(No Model.) 4 Sheets—Sheet 1.

E. E. RIES.

METHOD OF ELECTRO CHEMICAL HEATING.

No. 381,818. Patented Apr. 24, 1888.

Fig. 2.

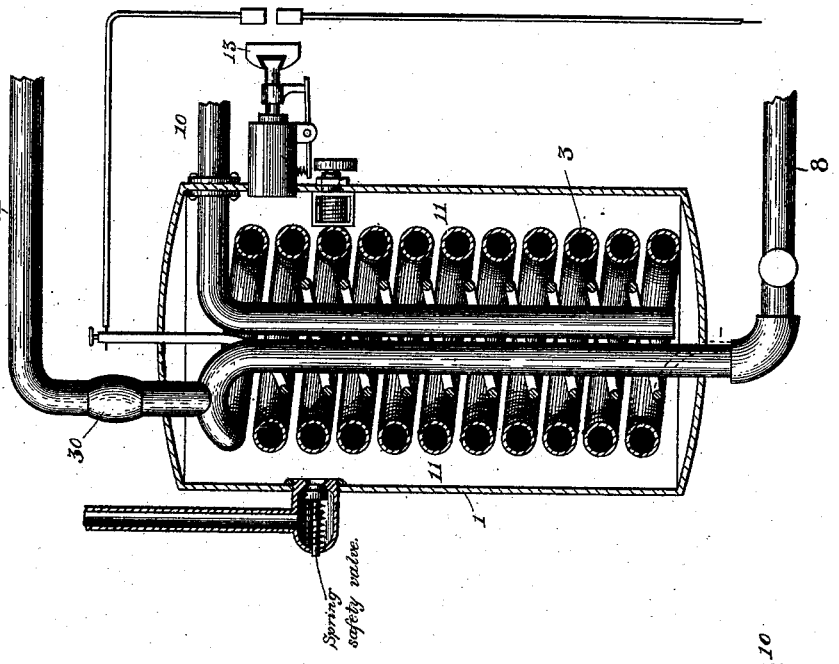
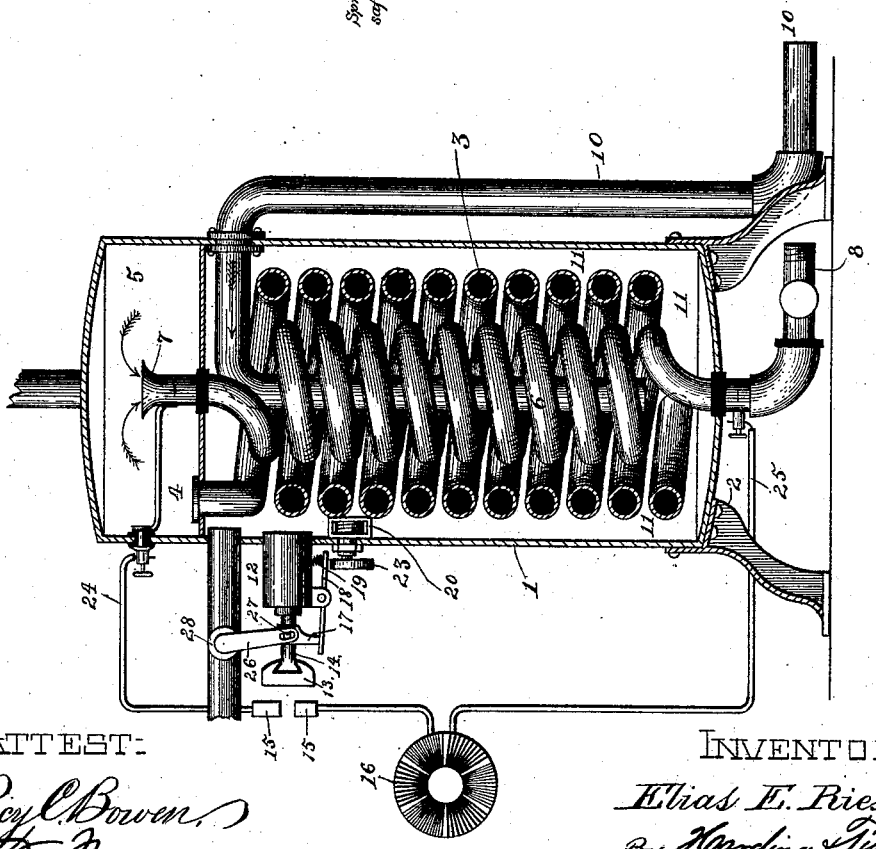


Fig. 1.



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(No Model.) 4 Sheets—Sheet 2.

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METHOD OF ELECTRO CHEMICAL HEATING.

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Fig. 4.

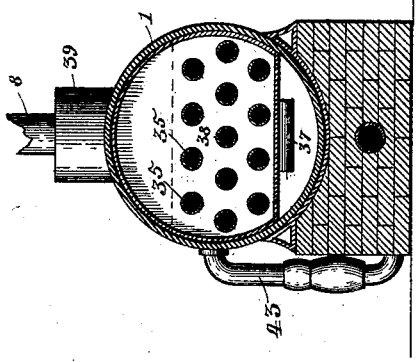

Fig. 3.

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(No Model.) 4 Sheets—Sheet 3.

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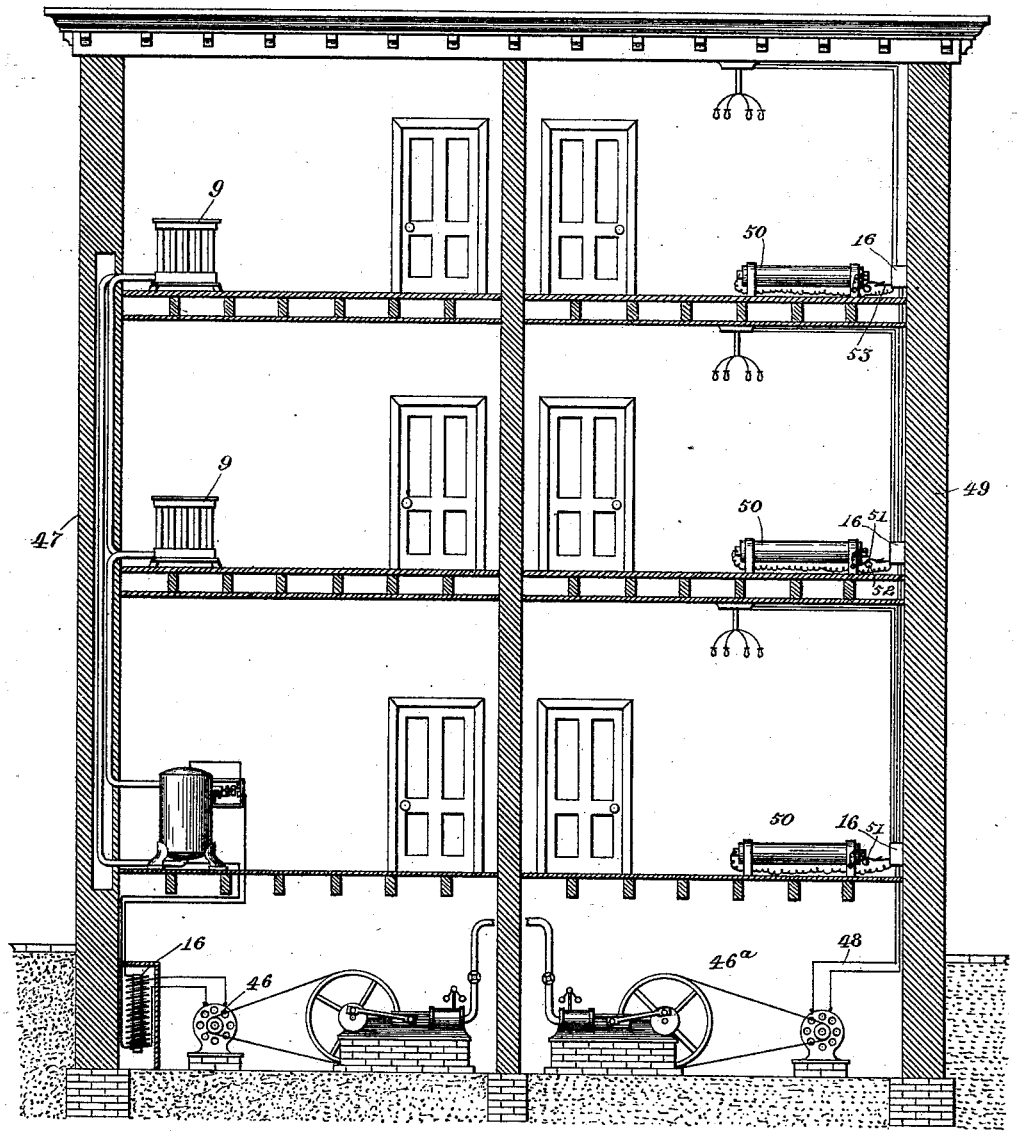
METHOD OF ELECTRO CHEMICAL HEATING.

No. 381,818. Patented Apr. 24, 1888.

Fig. 5.



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(No Model.) 4 Sheets—Sheet 4.

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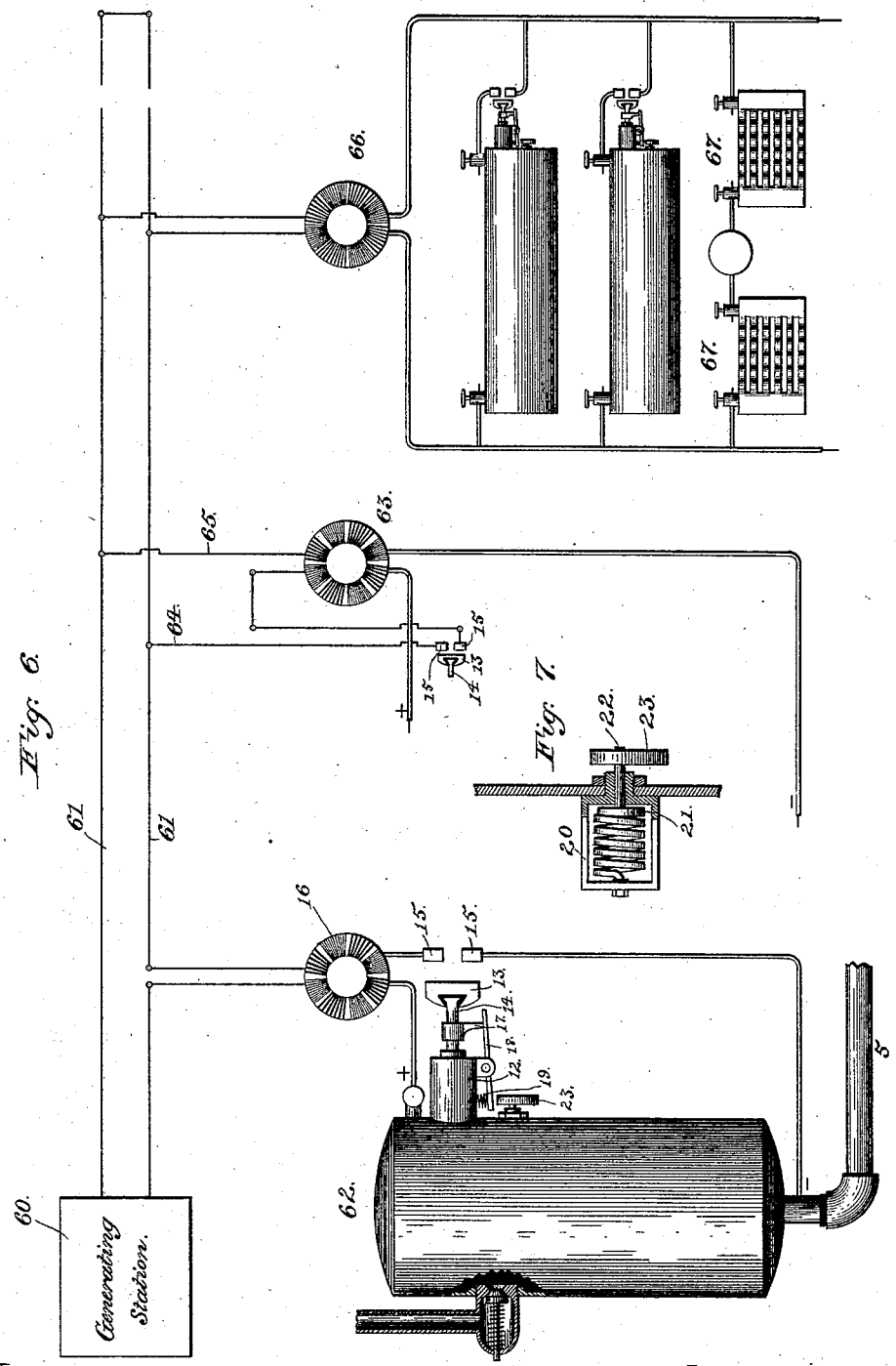

Fig. 6.

Fig. 7.

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UNITED STATES PATENT OFFICE.

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METHOD OF ELECTRO-CHEMICAL HEATING.

SPECIFICATION forming part of Letters Patent No. 381,818, dated April 24, 1888.

Application filed June 22, 1887. Serial No. 242,125. (No model.)

To all whom it may concern:

Be it known that I, ELIAS E. RIES, a citizen of the United States, residing at Baltimore, in the State of Maryland, have invented certain new and useful Improvements in Systems of and Apparatus for Electro-Chemical Heating; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to a new and improved method and apparatus for generating steam by electro chemical means for the purpose of heating buildings and all other stationary plants and for furnishing steam-power to engines, motors, &c. In this system the direct heating agent employed is a suitable chemical solution—such as caustic soda, concentrated lye, potash, or an equivalent substance—which is deposited or contained in suitable boilers or generators of novel construction and arrangement, whereby the said heating agent or agents are either employed to generate a desired quantity of steam from an adjacent quantity of water for exterior circulation and radiation through the ordinary system of steam pipes and radiators or are utilized directly within the said boilers or reservoirs, which latter are in this capacity used as the radiators themselves, the soda, lye, or potash acting as a source of the heat, and its respective reservoir being the radiating device, or the steam thus generated is used for motive purposes, as before stated. The chief difficulty which has been heretofore experienced in using the heating properties of caustic soda and other heat-giving solutions for this particular purpose was the inconvenience and expense attendant upon the continual manual attention necessarily required for operating the generating apparatus. The necessity of removing the steam-generating substance from its receptacle in order to evaporate and strengthen the same after exhaustion also involved a loss of time, waste, and great expense, while, on the other hand, if it had been attempted to revivify and regenerate such substance in its reservoir by utilizing ordinary heating expedients the expense of constructing heating apparatus available for this purpose, the maintenance of continual fires, &c., would have exceeded the cost of replacing the exhausted substance with a fresh supply. Again, the methods heretofore employed for regenerating and reconcentrating similar heat-generating solutions after they had been deprived of their heating qualities by continual or uninterrupted use were exceedingly crude and expensive. Consequently one essential object of this invention is to overcome these objections by aiding the maintenance of the working temperature of said solution by eradicating or evaporating any objectionable moisture deposited therein by means of an electric current of comparatively low potential and heavy heating capacity, which is conducted at required intervals through the soda or other solution contained within the boilers by the automatic operation of certain electrical connections and thermostatic devices, which will be more particularly described hereinafter. Furthermore, the useful adaptability of the electric current for automatically reheating and regenerating the caustic solution at the proper intervals tends to increase the efficiency of operation, to avoid the personal attention of an operator, and to provide a safe, clean, and compact generating apparatus which does not require the constant application of the reheating and regenerating qualities of the electric current. The electric current for this purpose is preferably derived from a central station or stations and is distributed to the various points of consumption at which my apparatus is situated in the ordinary manner; but, as will be readily apparent, since the current required at stated intervals for regenerating, reconcentrating, and for evaporating the surplus moisture from the solution can be more economically generated and distributed from a dynamo furnishing currents of comparatively high tension or electro-motive force, the said currents must be converted from high tension to low tension in order to gain the desired quantity or volume in the secondary circuit, which is necessary to produce the required heating effect. Therefore, in practice I prefer to employ alternating generators at the central station and to convert the current into the required low potential through inductional transformers of the desired construction located, preferably, in

proximity to the boilers or generators containing the heat-generating solution, thereby attaining a more effective and equal distribution and increased heating efficiency of the secondary current. However, it will be understood that continuous-current machines might be located at the said central station or stations and that the current furnished thereby might be converted into one of alternating character in a manner well known to those skilled in this art; but, as before stated, in practice I consider it more economical and convenient to utilize a generator of alternating type.

As different stations will require the reheating-current at different times for only a short period each, it will be seen that this system of heating is extremely economical in the use of current, the supply of which for a number of stations need be comparatively small, and it is possible to place the transforming and heating apparatus in circuit with the ordinary conductors that supply light and motive power, and thereby obtain a sufficient and constant supply of heat without interfering with or materially increasing the amount of current required to be generated at the station. In the present drawings, however, I have shown an independent heating circuit only for the sake of clearness.

A further object of my invention is to provide auxiliary apparatus of the necessary construction for re-enforcing and augmenting the action of the caustic solution and for radiating and equally distributing the generated heat to the different points of consumption with increased efficiency of operation, economy, and safety.

For the attainment of these several objects my invention consists in a certain organization of apparatus, and arrangement and combination of parts, which will be more accurately and fully described hereinafter, and the points of novelty in which will be specifically designated in the appended claims.

In the accompanying drawings I have illustrated certain appliances for operatively carrying out my invention. However, I wish it to be distinctly understood that such is not to be construed as limiting myself to specific constructions.

Figure 1 is a vertical transverse section of a preferred form of upright boiler or generator, parts being shown in side elevation. In this form of boiler the steam generated by the caustic solution is superheated before passing out, and the current for regenerating and strengthening the solution is conducted therethrough by means of the superheating coil. Fig. 2 is a similar view showing a different manner of superheating the steam and a separate spiral for conducting the current through the solution. Fig. 3 is a longitudinal section of a form of stationary generating apparatus for heating dwelling-houses, &c., or for supplying steam for motive-power purposes. This apparatus is specially designed to be used in connection with the electric current supplied from a central station. Fig. 4 is a cross-section on line *x x* of Fig. 3, with parts broken away. Fig. 5 is a view in elevation of two adjoining houses with their fronts removed in order to show the arrangement, equipment, and distribution of my system therein, the installation being in this instance, for the sake of clearness, represented as isolated plants. Fig. 6 is a diagrammatical view showing conventionally a central station and the arrangement of the circuits to the transformers, the heat-generators, and radiators at different remote points. Fig. 7 is a detail view of the thermostatic cut out shown in Fig. 6.

It will be understood that the apparatus about to be described is equally adapted for the generation of steam for heating or power purposes, the only difference required being a proper adjustment of the apparatus to produce the requisite pressure for the different purposes.

Like numbers of reference indicate corresponding parts in the several views.

Referring to Fig. 1, which illustrates an upright boiler or generator for either stationary or railway-car uses, 1 indicates the exterior casing, formed preferably of hammered boiler iron or steel and supported vertically by a suitable base, as shown conventionally at 2. Within this cylindrical casing is located an upright coil, 3, which is designed to hold the water, admitted thereto from a suitable tank or other supply (not shown) through the bottom of the casing 1 by means of a proper head or pressure. 6 designates a smaller coil vertically suspended within and enveloped by the coil 3, and communicates with the steam-chest 5 by the flaring pipe 7, as shown, this coil 6 being insulated from the boiler at its points of support, as hereinafter described. The lower end of this coil is connected with the distributing-pipe 8, which in turn enters on one side of one of the ordinary steam-radiators, 9 9, (see Fig. 5,) while the exhaust or return pipe 10 connects the other side of one of said radiators with the interior chamber, 11, of the boiler, (see Fig. 1,) which contains the soda or other caustic solution. Thus it will be understood that the heating property of the caustic solution which surrounds the water contained in the coil 3 will generate steam from said water, which steam will rise through the mouth of the upper terminal, 4, of the coil 3 into the steam-chest 5, and will be conducted therefrom through the flaring mouth 7 into the superheating-coil 6, as shown by the arrows in Fig. 1. Thus the steam in its passage through the said coil 6 will be superheated by means of the caustic solution, the object of this latter process being to render the steam sufficiently expansible and dry in order that a less amount thereof need only be generated for the required purpose. Then the said superheated steam is conducted through the distributing-pipe 8 to a heater, 9, (see Fig. 5,) and returns by the exhaust-pipe 10 into

the soda solution near the bottom of the chamber 11, where it is absorbed by the soda for a great length of time before the solution is completely saturated or back-pressure is evinced. However, in course of time the soda will become thoroughly saturated with steam and will cease to further absorb the exhaust-steam. Therefore, in such event I have devised means for automatically opening a safety or blow-off pipe and for simultaneously closing an electric circuit, so that a current of the requisite heating effect may be conducted through the solution for the obvious purpose of evaporating the moisture deposited by the exhaust and reconcentrating, reheating, and revivifying the same to the necessary working temperature. In order to effect this end the following mechanism is employed:

12 is a back-pressure cylinder, which has its open end protruding into the chamber 11. A bridge-piece, 13, insulated from and attached to the outer end of the spring-actuated piston-rod 14, is adapted to make contact with the terminals 15 15 in the secondary circuit from the transformer 16, (see Figs. 1 and 6,) and to the piston-rod 14 is attached a small cam projection, 17, against the lower end of which rests the forward end of a small lever, 18, which is held thereagainst by a small compression-spring, 19. Directly underneath and in line with the cylinder 12, on the interior of the casing 1, is affixed a frame, 20, containing a helix or spiral spring composed of a continuous strip of two metals having different ratios of expansibility, so as to produce an axial or rotary motion in a well known manner. One end of this spiral is attached to the frame 20, which is provided with a threaded hub for securing the said frame to the wall of the boiler, and the other end of said spring is fastened to the periphery of a small disk, 21, which is mounted on the inner end of the shaft 22, which carries on its outer end an adjustable cam projection, 23, said projection serving to operate upon the lever 18 in a manner to be hereinafter explained.

The operation is as follows: When the soda has become saturated with moisture up to the point at which it no longer freely absorbs the exhaust steam, back-pressure in the boiler and distributing-pipes will result, owing to the presence of the exhaust-steam, and the soda solution will therefore require regeneration or reconcentration before it can be further used for steam-generating purposes. When this period occurs, the exhaust-steam will be cut off from the heat-giving substance by the blow-off valve (see explanation hereinafter) and the rapidly-increasing back-pressure in the soda boiler will force outwardly the piston-rod 14 of the switch-cylinder until the bridge or contact piece 13 makes contact with the terminals 15 15 of the secondary circuit from the transformer 16, thereby closing the said circuit and simultaneously causing the current to traverse it by way of the wire 24, the coil 6, and the wire 25 back to the transformer, the upper and lower ends of the coil 6 being insulated from their supports, as shown clearly in Fig. 1. At the same instant the bridge-piece makes contact with the terminals 15 15 the projection 17 will pass beyond the end of the lever 18, which will then be forced up by spring 19 on the curve of the projection 17, and will be there held until disengaged, in a manner to be hereinafter explained. Also, at the same time the piston-rod is moved forward the lever 26, which is moved by pin 27 on the said piston-rod, is actuated, thereby opening the rotary valve 28 and allowing the blow-off pipe to be open. Thus the current will continue to traverse its path until the surplus moisture has been evaporated and the heat absorbed by the caustic soda becomes sufficiently intense to expand or dilate the spiral spring of the thermostat, which action will rotate the shaft 22, and consequently the cam 23, which latter will in its revolution engage the lever 18 and compress the spring 19, thereby releasing the other end of the lever from engagement with the projection 17 and allowing spring 29 (see Fig. 3) to retract the piston-rod to its original inactive position, thus breaking the circuit and closing the valve 28, the parts assuming their normal position, as shown in Fig. 1. Referring to the modification of the before-described generator, (shown in Fig. 2,) the principle of operation is similar to that illustrated in said Fig. 1, except that the blow-off pipe is operated independently by an expansible spring safety-valve, as shown, this being kept open by the interior pressure during the moisture-evaporating process. The steam-chamber 5 is dispensed with and the steam reservoir is formed by the upper coils of the water coil 3. The steam is superheated in a single vertical downwardly-projecting pipe passing through the soda solution. The conductor for the electric current is made in the form of a separate coil and passes perpendicularly through the said solution, as shown, and the coil 3 is provided with a branch safety-pipe, 31, which may either communicate with the atmosphere or be connected to a suitable condenser which is used to reduce or to condense the blow-off steam into a proportionate quantity of water, and the water is then returned to the water coil 3 by means of the injector (shown in Figs. 3 and 4) and intermediate auxiliary pipes. (Not shown.) In either case I would consider it advisable to have a safety plug or valve made of suitable fusible metal, such as is shown at 30, Fig. 2, so that in case of the coil being supercharged with steam the heat developed thereby would be sufficient to melt the plug 30 and give vent to such overcharge. In all other respects these constructions correspond. In Fig. 3 is shown a somewhat different form of generating apparatus, which is, as shown, of the longitudinal type, and consists, essentially, of an exterior casing, 1, having its interior divided into two compartments—one for the solution and the other for the water. The soda-compart-

ment 32 occupies a space, 33, at each end, as shown, said spaces 33 33 communicating with each other by the lower channel, 34, and also by a series of longitudinal pipes, 35 35, which are open at their respective ends and terminate flush with the partitions 36 36 between the soda and water compartments. The conductor for the electric current, which is designed to pass through the heating substance, is made preferably in the form shown—*i. e.*, of a corrugated broad strip of copper or other conducting metal, 37, passing centrally throughout the soda-compartment 32 and connected, respectively, at its extremities to the binding-posts, which are mounted in suitable non-conducting air-tight packing-rings (not shown) on the top of the generator. The water-compartment 38 is filled from any suitable source and through any convenient entrance (not shown) which corresponds to injector-connection with water up to the water-line designated in Fig. 3, and the remaining space above the said water-line and within the compartment 38 is utilized for the steam-chamber, which is kept constantly supplied by the evaporation of the water due to the heating agency of the caustic solution in the compartment 32. The conducting-strips are of larger cross section above the soda-level to prevent overheating from the passage of the current. Centrally on top of this generator is located a steam dome or flue, 39, which is preferably formed integral with the casing 1 of the boiler, and is provided with a central circular perforation in its top to permit the insertion of the steam-distributing pipe 8, which extends out to one or more of the ordinary steam-heaters or other radiating devices, or to the engines or other translating devices, as previously described in conjunction with Fig. 1, the exhaust or return pipe 10 carrying back the exhaust-steam into the soda-compartment 32, where it is absorbed in a manner also hereinbefore explained.

By an inspection of Fig. 3 it will be seen that the electric conductor 37 does not come directly in contact with solution contained within the pipes 35 35; but in reheating and evaporating by the heating agency of the electric current it must be understood that the soda contained within as well as without said tubes or pipes will receive by conduction and ebullition the proper amount of heat, owing to the heat conductivity and affinity of the soda or similar substance, which is in direct contact with the said conductor within the compartment 32 and the natural agitation or change in position of molecules. In order to prevent the escape of current through the soda solution, the heating-conductors are preferably coated with insulating paint or enamel that will not appreciably obstruct the heat. As the electro-motive force of the current employed is extremely low, however, this protection can in some cases be entirely dispensed with.

40 indicates the blow-off pipe for this particular form of apparatus, which enters above the soda-line in each end space, 33 33, and is connected by means of a branch pipe, 41, with an ordinary condenser and separator, (conventionally shown at 42, Fig. 1,) which in turn is provided with the usual injector, 43, (see Fig. 4,) for utilizing and returning the water of condensation after the scum which has been discharged with it has been separated therefrom.

44 is a rotary valve controlling the egress of the steam from the blow-off pipes, and is operated by a crank-lever, 45, pivotally connected at one end with the handle of said valve and at the other extremity with the bridge-piece 13 of the switch-cylinder 12, which in point of construction and operation is similar to that shown and described in Fig. 1, except that said switching and valve-controlling apparatus is actuated by the back-pressure in pipe 10, instead of by the overpressure of the charge in chamber 11, as previously described in connection with Fig. 1.

The valve and controlling mechanism above described are shown only for the purpose of operatively illustrating my invention. However, in practice I would deem it advisable to employ a valve of more improved construction, inasmuch as such departure could be made without materially deviating from the spirit of my invention.

The object of the illustration shown in Fig. 5 is to adequately represent a complete equipment, illustrating this method of heating from the initial generation of the current, as well as the feasibility of my system for heating and lighting buildings by individual plants, as will be better understood from the following description.

In the basement of both houses is located an alternating generator, 46 or 46ª, which is driven by belting from a small stationary engine, which can be supplied with motive steam from any convenient adjacent or even exterior source. The primary circuit of the dynamo 46 of house 47 is connected electrically with the terminals of the fine wire of the inductorium 16, the secondary circuit of which includes the form of boiler shown more clearly in Figs. 1 and 2, which is permanently located on the first floor, and is intended to supply the ordinary heaters, 9 9, with the requisite steam heat through the steam-distributing pipes 8 8, the exhaust or return pipe returning from the radiator on the last floor to the soda-compartment of the boiler, as before mentioned. The primary circuit 48 of the generator 46ª in house 49 passes in series through the three transformers 16 16, located on the different floors of this dwelling, while the secondary circuit of each transformer 16 is branched both to the incandescent lights and to the stationary heat generating and radiating apparatus 50, which latter in this case acts as a heat-reservoir and contains only a supply of the caustic solution, the boiler itself serving as the radiator. This form of heater is preferred for heating small apartments in a direct manner—that is to say, where no steam-

distributing pipes 8 8 are employed—inasmuch as the large heating properties of the soda when used in conjunction with my electro-regenerating process is amply sufficient to comfortably warm the largest room.

When the soda in the reservoir heaters or radiators 50 requires regeneration and reconcentration, this is accomplished, as before, by means of the electric current converted in the secondary circuit of the respective transformer 16, the admission of which is automatically controlled by the thermostat 51, which consists of an expansible strip of metal pivoted at some convenient point to the boiler 50 and coiled once at the point 52, as shown. This coiled strip is kept normally out of contact with the terminal 53 of the secondary circuit of the particular transformer, as the existent heat from the caustic solution is sufficient to expand the coil 52, so as to be out of contact; but should the apparatus become cool, owing to the decrease of the heating properties of the said solution contained therein, the coil will contract and make contact with the terminal 53, thereby closing the circuit and causing the current to traverse its conductor 37, (see Fig. 3,) to revivify the solution and to raise its temperature until the coil 52 will again expand and break contact.

In explanation of the diagram shown in Fig. 6, the central or generating station, 60, is suitably equipped with alternating dynamos, (only one being conventionally shown.)

61 61 is a primary circuit, extending out to a considerable distance, for supplying the inducing-current to the primaries of the several transformers 16 16, which latter are located each in proximity to its respective generator or boiler, each of which is intended to indicate a heating-plant for some building, warehouse, or other edifice.

The apparatus located at station 62 is similar in construction and operation to that shown in Figs. 1 and 2, the primary of its transformer 16 being connected or looped in the present instance in series with the line. At the station indicated by 63 no heat-generating apparatus is shown, as the same apparatus shown at 62 may be there located; or the form of boiler illustrated in Fig. 3 might also occupy the space between the terminals + and — at this station. There is a difference here, however, in connecting the primary of the transformer 16, as the branch 64 from the line is arranged in parallel therewith, and one leg, 65, of said branch forms the primary of the transformer 16 and continues down to one of the contacts 15 15, while the other leg connects one side of the line directly with the other contact 15, as clearly shown. Thus the contacts 15 15 are intended to represent a sub-station where only an occasional primary current is required for any desirable purpose, the secondary circuit at this station being represented as being continuously closed. The station 66 shows the system of arrangements where a number of heat-generators are so arranged in the circuit of the secondary of the transformer 16 as to be regenerated and strengthened by the current at different intervals. This arrangement is also intended to show how a portion of the current from said transformer may be continuously utilized for heating by direct radiation—that is, to radiate the heat developed by the electric current in suitable radiating devices, the construction of which is clearly indicated at 67 67 at this station.

A further explanation of the devices located at said station 66 is not deemed necessary, as an inspection of the figures will show their character.

As will be obvious from the foregoing description and drawings, the various functions of the apparatus are performed automatically, requiring no personal attention whatsoever, except a periodical cleaning out after the soda has been completely exhausted from long and continued use and the substitution of a fresh supply of water for that evaporated. In addition the current-regulating devices are so arranged and adjusted that the amount of steam generated by the solution is entirely under control and never exceeds that drawn for use in the radiators, as a larger consumption will be followed by a corresponding production, and vice versa.

By the application of the electric current of the proper strength (quantity) for a few minutes directly to the solution sufficient strength can be imparted to said solution to generate the heat or steam necessary to furnish the requisite heat for a number of hours. Moreover, as the most efficient and economical effects in steam-heating systems are available only by utilizing low pressure and corresponding large radiating surfaces, the regenerating period might be arranged at long intervals apart, and the heat-storing properties can be employed to much better advantage than with high pressure, as is required for motive-power purposes. However, it will be understood that the generic form of my apparatus may without any substantial change be used to generate high-pressure steam for said motive purposes, if found desirable, or the coil-boilers can be employed as cooling mediums in summer, the refrigerating substance being of any well-known and approved composition, such as ammonia or other liquid or gaseous material. The radiating-pipes can be utilized without any additional expense and with great advantage as the distributing means for the cooling compound, and to meet this requirement the ammonia-gas might be liquefied in any suitable manner, as will be apparent.

Having thus fully described my invention, what I claim, and desire to secure by Letters Patent of the United States, is—

1. The herein-described method of revivifying a steam-generating substance located in a receptacle and having heat-giving qualities, which consists in periodically subjecting the same to the heating effect of an electric current or currents, substantially as specified.

2. The herein-described method of maintaining the generation of steam in a generator, which consists in exposing water to the action of a steam-generating substance having heat-giving qualities and revivifying the heat-giving qualities of said substance by periodically subjecting said substance to the heating effect of an electric current or currents, substantially as specified.

3. The herein described method of maintaining the generation of steam in a generator, which consists in exposing water to the action of a steam-generating substance having heat-giving qualities, re-enforcing the life of said substance by constantly impregnating the same with exhaust-steam until it reaches a desired point of saturation, and evaporating and revivifying said substance by subjecting it to the heating effect of an electric current or currents when said point of saturation is reached, substantially as specified.

4. The herein-described method of automatically revivifying a steam-generating substance located in a receptacle and having heat-generating qualities, which consists in establishing an electric circuit in proximity to said substance and controlling the flow of electric currents of heating effect through said circuit by the variation of the heat-giving qualities of said substance.

5. The herein described method of maintaining the radiation of heat in radiators supplied with steam from a generator, which consists in generating steam by exposing water to the action of a steam-generating substance having heat-giving qualities, distributing the steam thus generated to points of radiation, and maintaining the heating qualities of said substance by impregnating it with exhaust-steam until a desired point of saturation is reached, and evaporating and revivifying said substance by subjecting the same to the heating effect of an electric current or currents when said point of saturation is reached, substantially as specified.

6. The herein described method of revivifying a heat-generating substance located in a receptacle and having heat-giving qualities, which consists in converting high tension electric currents into currents of lower tension and heavier heating effect and periodically subjecting said substance to the heating effect of such converted currents.

In testimony whereof I affix my signature in presence of two witnesses.

ELIAS E. RIES.

Witnesses:
LEOPOLD RIES,
JNO. T. MADDOX.