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T. S. C. LOWE.

Improvement in Process and Apparatus for Making Gas.

No. 130,383. Patented Aug. 13, 1872.

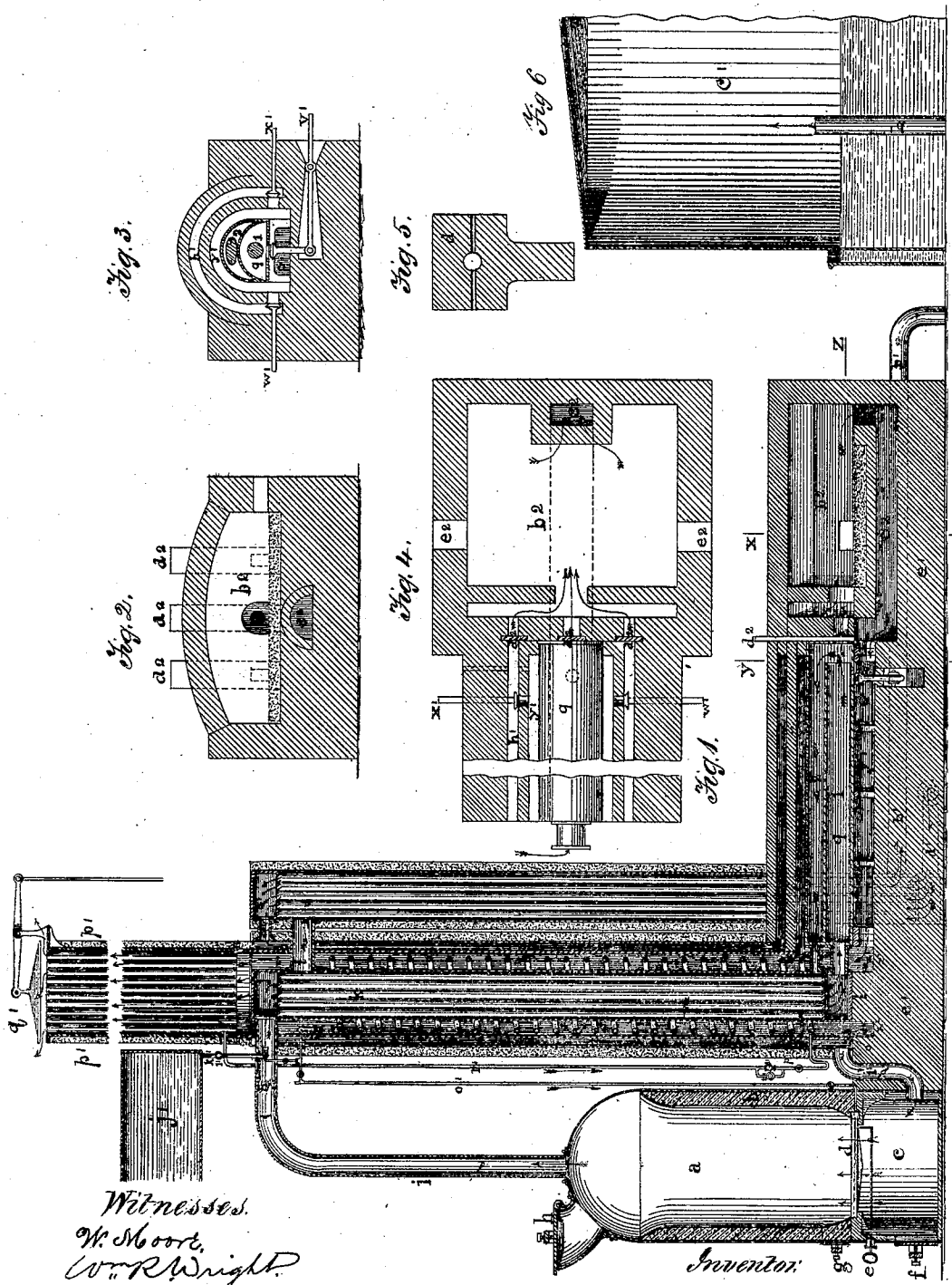

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Fig. 8.

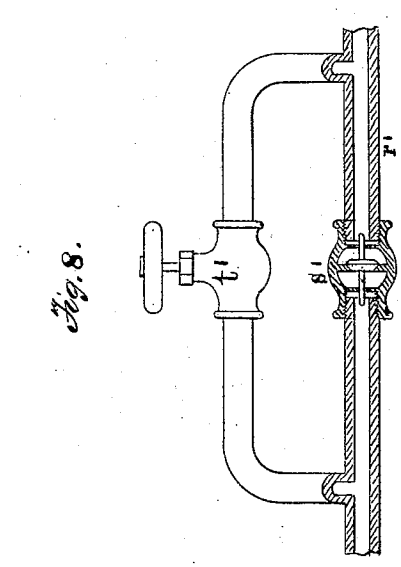

Fig. 7.

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THADDEUS S. C. LOWE, OF NORRISTOWN, PENNSYLVANIA.

IMPROVEMENT IN PROCESSES AND APPARATUS FOR MAKING GAS.

Specification forming part of Letters Patent No. **130,383**, dated August 13, 1872.

Specification describing a Process and an Apparatus for Making Gas, for use in reducing metals and for heating purposes, and for illumination, invented by THADDEUS S. C. LOWE, of Norristown, Montgomery county, Pennsylvania.

In the drawing, Figure 1 represents a vertical section of the complete apparatus; Fig. 2, a transverse vertical section of a reverberatory furnace taken on the line *x* of Fig. 1; Fig. 3, a transverse vertical section of the horizontal double retort, and the flues and valves for admitting hot air and gases for combustion, taken on the line *y* of Fig. 1; Fig. 4, a sectional plan of the retort and reverberatory furnace taken on the line *z* of Fig. 1; Fig. 5, a transverse vertical section, on an enlarged scale, of one of the grate-bars at the bottom of the primary generator *a;* Fig. 6, a vertical section of an ordinary gas-holder and of the pipes by which it is connected with gas-producers. Fig. 7, Plate 2, is a vertical section of the complete apparatus, omitting the generator *a* and the flue-damper *q'*. Fig. 8, Plate 2, is, in part, an elevation; and, in part, a longitudinal section, of the cock *t'* and self-acting safety-valve *s'*, on an enlarged scale.

a, Fig. 1, Plate 1, is a vertical retort or gas-generator, herein referred to as the primary generator, consisting of a case of cast-iron or other suitable material, *b*. *c* is an air-tight ash-pit, across the top of which I arrange a set of grate-bars, *d*, Figs. 1 and 5, which are hollow lengthwise and pierced by a number of small holes, laterally, as shown in Fig. 5. *e* is a rake, provided with teeth to pass up between the grate-bars for removing ashes and cinders. The ash-pit is provided with an ordinary air-tight door, *f*. *g* is an air-tight hand-hole, for the removal of cinders and such non-combustible matters as do not, on account of their size, pass down between the grate-bars. *h* is an air-tight door, through which coal or other carbonaceous materials are put into the generator *a*. *i* is a pipe or flue for conducting the gases and oleaginous vapors formed in the primary generator *a* into the chamber *j*, herein referred to as the union chamber. A series of vapor-converting tubes, marked *k*, are connected at their upper ends to the union-chamber *j*, and at their lower ends to chamber *l*. The vapor-converting tubes *k* are inclosed by a cylindrical iron casing, *m*. *n* is an iron pipe coiled around outside of casing *m*. *o* and *p* are cylinders of iron outside of coiled pipe *n*, and g^1 is an air-space of a few inches inclosed between said cylinders. *q*, Figs. 1, 3, 4, and 7, is a retort of fire-clay or other suitable refractory material, constructed with two compartments marked, respectively, 1 and 2, of which the compartment 1 is connected with chamber *l* by a tube, *r*, of iron or other suitable material, and the chamber 2 is connected by a tube, *s*, with the space around tubes *k*, inclosed in the iron casing *m*. *t* is an iron tube connecting the space last referred to with the space surrounding a series of vertical tubes, *u*, inclosed in the iron casing *v*. *w* and a^1 are two chambers at the bottom and top, respectively, of the tube *u*. b^1 is an iron tube connecting the space inclosed by casing *v* with the common gas-holder c^1, or to a furnace or other places of consumption. d^1 is an iron pipe, shown in dotted lines through the foundation masonry e^1. *f'* is an iron tube connecting the chamber a^1 with the air-space *g'*, which is between the cylinders *o* and *p*. *h'*, Figs. 1, 3, 4, and 7, is an air-passage, connected with the space *g'*. *i'* is an iron tube connecting the space *g'* with the ash-pit *c* of the primary gas-generator *a*. *j'* is a tank for petroleum, or other liquid hydrocarbons. *k'* is a pipe, provided with a stop-cock, *l'*, and leading down into gas-flue *i*. *m'* is a steam-pipe, proceeding from the steam-generating coil *n'*, and terminating in the nozzle of the pipe *k'*. *o'*, Fig. 1, is a branch steam-pipe connecting the steam-pipe *m'* with the hollow grate-bars *d*. *p'* is an ordinary tubular boiler or water-heater, set on top of casing *o* and provided with a damper, *q'*, Fig. 1, for regulating the draft. *r'* is an iron pipe, connecting the boiler or water-heater *p'* and the lower end of the steam-coil *n*. *s'*, Figs. 1, 7, and 8, is an ordinary puppet-valve, for allowing surplus water accumulated in the coil *n* to be driven back by the pressure of the steam in the coil into the boiler or water-heater *p'*. *t'* is a stop-cock to regulate the flow of water from the heater into the coil *n'*. *u'*, Figs. 1, 3, 4, and 7, is a gas-valve, operated by a lever, *v'*, or otherwise, as desired. *w'* and *x'*, Figs. 3, 4, and 7, are air-valves. *y'*, Figs. 1 and 7, is a flue for conducting off the waste products of

combustion into the chimney-space z', inclosed between casing m and cylinder o, which space z' connects with the flues or tubes in the water-heater p'. a^2 represents an exterior casing, filled with asbestus or other non-conductor of heat. This casing may be formed of bricks or other masonry. b^2, Figs. 1, 2, and 4, is a reverberatory furnace, of ordinary construction, having an arched flue, c^2, under its bed, and provided with sliding valves or dampers d^2 for regulating the admission of heated gases and air for combustion into the furnace b^2. e^2, Fig. 4, represents apertures through which metals and other substances to be heated are introduced into and removed from furnace b^2.

When it is desired to put the apparatus in operation for the production of gas, I introduce into the generator a bituminous coal, coal-dust, wood, sawdust, tan-bark, leather scraps, peat, straw, shavings, or other carbonaceous combustible substances, which are ignited at the bottom, where a limited amount of atmosphere is admitted, sufficient to keep up a slow combustion on the grate-bars. Gases and oleaginous vapors are generated and pass off through the flue i into the union chamber j, and down through a series of vapor-converting tubes, k, into the lower chamber l, and thence through the connecting-pipe r into the chamber 1 of retort q, which chamber may be filled with broken fire-bricks or other refractory or suitable substances, for the purpose of presenting a large heated surface to the gases passing through this chamber. The hot gases, after passing through the chamber 1, return through chamber 2 of the retort q, and are conveyed through the tube s into casing m, where they circulate around the tubes k and rise to the upper end of the tubes, and pass out through the tube t into casing v, where they circulate around tubes u and pass out at the lower end of casing v into tube b^1, and through it into the holder c^1, from which they can be drawn as required for all heating and lighting purposes.

For the purpose of creating heat under the retort q, a small portion of the gas produced as above described is allowed to escape through the valve w', where it mingles with a hot blast (the production of which will hereinafter be described,) and is ignited and the hot products of its combustion pass through the flue y' into the space z' between casings o and m, and heat these casings and the steam-coil n, and then pass up through the tubes into the boiler or water-heater p', heating the water contained in it and then escaping into the air nearly cold. I am thus enabled to utilize the heat contained in the waste products of combustion which arise from flue y'. To more thoroughly utilize this heat, I force atmospheric air into the tube or flue d^1 by a fan-blower or other suitable device, and thence into the chamber w and up through the tube u into the chamber a^1, through the tube f^1, into the space g', passing down which it becomes considerably heated, and it is afterward heated to a still greater degree during its passage through the space h', and in this condition a portion is drawn off through the valves w' and x' with the flue y' under the retort q, where it mingles with the gas admitted as above described through the valve u', supporting the combustion of the gas and creating an intense heat. Another portion of the heated air is allowed to pass from the space g' through the flue i' by opening the damper therein into the ash-pit c of the primary generator a, for the purpose of keeping up partial combustion in this generator. From the fact that the air is heated, less of it is required to keep up the heat and slow combustion in the generator a, and hence less nitrogen enters the generator. The fire-clay retort q having around a large part of its circumference a return-flue, 2, through which the greater portion of the gases pass while the gases are very hot, helps greatly in keeping up the heat in the lower chamber 1 of the retort, and after performing this duty it enters, still quite hot, the casing m of the tubes k, and, circulating and passing among these tubes, it makes them hot enough or nearly hot enough to convert the undecomposed particles of the vapors of water and carbon which are coming in from generator a into hydrogen and carbonic oxide; but in case any undecomposed particles escape through the tubes k, then the next retort, q, which is constructed to stand a much greater heat, completes the decomposition.

Thus it will readily be seen that the mixed vapors and gases composing the incoming fuel are not only converted into a permanent gas, and highly heated by the outgoing gases and waste products of combustion, but that all or nearly all of the heat contained in the waste products of combustion is absorbed or nearly absorbed by the incoming gases and air for supporting combustion, and that the heat is continuously returned to the furnace, where the greatest heat is required.

The gas generated in this way is employed with the greatest economy when used in furnaces as fast as generated, and while hot, and for this purpose I have shown a furnace, b^2, for heating, working, refining, and melting metals and for other purposes with sliding valves d^2, for admitting the heated air and gases, as represented in Figs. 1, 2, and 4. In this last-named furnace the gases and atmosphere admitted through the valves d^2 mingle and are ignited, and the flame sweeps across the hearth of the furnace and passes down and through the arched flue c^2 under the hearth and the retort q.

One or more of these furnaces may be used in connection with the gas-generating apparatus described, and when in operation the valves u, x, and w are closed, and no other heat than the hot products of combustion passing through the flue c^2 need be used under the retort q in the chimney-space z'.

Gases generated as above described, although combining all the elements of heat, have but little illuminating power, and for the purpose

of improving this, and for several other important purposes, I admit steam through the pipe m' and oil through the pipe k' simultaneously, both entering chamber j in the form of spray, and, passing down through tubes k, are converted into permanent gas on their passage through retort q, which is the hottest part of the apparatus.

When illuminating-gas is wanted I admit steam in limited amounts—that is to say, sufficient only when decomposed to properly dilute with hydrogen the rich hydrocarbon-gas from the oils—and when petroleum is used the resulting gases will require no purifying; and while making such gases I need not employ the generator a after the apparatus has become heated. But when the gas produced is to be used exclusively for heating purposes, I admit as much steam as the carbon, when sufficiently heated, will, in union with it, decompose, thereby obtaining the greatest amount of hydrogen and carbonic oxide obtainable from the elements employed. Coal-tar, asphaltum, and the cheapest kinds of oils may be used in generator a, not only for a quick supply of gas whenever the demand requires it, which is many cases is of the utmost importance, but for the purpose of enriching the gas generated from coal or whatever substance may be used in generator a, which latter gas must, from necessity, contain more or less non-combustible gases, one of these gases being nitrogen from which the oxygen has been burned in generator a. Besides, whenever these gases are enriched in this way, or the pure gases generated from oil and steam used alone, a much less quantity will be required to produce the same heat.

While using the generator a, some gases and considerable undecomposed vapor rapidly rise through the mass of material contained in the generator a, and are conveyed off through the flue i.

The hollow grate-bars d, upon which the material rests, are all connected at one end by the steam-pipe o'. Through this pipe dry steam is admitted in limited portions, and, issuing through the fine holes in the side of each bar, it is evenly distributed over the whole bottom of the generator a, and, passing up through the incandescent fuel, is, to a considerable extent, decomposed; the oxygen mingling with the carbon forming carbonic oxide and setting the hydrogen free, thereby greatly improving the quality of the combined gases. But for many reasons, to obtain the best results, it would not be desirable to admit as much steam through the grate-bars as the gases and vapors formed in the generator a would and should decompose. One of these reasons is, that to admit all the steam at the bottom of generator a which the carbon therein contained would decompose would extinguish the fire. I therefore admit only sufficient steam through the grate-bars to prevent the deposit of carbon in the generator a and admit the principal part of steam, and mingle the same with the hot gases and vapors at or near the point where the whole mass enters union-chamber j and tubes k, passing through which they are all converted into fixed or permanent gases, the same as described above in the case of oil and steam. This operation not only greatly increases the quantity, richness, and heating power of the gases, but prevents the deposit of tar, soot, and carbon, and the clogging of the flues and gas-passages.

I claim—

1. Introducing steam or hydrocarbons and steam into the gas and vapors from the primary generator, at a point between the primary generator and the converting-tubes, while the gas and vapors are on their way to the storage gasometer or the furnace, substantially as set forth.

2. Employing the heat contained in the gases after they have left the hottest part (retort q) of the apparatus, for the purpose of heating and decomposing the incoming vapors and gases on their way to said hottest part of the apparatus, substantially as set forth.

3. The combination and arrangement of the tubes u and air-spaces g' and h', for heating the air for combustion by the heat contained in the gases after they have left the converting-tubes k on their way to consumption or storage, substantially as set forth.

4. The combination of the elevated oil-tank j', steam-pipe m', union-chamber j, and the converting apparatus consisting of the tubes k and retort q, as and for the purpose described.

5. Using carbonaceous oils and steam separately or together, in conjunction with the generator a, or its equivalent, in the manner and for the purpose substantially as set forth.

6. The arrangement of a furnace, b^2, or of several such furnaces, in combination with the described apparatus for generating and converting the gases, so that the gases while highly heated can be used in the furnace, substantially as set forth.

7. The union-chamber j, in which the gases and vapors from the primary generator a, on their way to the converting apparatus, mix with the admitted steam and hydrocarbon vapors, substantially as set forth.

8. The gas and air valve-openings w', x', and u', in combination with the described converting apparatus, in the manner and for the purpose substantially as set forth.

9. The valves or dampers d^2, for admitting and regulating the amount of hot air and gas for use in the heating-furnace, substantially as set forth.

10. The return-flue y', for conveying the waste products of combustion for use in heating the converting apparatus, substantially as set forth.

11. The arrangement of boiler or water-heater as part of the chimney, so that the escaping waste products of combustion shall pass through the same to heat the contents thereof, substantially as set forth.

12. The combination of the steam-generating coil and water-supply pipe with the safety-valve and the elevated water-tank, substantially as set forth.

13. The gas and vapor generator *a*, flue *i* with its damper, steam-pipe *m*, oil-pipe *k'*, oil-tank *j'*, chamber *j*, tubes *k* with their casing *m*, chamber *l*, flue *r*, retort *q*, flue *t*, casing *v*, tube b^1, in combination with the air-flue d^1, chamber *w*, air-tubes *u*, chamber a^1, flue *f'*, air-spaces *g'* and *h'*, flue *i* with its damper, together constituting apparatus for the formation of gases, as set forth.

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