A. SORGE.

STEAM REGENERATOR.

APPLICATION FILED APR. 19, 1909.

1,045,904.

Patented Dec. 3, 1912.

2 SHEETS—SHEET 1.

Fig. 2.

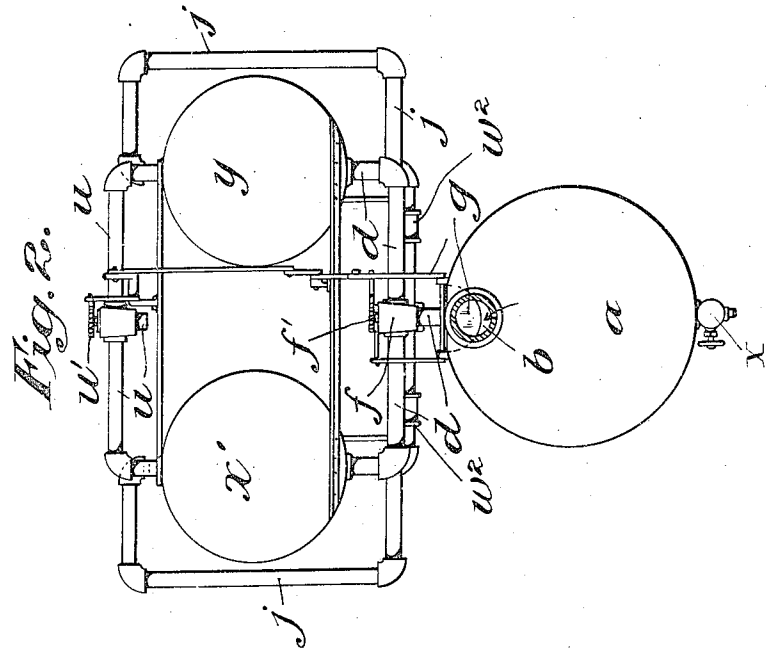
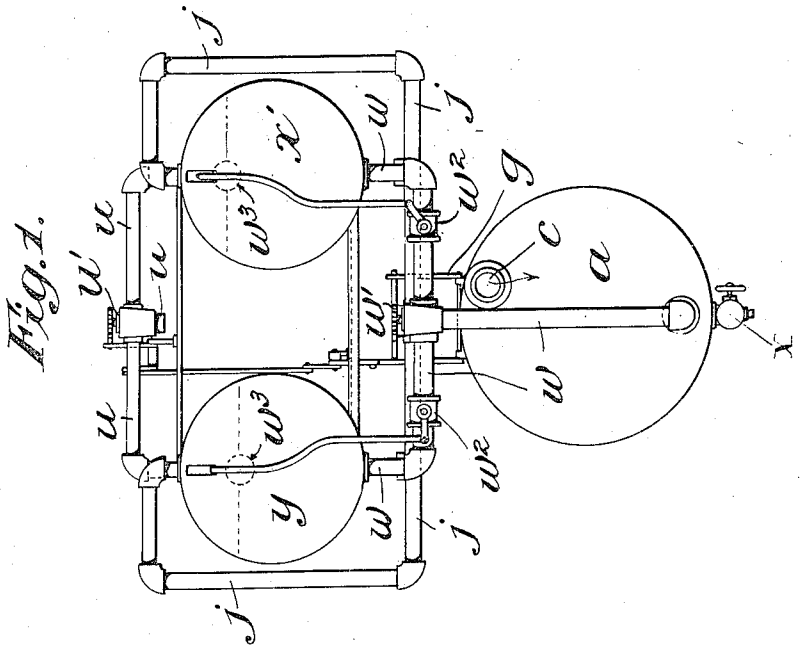


Fig. 1.



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2 SHEETS—SHEET 2.

Fig. 4.

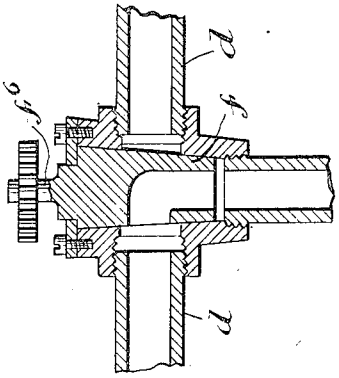


Fig. 6.

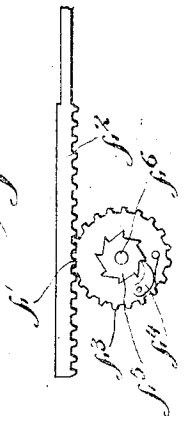


Fig. 3.

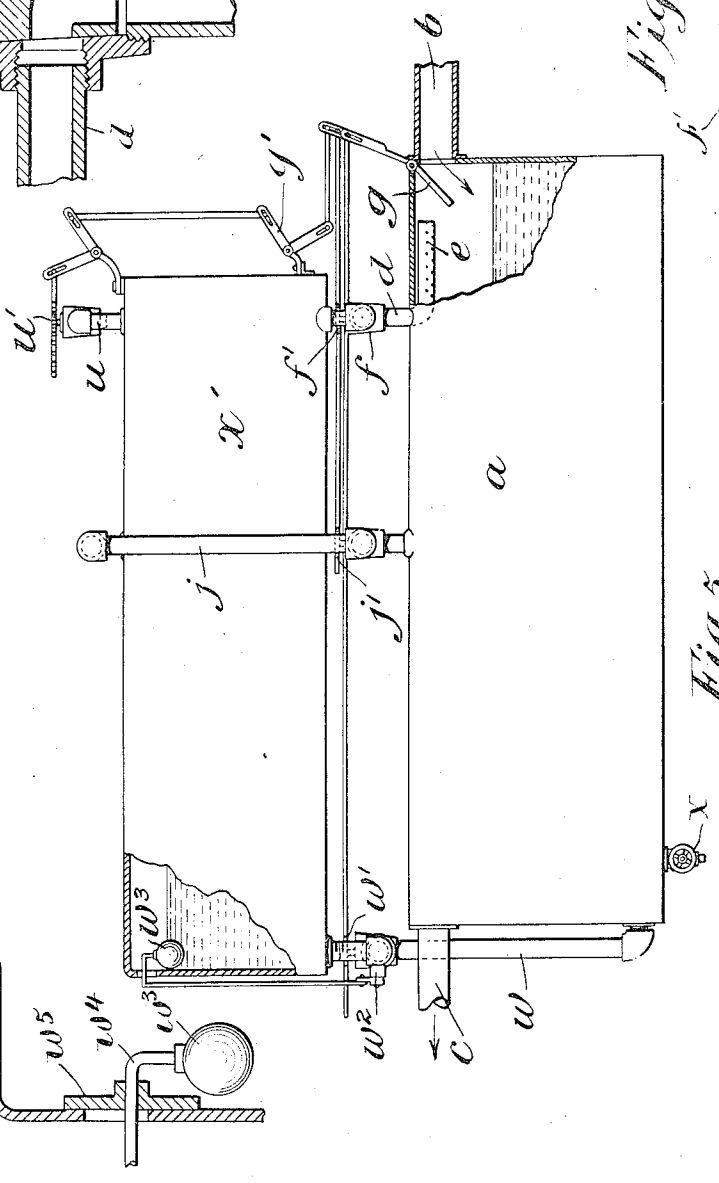


Fig. 5.

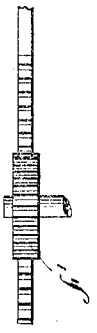
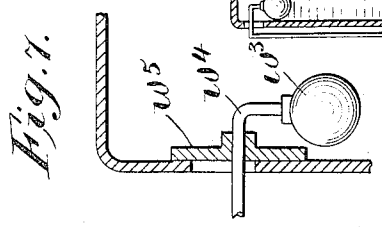


Fig. 7.



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UNITED STATES PATENT OFFICE.

ADOLPH SORGE, OF ST. JOSEPH, MICHIGAN, ASSIGNOR TO AMERICAN REGENERATOR COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

STEAM-REGENERATOR.

1,045,904. Specification of Letters Patent. Patented Dec. 3, 1912.

Application filed April 19, 1909. Serial No. 490,922.

To all whom it may concern:

Be it known that I, ADOLPH SORGE, a resident of the city of St. Joseph, in the county of Berrien and State of Michigan, have invented certain new and useful Improvements in Steam-Regenerators, of which the following is a specification, reference being had to the accompanying drawings, forming a part hereof.

In a steam regenerating apparatus, it is desirable for obvious reasons that the exhaust steam shall yield up heat to the general body of regenerating liquid immediately, or as nearly so as possible, as it is introduced into the regenerating chamber or accumulator. In another application for Letters Patent, filed February 18, 1909, Serial No. 478,718 I have described how the water or other liquid in the accumulator may be delivered in a finely divided condition upon the incoming steam in order to bring about this result, and in which case the water is allowed to drop by gravity from the accumulator upon the exhaust steam and is thereby carried bodily back and up into the accumulator again. In the present case as in that case, I take advantage of the delivery of the liquid of the accumulator in a finely divided condition upon the incoming steam, but I provide a different means for circulating the liquid for this purpose; for, in accordance with the present invention, I employ two tanks in addition to the regenerating chamber from which alternately I cause the water or other regenerating liquid to be discharged upon the exhaust steam as it is introduced into the regenerating chamber, and I arrange the connections between the several parts of the apparatus so that as water is being discharged from one of the tanks into the regenerating chamber, water will be transferred from the regenerating chamber to the other tank to form the basis of the next discharge of water into the regenerating chamber.

The invention will be more fully described in connection with the accompanying drawings in which,

Figure 1 is a view in rear elevation of an apparatus embodying the invention, Fig. 2 is a view in front elevation and Fig. 3 is a view in side elevation, partly broken away for the sake of completer illustration. Fig. 4 shows a section through the transfer valve *f*. Figs. 5 and 6 are respectively side and plan views of a portion of the escapement mechanism for operating the transfer valves. Fig. 7 is an enlarged detail sectional view showing a cover plate for preventing the escape of steam through the opening through which the rod from the float w^3 extends.

The regenerating chamber or accumulator *a* is preferably arranged underneath the two tanks *x* and *y*, which are referred to hereinafter as storage chambers, all of such chambers in the present case being shown as cylindrical in form.

Communicating with both storage chambers and terminating in a single pipe with a spraying means *e* arranged within the accumulator *a*, is a conduit *d* through which the liquid may be discharged from either of the storage chambers into the accumulator. The spraying device *e* is arranged adjacent to the discharge end of the means *b* for introducing exhaust steam into the accumulator. Also adjacent to the discharge end of the steam introducing means *b* is some such device as a gate *g* which is adapted to be lifted by every puff of the incoming steam and to drop back again to a substantially vertical position as soon as the steam has ceased flowing.

In the pipe or conduit *d* and at the point where it branches so as to extend to both storage chambers, is a valve *f*, preferably of a type which alternately opens one passageway and closes another to permit liquid to be intermittently and alternately transferred from tanks or chambers *x* and *y* to the regenerating tank or chamber *a*. Such a valve is illustrated in Fig. 4 and it will be observed that this valve is constructed so that when the conduit or pipe leading from the tank *x* to tank *a* is closed the conduit or pipe leading from the tank *y* to the tank *a* is open and vice versa. As will be clear from the above, these conduits are alternately opened and closed by movement of the valve *f*. Secured to this valve is an escapement mechanism indicated at *f'* (see Fig. 5 and Fig. 6), which mechanism is in operative relation with the gate *g*. With such connections, each successive lifting of the gate *g* will serve to move the transfer valve *f* 180° and thus to place the storage chambers *x* and *y* alternately in communication with the regenerating chamber or accumulator *a*. The escapement mechanism *f'* comprises the rack

f^2 (which may be connected by a rod to the arm g' that moves with the gate g) the gear wheel f^3 meshing with the rack, the spring pressed pawl f^4 on the gear wheel f^3 and the ratchet f^5 carried on the spindle f^6 of the valve f.

Leading from a point near the bottom and at the rear of the accumulator is a pipe or conduit w which branches so as to communicate with both of the storage chambers x and y, and at the point where this pipe branches there is a transfer valve and escapement mechanism w' similar to the transfer valve and escapement mechanism in the pipe d. This escapement mechanism is also connected with the gate g whereby the valve is rotated 180° each time the gate lifts and this valve is arranged to open communication with the storage chamber x at the same time the valve f opens communication with the storage chamber y, and vice versa. In each of the branches of the pipe w there is a valve w^2 controlled by a float w^3 in the corresponding storage chamber. Between the float w^3 and the valve w^2 there extends a rod w^4 that passes through the wall of the storage chamber and the steam is prevented from passing through the opening through which the rod w^4 extends by means of the cover plate w^5 indicated in Fig. 7.

The tops of both of the storage chambers are provided with a pipe u for communication with the atmosphere and with a pipe j for communication with the regenerating chamber a. Both of these pipes are provided with transfer valves and escapement mechanism, indicated at u' and j' respectively, and these escapement mechanisms are also connected with the gate g so that the respective valves shall be operated at the proper times, viz: to connect the top of the chamber x with the atmosphere and the top of chamber y with the regenerating chamber when the valve f connects the chamber y with the regenerating chamber, and vice versa.

The operation of the apparatus is as follows: When exhaust steam enters the regenerating chamber through the conduit b and lifts the gate g, and throws the valve f say in a position to establish communication between the chamber x and the chamber a, the water in chamber x will pass in a finely divided state through the spraying device e into the accumulator a and will drop through the incoming current of steam which is issuing from the discharge end of the conduit b. This operation heats the inflowing water which falls upon the top of the water already contained in the accumulator. At the same time that the valve f is operated to establish communication between the chambers x and a, the valve j' is operated thus establishing communication between the top of chamber x and the top of chamber a so that an equal pressure shall exist in the areas above the water space in both of these chambers, whereby the water may flow down freely by gravity from the chamber x to the chamber a. Also, at the same time that the valve f is operated as above stated, the valve u' is operated to connect the top of chamber y with the atmosphere, and the valve w' is operated to establish communication between the bottom of chamber a and chamber y. Thus, while water is flowing down from chamber x into chamber a, the pressure of the steam in the top of chamber a forces or transfers the water in the bottom of chamber a up through the pipe w into chamber y. As soon as the water in chamber y has reached a predetermined height the corresponding valve w^2 is closed through its float w^3. The chamber a now holds a body of water thoroughly heated, but this body of water soon becomes cooled by the action of the turbine or other engine drawing its supply of steam through a discharge conduit c, this action taking place after the steam has ceased to flow into the accumulator through the exhaust steam conduit b. When now steam commences again to be introduced into the accumulator a through the exhaust steam conduit b, the valve f is again operated and is turned 180° so as to establish communication between the chamber y and the chamber a, and all of the other valves are also rotated 180°, so that the action previously described takes place in the same manner but with the conditions just reversed so far as the chambers x and y are concerned. It will thus be seen that upon successive puffs or rushes of steam through the exhaust steam conduit b into the accumulator, the regenerating liquid will be drawn alternately from the storage chambers x and y and will be sprayed upon the exhaust steam and that while the spraying is being done from one of the storage chambers, the other chamber will be filled by the cooler liquid in the bottom of the accumulator.

The accumulator a is provided with a valve x' at the lower portion which permits withdrawal of water from the apparatus whenever desired.

I claim as my invention:

1. In a regenerator, a regenerating chamber, a storage chamber above the regenerating chamber, an outlet from the storage chamber and means for closing the same, an inlet to the regenerating chamber for the steam to be regenerated, an outlet therefrom for regenerated steam, a conduit between the chambers whereby liquid in the lower portion of the regenerating chamber may be forced by the steam therein into the storage chamber when the outlet therein is open, a conduit leading from the storage chamber adapted to deliver liquid in a finely divided

condition by gravity from the storage chamber when the outlet in the storage chamber is closed and means controlled by steam in the regenerating chamber to open and close the outlet in the storage chamber.

2. In a regenerator, a regenerating chamber, a storage chamber above the regenerating chamber, an outlet from the storage chamber and means for closing the same, an inlet to the regenerating chamber for the steam to be regenerated, an outlet therefrom for regenerated steam, a conduit between the chambers whereby liquid in the lower portion of the regenerating chamber may be forced by steam therein into the storage chamber when the outlet therein is open, a conduit leading from the storage chamber adapted to deliver liquid in finely divided condition by gravity from the storage chamber when the outlet in the storage chamber is closed and conduits between the upper portions of the chambers and a valve therein to be closed when liquid is being forced from the regenerating chamber to the storage chamber and to be open when liquid is dropping by gravity from the storage chamber into the regenerating chamber.

3. In a regenerator, a regenerating chamber, a storage chamber above the regenerating chamber, an outlet from the storage chamber and means for closing the same, an inlet to the regenerating chamber for the steam to be regenerated, an outlet therefrom for regenerated steam, a conduit between the chambers whereby liquid in the lower portion of the regenerating chamber may be forced by steam therein into the storage chamber when the outlet therein is open, a conduit leading from the storage chamber adapted to deliver liquid in a finely divided condition by gravity from the storage chamber when the outlet in the storage chamber is closed, a conduit means between the upper portions of the chambers and a valve therein to be closed when the liquid is forced from the regenerating chamber to the storage chamber and to be open when the liquid is dropping by gravity from the storage chamber into the regenerating chamber, and means controlled by steam in the regenerating chamber to cause opening and closing of said valve.

4. In a steam regenerating apparatus, the combination of a regenerating chamber, a storage chamber for part of the regenerating liquid, communications between the regenerating chamber and storage chamber, means to introduce exhaust steam into the regenerating chamber, a gate operatively related to said steam introducing means and mounted so as to be moved by the incoming exhaust steam, and a system of valves controlling the communication between the two chambers and in operative relation with the gate.

5. In a steam regenerating apparatus, the combination of a regenerating chamber having a steam inlet and a steam outlet, two storage chambers, means to alternately discharge liquid from the storage chambers to the regenerating chamber, means to alternately transfer liquid from the regenerating chamber to the storage chambers, means to introduce steam into the regenerating chamber, valves in said discharging and transferring means, and a gate in operative relation with the steam introducing means and operatively connected with said valves.

6. In a steam regenerating apparatus, the combination of a regenerating chamber having a steam inlet and a steam outlet, two storage chambers, means to discharge liquid from the storage chambers to the regenerating chamber terminating in a single pipe and including a valve, means to transfer liquid from the regenerating chamber to the storage chambers including a pipe leading from the regenerating chamber and having a valve therein, means to introduce exhaust steam into the regenerating chamber, a gate in operative relation with said steam introducing means, and controlling mechanism between the gate and each of said valves respectively.

7. In a steam regenerating apparatus, the combination of a regenerating chamber having a steam inlet and a steam outlet, two storage chambers, means to discharge liquid from the storage chambers to the regenerating chamber terminating in a single pipe and including a valve, means to transfer liquid from the regenerating chamber to the storage chambers including a pipe leading from the regenerating chamber and having a valve therein, means to connect the tops of both storage chambers with the atmosphere including a valve, means to connect the upper parts of the storage chambers with the upper part of the regenerating chamber including a valve, means to introduce exhaust steam into the regenerating chamber, a gate in operative relation with steam introducing means, and controlling mechanism between the gate and each of said valves respectively.

8. In an apparatus of the class described, a regenerating chamber, a storage chamber above the regenerating chamber, an outlet from the storage chamber and means for closing the same, an inlet to the regenerating chamber for the steam to be regenerated, an outlet from the regenerating chamber for the regenerated steam, a conduit between the chambers whereby liquid in the lower portion of the regenerating chamber may be forced by the steam therein into the storage chamber when the outlet therein is open, a conduit leading from the storage chamber adapted to deliver liquid in a finely divided condition by gravity from the storage chamber when the outlet in the storage

chamber is closed and means controlled by steam in the regenerating chamber to open and close the outlet in the storage chamber.

9. In an apparatus of the class described, a regenerating chamber, a storage chamber above the regenerating chamber, an outlet from the storage chamber and means for closing the same, an inlet to the regenerating chamber for the steam to be regenerated, an outlet therefrom for regenerated steam, a conduit between the chambers whereby liquid in the lower portion of the regenerating chamber may be forced into the storage chamber when the outlet therein is open, a conduit leading from the storage chamber adapted to deliver liquid in a finely divided condition by gravity from the storage chamber when the outlet in the storage chamber is closed, means controlled by steam in the regenerating chamber to open and close the outlet of the storage chamber, conduits between the upper portions of the chambers and a valve therein to close when the liquid is being forced from the regenerating chamber to the storage chamber and to be opened when liquid is dropping by gravity from the storage chamber into the regenerating chamber.

10. In a steam regenerating apparatus, the combination of a regenerating chamber having a steam inlet and a steam outlet, a storage chamber above the regenerating chamber and means comprising valves under the control of the steam in the apparatus to permit transfer of liquid to and from the said chambers.

11. In a steam regenerating apparatus, the combination of a regenerating chamber having a steam inlet and a steam outlet, two storage chambers above the regenerating chamber and means to permit liquid to be transferred from one of the storage chambers to the regenerating chamber and from the regenerating chamber to the other storage chamber simultaneously.

12. In a steam regenerating apparatus, the combination of a regenerating chamber having a steam inlet and a steam outlet, two storage chambers above the regenerating chamber, means to permit liquid to be transferred from one of the storage chambers to the regenerating chamber and from the regenerating chamber to the other storage chamber simultaneously and means to control the transfer so that the storage chambers will discharge alternately into the regenerating chamber.

13. In a regenerating apparatus, the combination of a regenerating chamber having a steam inlet and a steam outlet leading from the upper portion thereof, a storage chamber, means for conducting liquid from the storage chamber to the regenerating chamber, means within the regenerating chamber to cause an intermingling of the steam and water in the regenerating chamber, means for conducting liquid from the lower portion of the regenerating chamber to the storage chamber, a valve therein, means within the regenerating chamber controlled by the steam in the apparatus and operatively connected to said valve whereby said valve will be regulated by and dependent upon the steam.

14. In a regenerating apparatus, a regenerating chamber having a steam inlet, a steam outlet, a pipe leading from the lower portion of said chamber for conducting water to a second chamber, a pipe for conducting water from the second chamber to the regenerating chamber, said pipe having a valve therein, means within the chamber controlled by the flow of steam to the regenerating apparatus and means between the means within the chamber and the valve whereby the latter is under the control of said means within the chamber.

15. In a steam regenerating apparatus, the combination of a regenerating chamber having a steam outlet leading from its upper portion and a steam inlet, a storage chamber, means within the regenerating chamber to cause an intermingling of the steam and water within said regenerating chamber, a conduit leading from the lower portion of the regenerating chamber to the storage chamber and means within said conduit to regulate the flow of water therethrough.

16. In a steam regenerating apparatus, the combination of a regenerating chamber having a steam outlet leading from its upper portion and a steam inlet, a storage chamber, means within the regenerating chamber to cause an intermingling of the steam and water within said regenerating chamber, a conduit leading from the lower portion of the regenerating chamber to the storage chamber and means within said conduit to regulate the flow of water therethrough, said means under the control of the steam in the apparatus.

This specification signed and witnessed this 16th day of April, A. D., 1909.

ADOLPH SORGE.

Signed in the presence of—
LUCIUS E. VARNEY,
GRACE MCGRANN.