STUT.

Witnesses:
FRANK L. OWEN,
CLAY P. GOODING.