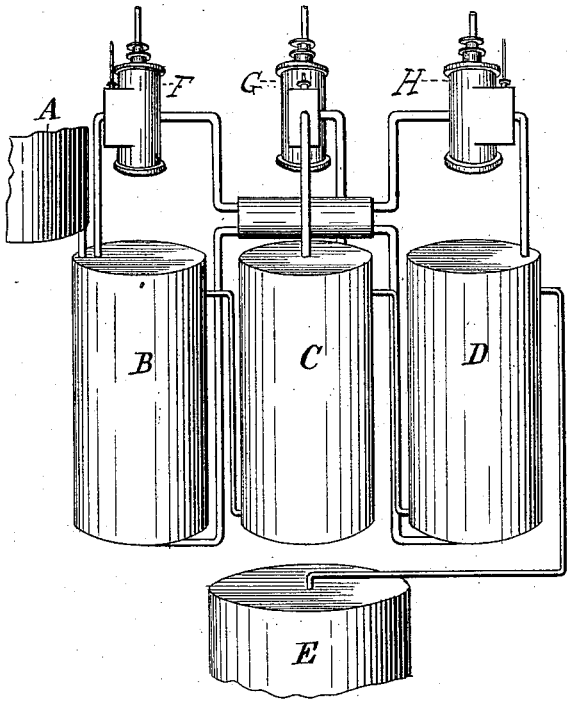
(No Model.) 2 Sheets—Sheet 1.

A. H. STOW.

CAUSTIC SODA STEAM ENGINE.

No. 381,967. Patented May 1, 1888.

Fig. 1.



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(No Model.) 2 Sheets—Sheet 2.

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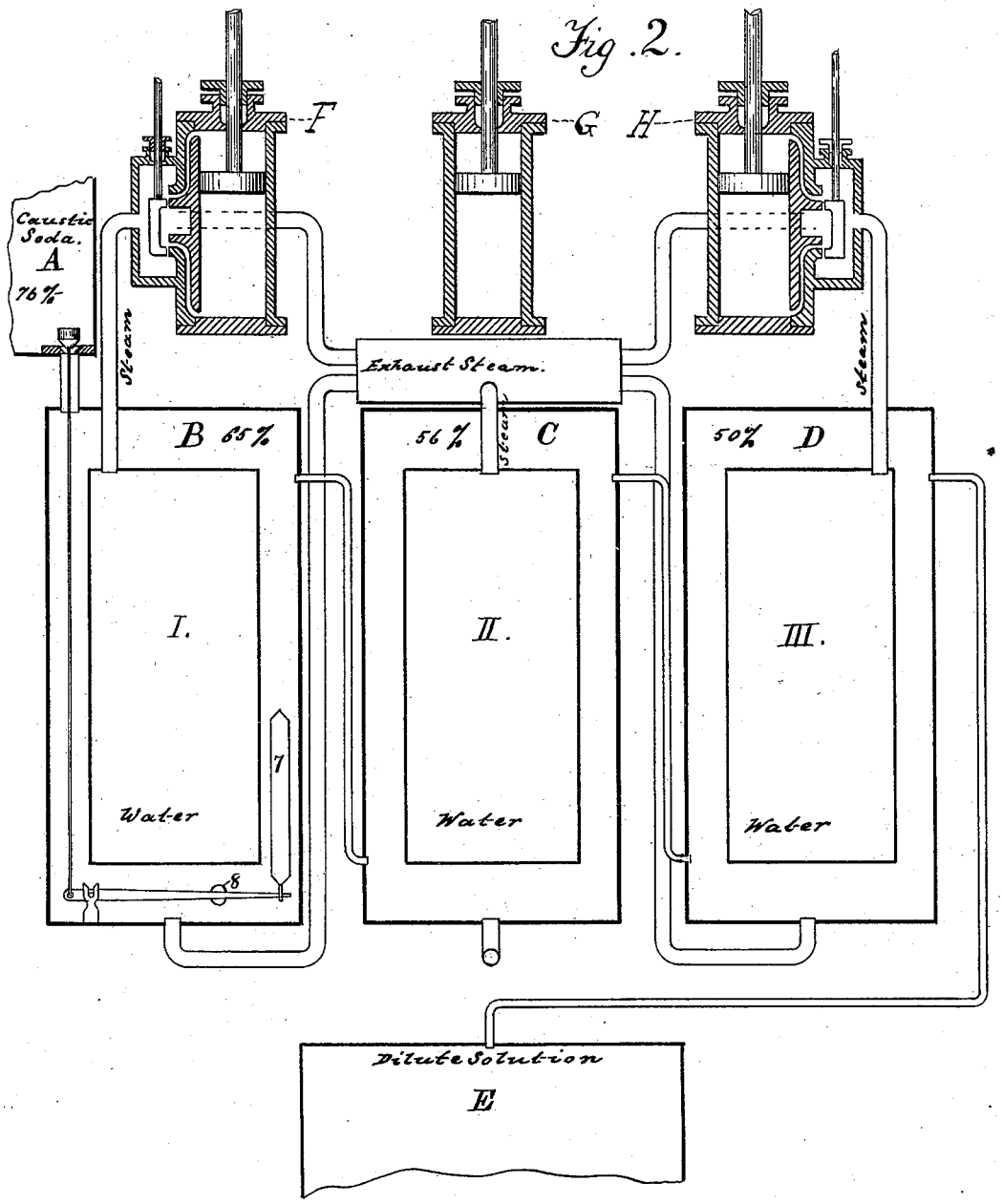
Fig. 2.



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UNITED STATES PATENT OFFICE.

AUDLEY H. STOW, OF BALTIMORE, MARYLAND.

CAUSTIC-SODA STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 381,967, dated May 1, 1888.

Application filed April 22, 1887. Serial No. 235,819. (No model.)

To all whom it may concern:

Be it known that I, AUDLEY H. STOW, a citizen of the United States, residing in Baltimore, in the State of Maryland, have invented an Improved Caustic-Soda Steam-Generator, of which the following is a specification.

My invention relates to an improved caustic-soda steam-generator in which steam is generated by means of one or more "caustic-soda" tanks, in connection with a reservoir for the concentrated solution of caustic soda and a receptacle for the diluted solution, so connected together by pipes that the solution in each caustic-soda tank may be renewed as fast as necessary by the inflowing of a stronger solution; and the object of my invention is to maintain a constant percentage of caustic soda in solution in each caustic-soda tank, whereby the steam-pressure in the immersed boiler may remain constant. I attain this object by the invention illustrated in the accompanying drawings, in which—

Figure 1 is a perspective view of my improved caustic soda steam-generator, (consisting in this case of three caustic-soda tanks, a reservoir, &c.,) and Fig. 2 a vertical section along the line X in Fig. 1.

The closed tank A, of boiler-iron or other material, is the reservoir in which is placed the solution of caustic soda after it has been concentrated for the purpose of generating steam. A pipe connects the reservoir A and the first caustic-soda tank, B, communication being controlled by an automatic regulator, as shown in Fig. 2. Each of the three caustic-soda tanks B, C, and D, which form the "series" in this case, contains a solution of caustic soda and incloses an immersed steam-boiler. A second pipe connects B and C, a third pipe C and D, while a fourth pipe connects D and E, the receptacle for the diluted solution of caustic soda. From E the diluted solution of caustic soda goes to be reconcentrated, and is then returned to A.

My caustic-soda steam-generator may consist of one, two, three, or more caustic-soda tanks so joined together by pipes as to form a series. Except the case where the generator consists of one caustic-soda tank, a description of my generator as consisting of three, (3,) as is illustrated in the drawings, will serve for all cases. For this reason I will first explain the case where three caustic-soda tanks are used, when a few words only in regard to the case when one alone is used will be necessary. An actual example, then, will perhaps best serve to explain the general method of procedure.

Suppose A has been filled with a seventy-six-per-cent. solution of caustic soda, the dilution not to proceed beyond, say, fifty per cent. The final dilution can be limited in two ways at least—first, by placing in B an automatic regulator which will maintain in solution in that tank any percentage of caustic soda which may be decided upon, and, second, by placing in D such a device. While I prefer to place such a device in D, the case is simpler to explain where the automatic regulator is placed in B. The drawings have been executed accordingly.

In my invention the spent steam is divided into as many (in the drawings three) equal parts as there are caustic-soda tanks, (if there are more than one,) the solution in each absorbing just one such equal part. Hence, if thirty pounds of spent steam pass through the exhaust-pipes in a certain number of minutes, in this same time the solution in each of the three caustic-soda tanks B, C, and D will absorb just ten pounds of spent steam. If, then, my automatic regulator be adjusted for a sixty-five-per-cent. solution, sixty pounds of the solution in A (seventy-six per cent.) must be let into B in the time the solution in B absorbs ten pounds of spent steam, as these together are equivalent to seventy pounds of a sixty-five-per-cent. solution.

Suppose B had been filled with a sixty-five-per-cent. solution. This makes seventy pounds of a sixty-five-per-cent. solution that passes into C, while the solution in C absorbs ten pounds of spent steam, together equivalent to eighty pounds of a fifty-six-per-cent. solution.

Suppose C had been filled with a fifty-six-per-cent. solution. This makes eighty pounds of a fifty-six-per-cent. solution that passes into D, while the solution in D absorbs its ten pounds of spent steam, together equivalent to ninety pounds of a fifty-per-cent. solution.

Suppose D had been filled with a fifty per

cent. solution. This makes ninety pounds of a fifty-per-cent. solution that passes into E in the time thirty pounds of spent steam are absorbed in B, C, and D together. This ninety pounds of a fifty-per-cent. solution, on losing thirty pounds of water in the reconcentration, will be returned to the reservoir A as sixty pounds of a seventy-six-per-cent. solution.

It can be shown in this way, as well as practically, in such a case as the above that a constant percentage of caustic soda being automatically maintained in any one tank, the percentage of caustic soda in solution in every other tank in the series will remain fixed. Changing one will change all. However, in practice there will be slight variations in the degree to which the solution is concentrated before being returned to the reservoir.

If the automatic regulator be placed in the first caustic-soda tank, the resulting variations in the last tank will be considerable and will lead to loss of effectiveness as a heat-engine, whereas if the automatic regulator be placed in the last caustic soda tank the resulting variations will be greatest in the first tank, but will not lead to loss of effectiveness as a heat-engine, and may therefore be disregarded for our purpose; hence, to maintain a constant percentage of caustic soda in each tank of the series, it is in practice only necessary, first, that the solution in each caustic-soda tank shall absorb an equal share of the spent steam, and, second, that a constant percentage of caustic soda be maintained in the last tank by some automatic device.

Division of spent steam.—That the solution in each tank of the series may absorb an equal share of spent steam, all the exhaust-pipes are led into a common compartment, R, which is connected with each tank at the bottom by pipes of the same size, so that the exhaust-steam may distribute itself equally to each. In addition to using the same size, more delicate adjustments can be made by placing a valve in each pipe, by which the internal resistance can be increased or diminished at will.

Automatic regulator—The specific gravity of an aqueous solution of caustic soda depends upon the percentage of caustic soda in that solution; hence the absorption of steam by such a solution lowers its specific gravity, while the addition of a stronger solution increases it. A large hollow float (which is to be immersed in the solution in question) and a solid-metal sinker can be attached to a lever controlling an admission-valve, so as to automatically maintain a constant percentage of caustic soda in solution. The percentage which this device will maintain in a tank can be changed at will by altering the relative distances apart, the relative sizes, or both, of the float and sinker, &c. Such a device is shown in position in Fig. 2. 7 is the solid sinker; 8, the hollow float. As the solution in B becomes diluted, the longer lever-arm will fall, owing to the lessened buoyancy of the float, at the same time allowing the solution in A to enter B. When the percentage to be maintained in B is again reached, owing to the stronger solution admitted from A, the longer lever-arm will rise, owing to the now-increased buoyancy of the float, thus closing the admission-valve. In this way any desired percentage of caustic soda may be maintained in solution in any tank.

Utilization of steam.—When steam is passed into a cooled solution of caustic soda, the caustic soda condenses the steam, thus liberating its latent heat and at the same time raising the temperature of the solution, whereby fresh steam may be generated in an immersed boiler. Given a certain percentage of caustic soda in solution, there is a certain maximum pressure under which the water in the immersed boiler will continue to boil. The percentage of caustic soda in each of the three tanks B, C, and D being different, the pressures of steam in the three boilers I, II, and III will also be different. In the case supposed the maximum pressure for a sixty-five-per-cent. solution (in B) would be about eight atmospheres, for a fifty-six-per-cent. solution (in C) about six, and for a fifty-per-cent. solution (in D) some four atmospheres. As represented in the drawings, the high-pressure steam in I acts upon the high-pressure piston in F alone, the medium-pressure steam in II upon the medium-pressure piston in G alone, and the low-pressure steam in III upon the low-pressure piston in H alone, the spent steam from each of the three cylinders going to R direct. This is certainly the simplest way to use steam of three different pressures, and may prove to be the best adapted to a caustic-soda steam-generator; but the following method, based upon the triple-expansion system, also suggests itself: The high-pressure steam drives the high-pressure piston and is cut off at the end of the full stroke. The steam now in the high-pressure cylinder F expands into the medium-pressure cylinder G, and from there into the low-pressure cylinder H. The spent steam now in the three cylinders goes to the compartment R, and from there equally to each of the three tanks B, C, and D. The medium-pressure steam in II now drives the medium-pressure piston, and is cut off at the end of the full stroke. The steam now in the medium-pressure cylinder expands into the low-pressure cylinder, the steam from both then going to R, as before. The low-pressure steam, after acting upon the low-pressure piston, goes to R, as before. While the increased economy would of itself recommend this system, the resulting decrease in the spent steam might be a serious objection in a caustic-soda steam-generator.

In place of three caustic soda tanks, one, two, four, or even more, may be used. Except when a single caustic-soda tank is used, the method of procedure is in all cases exactly similar. A few additional words will serve to explain the differences when a single caustic-soda tank is used. The single tank—as B, for instance—is connected directly with the reservoir

by one pipe and with the dilute-solution tank by another pipe. The spent steam is not divided into equal parts, but all passes immediately into the solution in the tank in question. The regulating device can be arranged so as to either admit the stronger solution in the reservoir as needed, or to allow the solution in the caustic-soda tank to flow out as it becomes too dilute, the stronger solution then flowing in by gravity as room is made for it.

While my invention most resembles that patented by Mr. Honigman in the case where a single caustic-soda tank is used, the points of difference can also be most easily seen in this case. In both cases, then, a single tank containing a solution of caustic soda surrounds the one steam-boiler. In Mr. Honigman's patent, this caustic-soda tank is complete by itself, while in my invention it can only act in connection with a reservoir, a dilute-solution receptacle, and connecting-pipe, and, further, a solution of caustic soda which has been concentrated for the production of steam is first placed in a reservoir and not in a tank surrounding a steam-boiler. Such a solution is used for the production of steam by flowing through one or more caustic-soda tanks, thereby counteracting the absorption of spent steam. The level of the solution in each caustic-soda tank remains practically the same, and does not rise in proportion to the water absorbed, as in Mr. Honigman's. The solution in each caustic-soda tank is renewed not by emptying and refilling, but by the (practically) continual (partial) displacement of the solution in each by the inflowing of a stronger solution, &c.

In a possible case where a large quantity of solution would not cause a proportionate amount of inconvenience I prefer to use a single tank, and to replace the more expensive caustic soda by the cheaper calcium chloride. In such a case calcium chloride can replace caustic soda without loss of effectiveness as a heat-engine, as a small range of dilution will answer the purpose. For instance, in the case supposed, the sixty pounds of a sixty-five-per-cent. caustic-soda solution might be replaced by one hundred and eighty pounds of a saturated calcium-chloride solution, the amount of spent steam to be absorbed—thirty pounds—remaining the same in each case. Further, whenever caustic soda is spoken of in connection with a caustic soda steam-generator it is presupposed that any of these substances which act in the same way in condensing spent steam—such as calcium chloride—may be substituted for the caustic soda, if desired. The form of boiler can also be varied, as desired. A tubular boiler with a number of small longitudinal flues set on end is to be preferred.

In this specification by a "caustic-soda" tank is meant a tank of boiler-iron or other suitable material which holds a solution of caustic soda and incloses an immersed steam-boiler, the caustic-soda solution being intended to generate live steam in the boiler by condensing spent steam. By a "series" is meant the combination of two or more caustic-soda tanks, one pipe connecting the first caustic-soda tank with the second, a second pipe connecting the second caustic-soda tank with the third, if there are three, and so on in exactly the same way, if there are more, until all are so connected.

I am aware that previous to my invention caustic-soda steam-generators have been invented in which live steam is generated by the condensation of spent steam in a solution of caustic soda surrounding a steam-boiler. I therefore do not claim caustic-soda steam-generators, broadly; but

What I do claim as my invention, and desire to secure by Letters Patent, is—

1. In a caustic-soda steam-generator, the combination of a reservoir, a caustic-soda tank, and a dilute-solution tank, the caustic-soda tank being connected with the reservoir by one pipe and with the dilute-solution tank by another pipe, whereby the stronger solution in the reservoir may flow into the caustic-soda tank, there counteracting the absorption of the spent steam, and at the same time causing an overflow into the dilute-solution tank, as described.

2. In a caustic-soda steam-generator, the combination of a reservoir, two or more caustic-soda tanks, and a dilute-solution tank so arranged and connected together in series by one or more pipes that the solution in each caustic-soda tank may be renewed by the inflowing of a stronger solution, and an equal share of the spent steam being absorbed by the solution in each caustic-soda tank, whereby a concentrated solution of caustic soda in generating steam will undergo a progressive dilution, as described.

3. In a caustic-soda steam-generator, the combination of a reservoir, one or more caustic-soda tanks, and a dilute-solution tank, all so arranged and connected together by pipes that the absorption of spent steam may be counteracted by the inflowing of a stronger solution, all essentially as described.

4. In a caustic-soda steam-generator, the combination of a reservoir, one or more caustic soda tanks, and a dilute-solution tank, a first pipe connecting the reservoir with the first caustic-soda tank, a second pipe connecting the first tank with the second, and so on, if there are more, until all are so connected, a last pipe connecting the last caustic-soda tank with the dilute-solution tank, whereby the absorption of spent steam may be counteracted by the inflowing of a stronger solution, all substantially as set forth.

5. In a caustic-soda steam-generator, the combination of a reservoir for the concentrated solution, one or more caustic-soda tanks, and a tank for the diluted solution, a first pipe connecting the reservoir with the first tank, a second pipe connecting the first tank with the second, and so on until all are so connected, a last pipe connecting the last caustic-soda

tank with the dilute solution tank, whereby the absorption of all the spent steam in the one caustic-soda tank, or of an equal share in each, may be counteracted by the inflowing of a stronger solution, and a constant percentage of caustic soda being automatically maintained in one tank, preferably the last if there are more than one, whereby the pressure of the steam in the single immersed boiler or in each boiler may remain constant, all substantially as described.

6. In a caustic-soda steam generator, the combination of a reservoir, one or more caustic soda tanks, and a dilute-solution tank, all so arranged and connected together by pipes that the absorption of all the spent steam in the one caustic-soda tank, or of an equal share in each, may be counteracted by the inflowing of a stronger solution, and a constant percentage of caustic soda being automatically maintained in one tank, preferably the last if there are more than one, whereby the pressure of the steam in the single immersed boiler or in each boiler may remain constant, all substantially as set forth.

7. In a caustic-soda steam-generator, the combination of two or more caustic-soda tanks so arranged and connected together in series by one or more pipes that the solution in each tank may be renewed by the inflowing of a stronger solution, and an equal share of the spent steam being absorbed by the solution in each tank, whereby a concentrated solution of caustic soda in generating steam may undergo a progressive dilution, all as set forth.

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