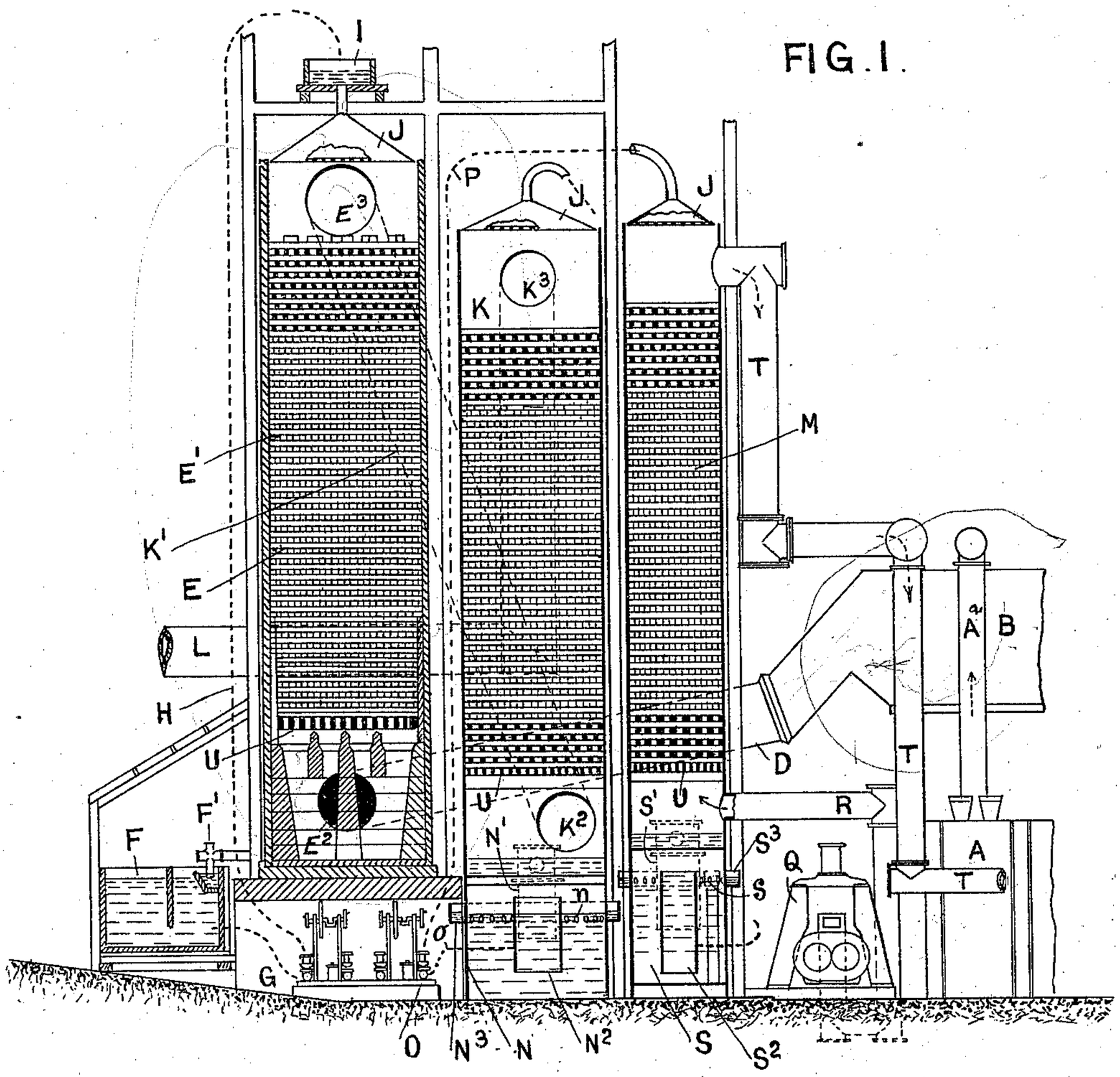
(No Model.) 2 Sheets—Sheet 1.

L. MOND.

PROCESS OF AND APPARATUS FOR OBTAINING AMMONIACAL PRODUCTS.

No. 547,276. Patented Oct. 1, 1895.

FIG. 1.



Witnesses

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(No Model.) 2 Sheets—Sheet 2.

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FIG. 4.

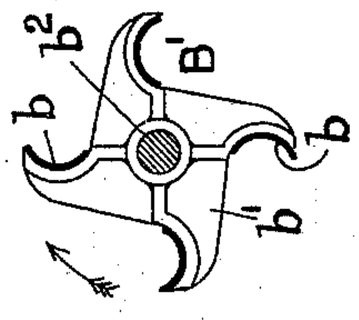


FIG. 3.

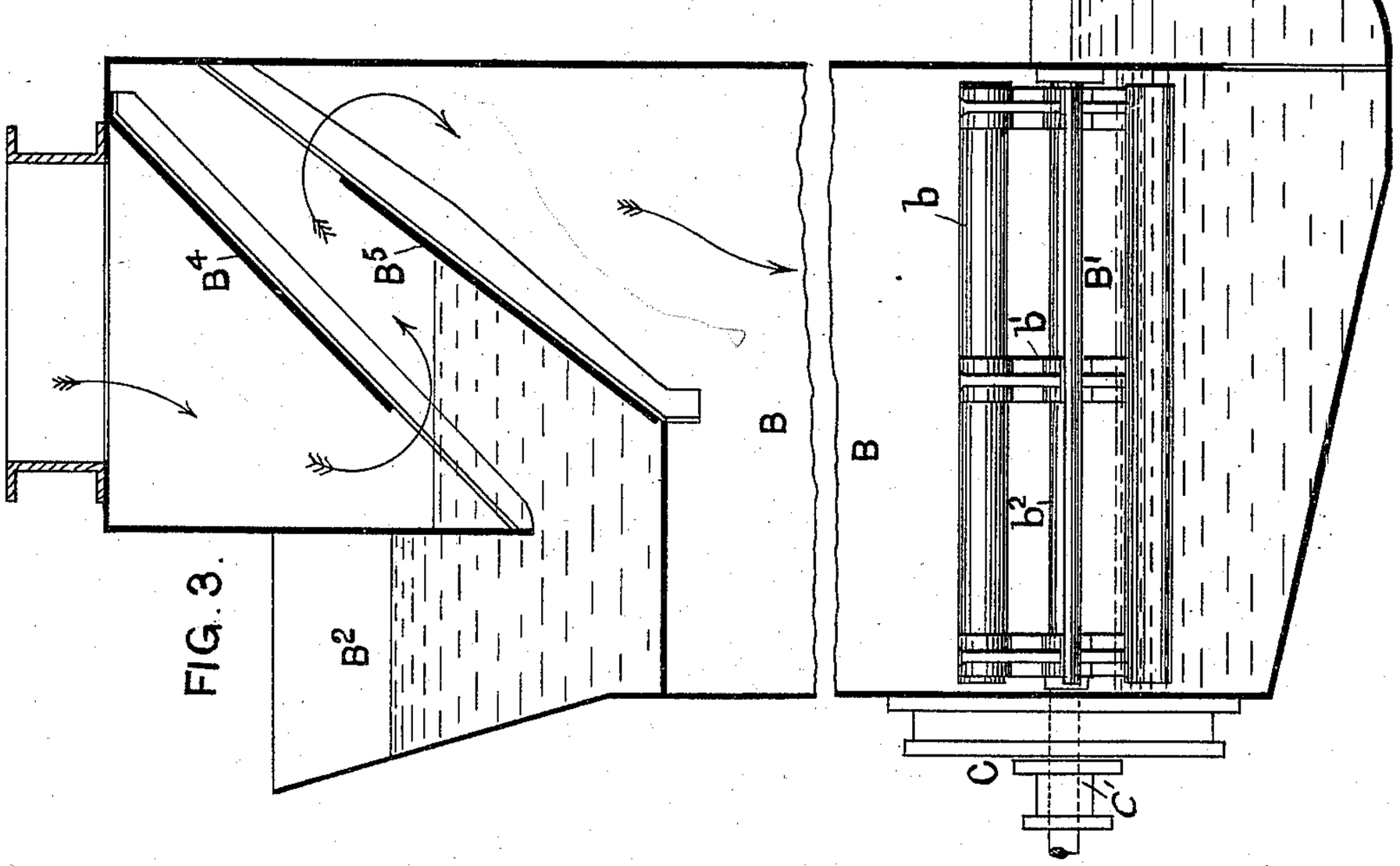
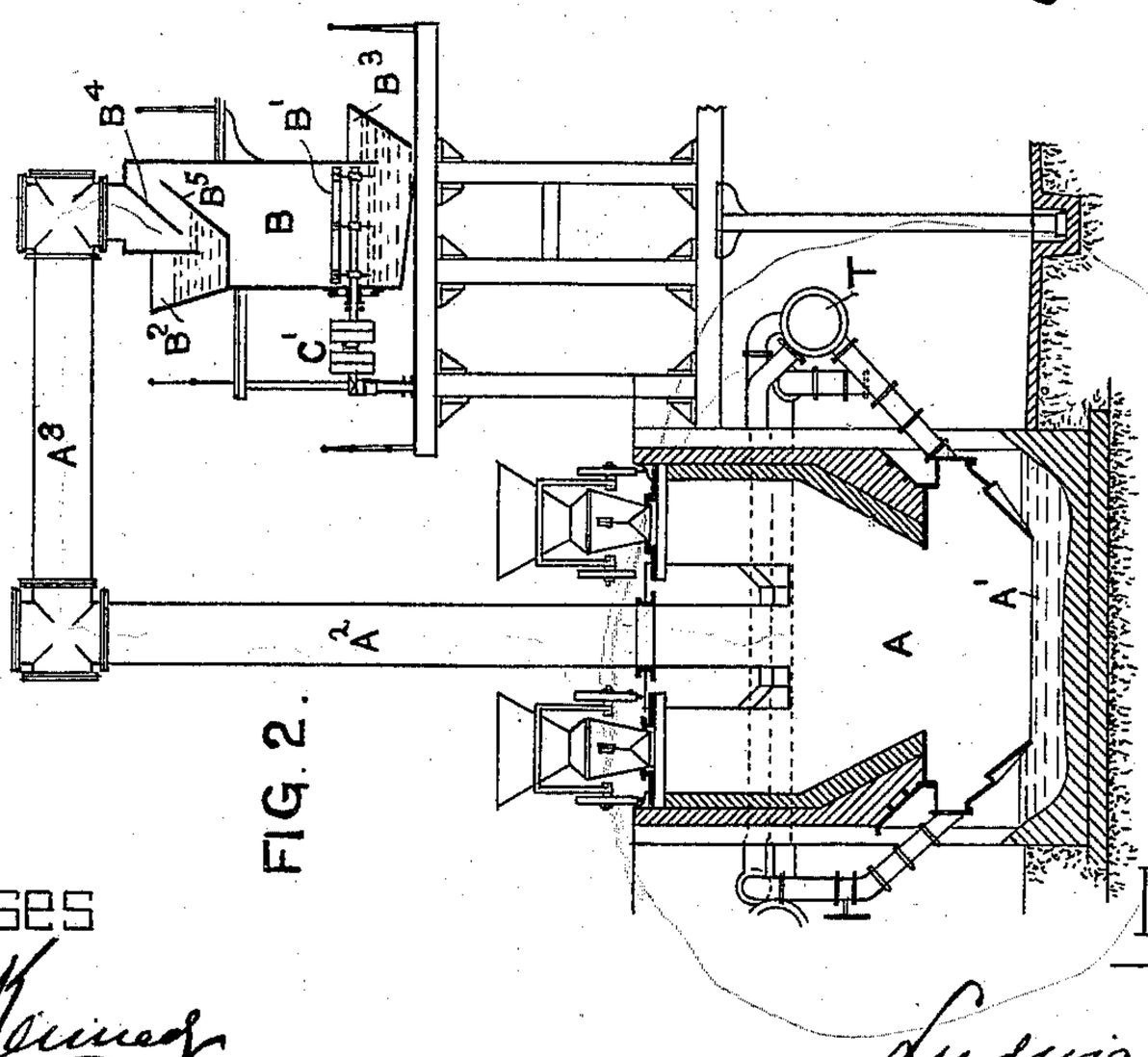


FIG. 2.



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UNITED STATES PATENT OFFICE.

LUDWIG MOND, OF WINNINGTON, ENGLAND.

PROCESS OF AND APPARATUS FOR OBTAINING AMMONIACAL PRODUCTS.

SPECIFICATION forming part of Letters Patent No. 547,276, dated October 1, 1895.

Application filed January 18, 1895. Serial No. 535,413. (No model.) Patented in England July 25, 1885, No. 8,973.

To all whom it may concern:

Be it known that I, LUDWIG MOND, a subject of the Queen of Great Britain, residing at Winnington, in the county of Chester, England, have invented new and useful Improvements in or Incidental to the Obtaining of Ammoniacal Products and Tar from Producer-Gases, (for part of which I have obtained a patent in Great Britain, No. 8,973, bearing date July 25, 1885,) of which the following is a specification.

I have pointed out in a patent granted to me in England, No. 3,923 of 1883, how ammonia can be obtained in large quantities as a by-product of the gasification of coal and other fuel in gas-producers by introducing into the producer along with the air such a quantity of steam that the temperature of the burning fuel in the producer is thereby kept below the dissociation temperature of ammonia.

In a subsequent patent granted to me in England, No. 8,973, of July 25, 1885, I have described a method for obtaining a mixture of air and steam suitable for this purpose in an expensive way by means of the heat of the producer-gas and the latent heat of the steam with which it is mixed, thus utilizing this heat otherwise wasted, and at the same time cooling the gases to the proper temperature for extracting from it ammonia and tarry matters. The quantity of steam required to obtain a good yield of ammonia in this manner is rather considerable and threatened to become a serious item of expense. Only one-third of this steam is decomposed in its passage through the producer, and two-thirds remain mixed with the gases which leave the producer. My endeavors were consequently directed toward finding means to recover this steam and to return it to the producers, and also to utilize the heat of the gases which leave the producers with a temperature of 450° to 500° centigrade for raising steam for the same purpose. The difficulties in the way of attaining this end and at the same time of recovering in a simple manner the small amount of ammonia contained in the immense volume of gas I have to deal with were very great. I obtain from one ton of coal one hundred and sixty thousand cubic feet of dry gas at 0° centigrade and atmospheric pressure. The steam mixed with this gas as it leaves the producer adds another eighty thousand cubic feet to this, and the large amount of latent heat in this quantity of steam makes the problem still more difficult. The application of cooling arrangements such as have been successfully applied to blast-furnace gases, in which there is no steam present and which depend upon the cooling through the metallic sides of the apparatus, is here practically out of the question. After trying a number of different kinds of apparatus I have succeeded in solving the problem in the following way, reference being had to the accompanying drawings, in which—

Figure 1 is a front elevation, partly in section, of the actual apparatus employed by me. Fig. 2 is an enlarged sectional view taken at right angles to Fig. 1. Fig. 3 is a still further enlarged section through the mechanical washer; and Fig. 4 is a cross-section, drawn to the same scale, of the rotary beater.

In the drawings, A is one of a series of gas generators or producers, and A′ a water-lute. A^2 A^3 are pipes conveying the gases into the mechanical washer B. This latter is supplied with rotary beaters B′, water-lutes B^2 and B^3, and downwardly-sloping plates B^4 B^5. The soot and fire-dust conveyed with the gases fall first on these plates and then to the bottom of the lute B^2, and are removed therefrom when required. The lute B^2 also prevents any escape of gas in that direction. The rotary beater B′ is constructed, preferably, as shown in Figs. 3 and 4, the beaters proper *b* being curved in cross-section, as shown in Fig. 4, and carried by brackets *b*′, mounted on the shaft b^2, which latter passes through a stuffing-box C and is driven by means of pulleys C′ from any suitable source of power. The water-lute B^3 prevents any escape of gas from the bottom of the washing-chamber and also enables the condensed tar to be removed therefrom as required.

D is a pipe conveying the gases from the washing-chamber B to the bottom of a scrubber E, the latter being constructed of stone or lead and filled with perforated bricks E′. In this scrubber the free ammonia contained in the gases is absorbed by sulfuric acid.

F is a separator into which the liquid from

the scrubber runs by means of pipe F′ and in which the solution of sulfate of ammonia separates from the tar condensed in the scrubber. G is a pump pumping the greater portion of the clear liquid from this separator along a pipe indicated by dotted lines H through acid-tank I and rose J back again to the scrubber, taking with it a fresh quantity of acid. In this scrubber E^2 is the inlet and E^3 the outlet for the gases.

K is a second scrubber, of wrought or cast iron, filled with perforated wood blocks, into which scrubber the gas is next passed by means of pipe K′ and inlet K^2, and after being cooled by a current of cold water entering the top passes through the outlet K^3 to the gas-main L. The cold water is brought by means of a pump (not shown) from a third scrubber M, to be hereinafter described, to the top of the scrubber K.

N is a vessel communicating with the scrubber K by pipe N′, whereby the hot water from the said scrubber is conveyed to such vessel. This vessel is provided with a cylinder N^2, open at both ends, and an annular trough N^3, which latter communicates with the interior of the vessel by means of holes *n*. The tar which rises to the surface of the hot water passes through these holes into the said trough and is removed therefrom when required. The clear hot water from the bottom of the vessel is pumped by means of pump O along the pipe *o* (indicated by dotted lines) to the top of a third scrubber or heater M. It will be observed that the pipe *o* from the pump enters the cylinder N^2. Consequently the water drawn from the vessel N will have to pass up through the bottom of such cylinder, thereby making it impossible for any tar to be mixed therewith.

Q is a Roots blower forcing cold air *via* pipe R through the scrubber or heater M in a direction opposite to that of the hot water pumped from the scrubber K.

S is a vessel similar to the vessel N, hereinbefore described, in which the water from the third scrubber is collected, S′ being the connecting-pipe, S^2 the cylinder, S^3 the annular trough, and *s* holes in the vessel opening into the trough.

T represents pipes conveying hot air to the producers or generators A.

J represents a rose over each scrubber, and U perforated supports for the perforated blocks or filling of the scrubbers.

The mode of action is as follows: The gas issuing from the generators or producers A passes into the mechanical washer B, where it is effectually intermingled with the water or aqueous solution contained therein by means of rapidly-rotating beaters B′, which throw the solution up in a fine spray among the gas, thus washing out the soot and fire-dust and absorbing the fixed ammoniacal salts contained in the gas. The water becomes gradually enriched with ammonia salts, and a certain portion of it is regularly removed from the chamber and distilled with lime to recover the ammonia. From this washing-chamber B the gases, which are now cooled down to about 100° centigrade and are loaded with a large amount of water-vapor, are passed through the scrubber E, of stone or lead, filled with perforated bricks, in which the free ammonia contained in the gases is absorbed by sulfuric acid. In this scrubber a fairly-concentrated solution of sulfate of ammonia containing thirty-six to thirty-eight per cent. is preferably used, to which a small quantity of sulfuric acid is added, so that the liquid leaving the scrubber contains not more than 2.5 per cent. of free acid. This is necessary, as a liquid containing more acid would act upon the tarry matter and produce a very dark-colored solution. The liquid running from the scrubber is passed through the separator F, in which the solution of sulfate of ammonia separates from the tar condensed in the scrubber. The greater portion of the clear liquid is, after adding a fresh quantity of acid to it, pumped back through the scrubber E. A certain portion of it is, after treatment with a small quantity of heavy tar oils, which take the tarry matter dissolved in it out, evaporated to a thick consistency. It is then run out on a strainer and yields after draining and washing with a little water a sulfate of ammonia of very fair quality, which finds a ready sale. The gas on entering this scrubber E contains only 0.13 volume per cent. of ammonia, and on leaving the scrubber it contains not more than one-tenth of this quantity. Its temperature has been reduced to 80° centigrade, and it is fully saturated with moisture, so that practically no condensation of water takes place in the scrubber. The gas is next passed through the second scrubber K, of wrought or cast iron, filled with perforated wood blocks. In this it meets with a current of cold water, which condenses the steam, the water being thereby heated to about 78° centigrade. In this scrubber the gas is cooled down to about 40° to 50° centigrade and passes from it to the gas-main L, leading to the various places where it is to be consumed. The hot water obtained in this second scrubber K is passed through the vessel N, constructed as described, for separating the tar which is mixed with it, and is then pumped through the third scrubber M, also of iron, through which, in an opposite direction to the hot water, cold air is passed. This is forced by means of a Roots blower Q, *via* pipe R, through the scrubber M and along pipes T into the producer A. The air gets heated to about 76° centigrade and saturated with moisture at that temperature by its contact with the hot water, and the water leaves this third scrubber cold enough to be pumped back through the second scrubber K. The same quantity of water is thus constantly used for condensing the water-vapor in one scrubber and giving it up to the air in the other. This

is a very important matter, as the water being much contaminated with tar would create a nuisance if passed into the drains and watercourses. In this way, too, I recover and return to the producer fully two-thirds of the steam which has been originally introduced, so that I have to add to the air which has been loaded with moisture an additional quantity of steam equal to only one-third of the total quantity required before it enters the producer. This additional quantity of steam, which amounts to 0.6 tons of steam for every ton of fuel burned, I obtain as exhaust-steam from the engines driving the blowers and pumps required for working the plant.

In place of using scrubbers of stone or iron filled with perforated bricks or wood, as mentioned in this specification, I can use scrubbers or washers of any other material and construction which allow sufficient air for the passage of the very large volumes of gas to be treated, and in place of a Roots blower any other form of air-propeller giving a pressure of above six inches of water can be used.

When, further, it is desirable to recover the ammonia in another form than that of sulfate of ammonia, I use instead of an acid solution of sulfate of ammonia an acid solution of chlorid or phosphate of ammonium or the ammoniacal salt of any other strong acid to which a small quantity of the specified acid has been added.

I claim as my invention—

1. The improvement in the process of extracting ammonia and tar from producer gases and at the same time economically supplying hot air saturated with moisture at an elevated temperature to the gas producers, which consists in washing the gases with agitation in water to remove soot and dust and to condense the tar and the fixed ammonia, separating the free ammonia by means of an acid solution, passing the hot gases and water in prolonged contact with each other in reverse direction (whereby the gases are cooled methodically by the water and further ammonia and tar extracted and the water becomes heated) and passing this hot water and the air for the producer in prolonged contact with each other, in opposite directions, whereby the air is heated and saturated with moisture at an elevated temperature and the water cooled, and lastly using the water over again to cool the hot gases.

2. The improvement in the process of extracting ammonia and tar from producer gases which consists in washing the producer gases first with water and second with a slightly acidified solution of a salt of ammonia, such as described, whereby most of the tar is first separated and then the ammonia sulfated without sensible chemical action on the tar.

3. The improvement in the process of extracting ammonia and tar from producer gases which consists in separating the ammonia from the gases by a weakly acid solution of a salt of ammonia and separating the tar from the solution, bringing the solution up to the required strength of acid, and again utilizing the solution for further extraction of ammonia.

4. The improvement in the process of extracting ammonia and tar from producer gases which consists in separating the ammonia from the gases by subjecting the latter to the action of a solution of a salt of ammonia with a strong acid such as described and a small quantity of the strong acid in the free state, substantially as described.

5. The improvement in the process of extracting ammonia and tar from producer gases which consists in treating the latter with acid, cooling the hot gases from the acid treatment with prolonged contact with water passing in the reverse direction, and cooling this water by passing the air for supplying the producers through it with prolonged contact in the reverse direction.

6. The improvement in the process of obtaining ammonia and tar from producer gas, which consists in bringing the mixture of gas and steam (hot from the producer) into contact with water, whereby the steam is condensed and the water is thereby heated, and subsequently bringing the air which is to be supplied to the producer into intimate contact with such water, whereby the air is heated and saturated with steam and thus the heat of the surplus steam escaping from the producer is recuperated.

7. The improvement in the process of extracting ammonia and tar from producer gases which consists in cooling the gases with water subjecting the heated water to the action of a current of cold air, alternately cooling the gases and heating the air, and then again cooling the gases and so on with substantially the same water, for the purposes described.

8. In an apparatus for extracting ammonia and tar from producer gases, the combination of the producers, means for feeding the same with warm moist air, a mechanical washer, and apparatus for separating the ammonia substantially as described.

9. In an apparatus for separating ammonia and tar from producer gases, the combination with a gas producer, scrubbers K and E for separating the ammonia, and a scrubber M for heating and saturating the air for the producer and cooling the water for the scrubbers K and E.

10. In an apparatus for separating ammonia and tar from producer gases, the combination of producer A, scrubbers E, K, and M, and pipes and pumps connecting same, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

LUDWIG MOND.

Witnesses:
T. F. BARNES,
W. P. THOMPSON.