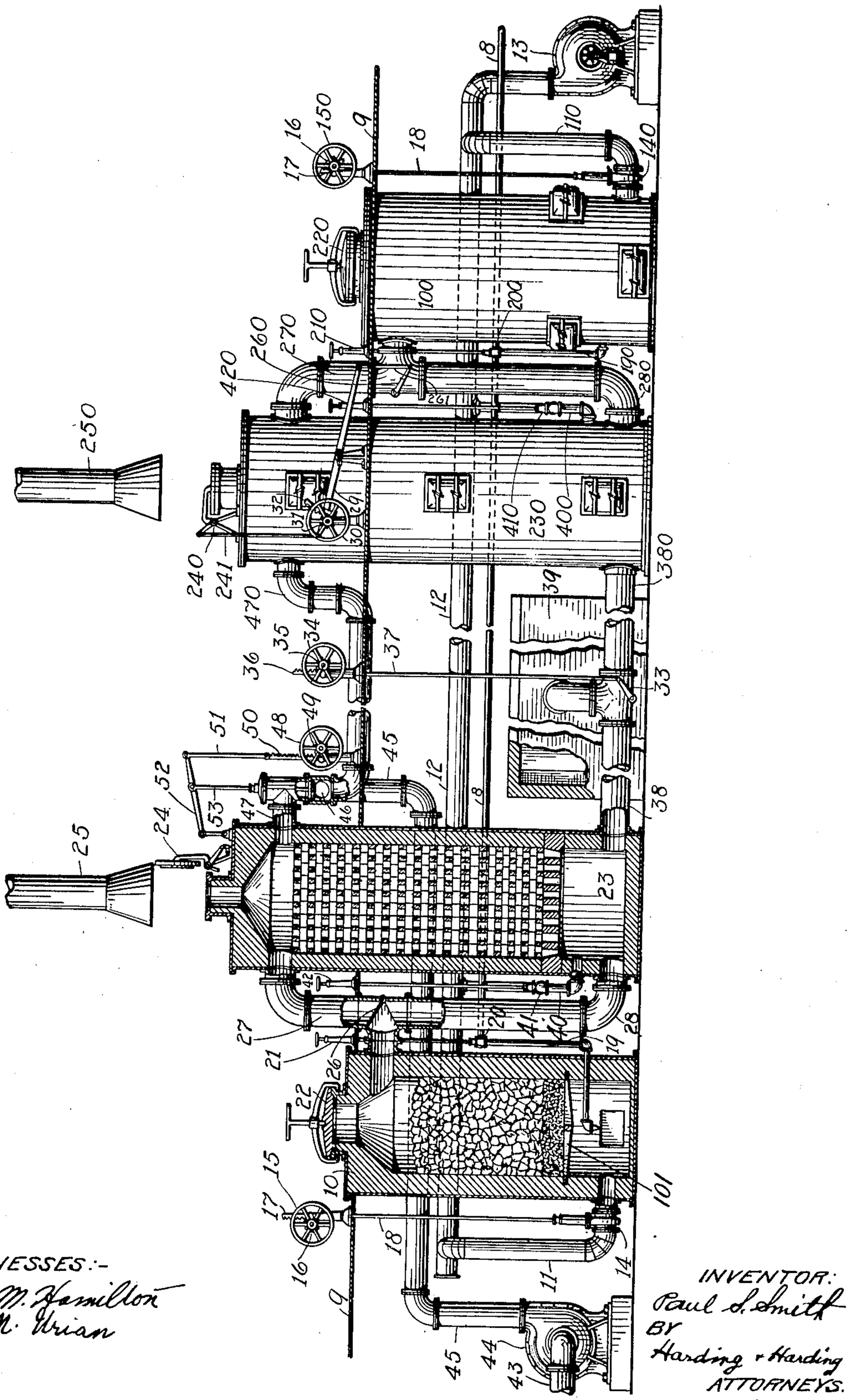
P. S. SMITH.

PROCESS OF RECOVERING SULFUR FROM SULFUR BEARING GASES.

APPLICATION FILED DEC. 3, 1907.

912,743.

Patented Feb. 16, 1909.



WITNESSES:-

M. M. Hamilton

A. M. Urian

INVENTOR:

Paul S. Smith

BY

Harding & Harding

ATTORNEYS.

UNITED STATES PATENT OFFICE.

PAUL S. SMITH, OF WILMINGTON, DELAWARE, ASSIGNOR TO THE E. I. DU PONT DE NEMOURS POWDER COMPANY OF WILMINGTON, DELAWARE, A CORPORATION OF NEW JERSEY.

PROCESS OF RECOVERING SULFUR FROM SULFUR-BEARING GASES.

No. 912,743 Specification of Letters Patent. Patented Feb. 16, 1909.

Application filed December 3, 1907. Serial No. 404,889.

To all whom it may concern:

Be it known that I, PAUL S. SMITH, a citizen of the United States, residing at Wilmington, county of Newcastle, and State of Delaware, have invented a new and useful Improvement in Processes of Recovering Sulfur from Sulfur-Bearing Gases, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, which form a part of this specification.

In a patent granted to me February 11, 1908, No. 878,569, I have set forth a process and apparatus for recovering sulfur from sulfur-dioxid in which producer gas and water gas is successively formed and the water gas mixed with the sulfur dioxid and the mixed gases heated by the combustion of the producer gas, thereby causing the mixed gases to react with evolution of sulfur vapor. In said process and apparatus the producer gas and water gas, alternately formed in the gas producer, are led respectively to storage tanks from which, as required, the two gases are separately led to the reducer. This process and apparatus are operative and comparatively efficient and economical, but the present invention has for its object to greatly enhance the efficiency and economy of the process by such modifications therein as will enable the producer gas and water gas to be manufactured continuously instead of alternately, and to be led, immediately upon their formation, to the reducer. In my prior application, while both water gas and producer gas are led continuously to the reducer, the storage of each gas, necessitated by the intermittent nature of its manufacture, causes a drop in its temperature, thus requiring an expenditure of a certain amount of energy to elevate it to its temperature of combustion or reaction. My present invention, by providing for the continuous manufacture of both gases, dispenses with the necessity of temporarily storing either and permits of both gases being led immediately to the reducer, thus enabling the process to be carried on with maximum efficiency and economy.

In the drawings, the figure represents a side elevation, partly in section, of my improved apparatus.

10 and 100 are gas-producers or generators consisting of steel shells lined with fire-brick and provided with grates 101.

11 and 110 are pipes leading from the blast-main 12, which is supplied with air by means of the blower 13, the admission of air beneath the grates of the generators 10 and 100 being controlled by the blast-gates 14 and 140, which are operated from the working platform 9 by means of the hand-wheels 15 and 150. Each hand-wheel is connected with its corresponding blast-gate by means of a pinion 16 on the hand-wheel shaft engaging a rack 17 on a rod 18 attached to the blast-gate.

19 and 190 are pipes leading from the steam header 8, by means of which steam under pressure is supplied beneath the grates of the generators 10 and 100, the admission of steam being controlled by the valves 20 and 200, which are operated from the working platform 9 by means of the floor stands 21 and 210.

22 and 220 are covers which are removable for the purpose of charging the generators 10 and 100 with fuel.

23 and 230 are retorts consisting of steel shells lined with fire-brick and largely filled with fire-brick checker work.

24 and 240 are stack-valves, by means of which either retort may be allowed to discharge into the stacks 25 and 250.

26 and 260 are two-way valves, by means of which the gases from the generators 10 and 100 may be caused to pass to the upper parts of the retorts 23 and 230 through the pipes 27 and 270 to the lower parts of the retorts through pipes 28 and 280. Each two-way valve 26 or 260, through rod 261, and the corresponding stack valves 24 or 240, through rod 241, is connected with a corresponding lever 29, which is operated from a hand wheel 30 by a pinion 31 on the hand-wheel shaft engaging a rack 32 on the lever. The connections are so arranged that when the valves 26 and 260 are in such position as to cause the gases from the generators 10 and 100 to pass to the retorts 23 and 230 downward through the pipes 28 and 280, the stack valves 24 and 240 are open, and similarly when the valves 26 and 260 cause the gases to pass upwards through the pipes 27 and 270, the stack valves are closed.

33 is a two-way valve, similar to valves 26 and 260, controlled from the working platform 9 by means of the hand wheel 34, pinion 35, rack 36, and rod 37, and so placed in the pipes 38 and 380, leading respectively

from the retorts 23 and 230, as to control egress of the gases from the retorts to the condensing system 39. This condensing system may be of any suitable size, form and arrangement, and is not herein further described as it forms no part of my invention herein claimed.

40 and 400 are pipes leading from the blast-main 12 by means of which air is supplied to the lower part of the retorts 23 and 230, the admission of air to the retorts being controlled by means of the valves 41 and 410, operated from the working platform by means of the floor stands 42 and 420.

43 is a pipe leading from a source of sulfur dioxid to the blower 44, which causes a current of sulfur dioxid to flow through the pipe 45 to the valve 46, which controls the supply of sulfur dioxid to the retorts 23 and 230 through the pipes 47 and 470. The valve 46 is operated by means of the hand wheel 48; the latter having a pinion 49 engaging a rack 50 on a rod 51 attached to a lever 52 to which is also attached the rod 53 carrying the valve 46.

The operation of making water-gas being of an intermittent character, inasmuch as the passage of steam through the incandescent fuel eventually lowers the temperature of the fuel below the point at which water-gas is most advantageously formed, it becomes necessary to raise the fuel again to the proper temperature by forcing a blast of air through it. This operation forms producer-gas, whose manufactur. is also of an intermittent nature. On the other hand, it is aimed to make the reduction of the sulfur dioxid continuous, involving a continuous supply of both water-gas and producer-gas, as well as a continuous supply of sulfur dioxid. The capacity of the foregoing apparatus to effect this continuous operation will be apparent.

Referring again to the drawing, the following conditions are represented: The fuel in the generator 10 is being raised to the proper temperature for making water-gas. The blast-gate 14 being open, the blast supplied by the blower 13 passes through the blast-main 12 through the pipe 11 and upward through the fuel in the generator 10, forming the so-called producer-gas, essentially a mixture of carbon monoxid and nitrogen. The producer-gas so formed passes through the pipe 27 to the lower part of the retort 23, where an auxiliary blast of air is supplied by the pipe 40 through the open valve 41. By this supply of air the producer-gas is ignited, its heat of combustion being added to its sensible heat, so that in its passage upward through the fire-brick checker work of the retort 23 the bricks are raised to a bright red heat, the waste gases finally escaping through the open stack valve 24, and passing to the air through the stack 25. The valve 33 is in such a position as to cut off the condensing system 39 from the retort 23, while the sulfur dioxid flowing through the pipe 45 is prevented by the valve 46 from entering the retort 23.

It is assumed that when the blast is put in operation on the generator 10, as described, for the purpose or bringing the fuel in the generator 10 to the temperature of maximum efficiency for the formation of water-gas, the fuel in the generator 100 has already been brought to a suitably high temperature by similar means. At this point the blast-gate 140 has been closed, and the steam valve 200 has been opened, admitting steam beneath the grate of the generator 100. The steam passing upward through the incandescent fuel is dissociated with the formation of water-gas, which passes through the valve 260 and the pipe 270 to the upper part of the retort 230, the inter-connection of the valve 260 and the stack valve 240 being such, as has been described, that when the valve 260 is open the stack valve 240 is closed. The current of sulfur dioxid supplied by the blower 44 through the pipe 45 is caused by the valve 46 to flow through the pipe 470 to the upper part of the retort 230. Here the sulfur dioxid becomes mixed with the water-gas, and passing downward through the red-hot checker work of the retort is reduced to sulfur. The sulfur vapor so formed, together with the other products of the reaction, water vapor and carbon monoxid, pass through the pipe 380 to the condensing system 39, to which access is given by the two-way valve 33. In contact with the extensive cooling surface of the condensing system, the hot gases fall to such a temperature that the sulfur vapor condenses; first to a liquid in the hotter parts of the condensing system, and finally to solid flowers of sulfur in the cooler portions. Suitable means should be provided for the occasional removal of the accumulated sulfur. It is assumed now that the continued operation of the air blast has restored the fuel in the generator 10 to its temperature of maximum efficiency for the formation of water-gas, and that the checker work in the reort 23 has been highly heated by the combustion of the producer-gas formed in heating the fuel in the generator 10. At the same time the continued production of water-gas in the generator 100 has reduced the temperature of the fuel below the point of maximum efficiency for the formation of water-gas, and the checker work in the retort 230 has been somewhat cooled by the continued passage of the comparatively cold sulfur dioxid. The blast-gate 14, and the auxiliary blast-valve 41 are now closed, cutting off the blast from the generator 10 and the auxiliary blast from the retort 23. By means of the hand wheel 30 the stack-valve 24 is now closed,

and the valve 26 reversed, while the valve 20 is opened, admitting steam to the generator 10. By means of the hand-wheel 48 the valve 46 is now reversed, cutting off the sulfur dioxid from the retort 230, and admitting it to the retort 23. At the same time the valve 200 is closed, cutting off the supply of steam from the generator 100, and the valve 33 is reversed, cutting off the retort 230 from the condensing system 39, and giving access to the condensing system from the retort 23. The blast-gate 140 is now opened, while the stack-valve 240 is opened, and the two-way valve 260 reversed by the operation of the hand wheel 300. Finally, the auxiliary blast-valve 410 is open, thus supplying the air necessary for the combustion, in the retort 230, of the producer-gas from the generator 100. The entire system of valves now presents relations the reverse of those indicated in the drawing, while the reactions in progress in the generator 10 and the retort 23, and in the generator 100 and the retort 230, are mutually reversed with reference to the foregoing description. The generators and retorts operating thus in alternation with reference to the generation of water-gas, and the heating of the retorts by the combustion of the producer-gas formed incidentally in maintaining the fuel in the generators at the temperature requisite for the formation of water-gas, the process of reducing sulfur dioxid to sulfur becomes continuous.

In an application filed of even date herewith, No. 404,890 I have shown and described another method and apparatus for recovering sulfur from sulfur dioxid having certain features in common with the specific method and apparatus hereinbefore described. The method of said application No. 404,890 is covered by the broader of the claims hereinafter recited, but is not herein claimed specifically.

I do not herein claim the apparatus herein described for carrying out the process herein claimed, as said apparatus forms the subject of a divisional application filed June 10, 1908, Serial No. 437,645.

Having now fully described my invention, what I claim and desire to protect by Letters Patent is:—

1. The process of recovering sulfur from sulfur dioxid consisting in manufacturing water-gas in each of a plurality of separate generators, mixing the water-gas formed in the several generators successively with sulfur dioxid, and heating said mixed gases, thereby causing a continuous reaction of water-gas and sulfur dioxid.

2. The process of recovering sulfur from sulfur dioxid consisting in manufacturing producer-gas and water-gas in each of a plurality of separate generators, mixing the water-gas formed in the several generators successively with sulfur dioxid, and successively utilizing the producer-gas formed in the several generators to produce the heat required for the reaction of the mixed gases.

3. The process of recovering sulfur from sulfur dioxid consisting in alternately manufacturing producer-gas and water-gas, leading the water-gas directly to and mixing it with the sulfur dioxid, and heating said mixed gases by the heat evolved by the combustion of the producer-gas, thereby causing the mixed gases to react with evolution of sulfur vapor.

4. The process of recovering sulfur from sulfur dioxid which consists in manufacturing producer gas in one generator and simultaneously therewith water gas in another generator and mixing the water gas so formed with sulfur dioxid, then manufacturing water gas in the first generator and simultaneously therewith producer gas in the second generator and mixing the water gas formed in the first generator with sulfur dioxid, and continuously heating water gas and sulfur dioxid so mixed by means of the heat evolved by the combustion of the producer gas successively formed in said generators.

5. The process of recovering sulfur from sulfur dioxid which consists in manufacturing producer gas in one generator and simultaneously therewith water gas in another generator and mixing the water gas so formed with sulfur dioxid heating said mixed gases by means of heat evolved by the combustion of producer gas formed in the second generator, then manufacturing water gas in the first generator and simultaneously therewith producer gas in the second generator and mixing the water gas formed in the first generator with sulfur dioxid and heating said mixed gases by means of heat evolved by the combustion of producer gas formed in the first generator, thereby causing a continuous reaction of water-gas and sulfur dioxid.

6. The process of recovering sulfur from sulfur dioxid which consists in alternately manufacturing producer gas and water-gas in each of a plurality of separate generators, and simultaneously manufacturing producer gas in one generator and water gas in the other generator, and vice versa, mixing the water-gas formed in one generator with sulfur dioxid and heating said mixed gases by means of the heat evolved by the combustion of the producer-gas formed in the same generator, and then mixing the water-gas formed in the second generator with sulfur dioxid and heating said mixed gases by means of the heat evolved by the combustion of the producer-gas formed in the second generator, thereby causing a continuous reaction of water-gas and sulfur dioxid.

7. The process of recovering sulfur from sulfur dioxid which consists in producing a substantially continuous stream of water-gas and mixing it with sulfur dioxid in order to utilize the same at substantially its initial heat, and also producing a substantially continuous stream of producer-gas and utilizing its heat as well as the heat produced by its combustion for heating said water-gas and sulfur dioxid, thereby causing the mixed gases to react with evolution of sulfur vapor.

In testimony of which invention, I have hereunto set my hand, at Wilmington Del., on this 25th day of November, 1907.

PAUL S. SMITH.

Witnesses:

D. COLEMAN BEASTEN,

S. J. THOMISON.