J. N. LEACH.

STEAM GENERATOR.

APPLICATION FILED AUG. 7, 1905.

983,296.

Patented Feb. 7, 1911.

3 SHEETS—SHEET 1.

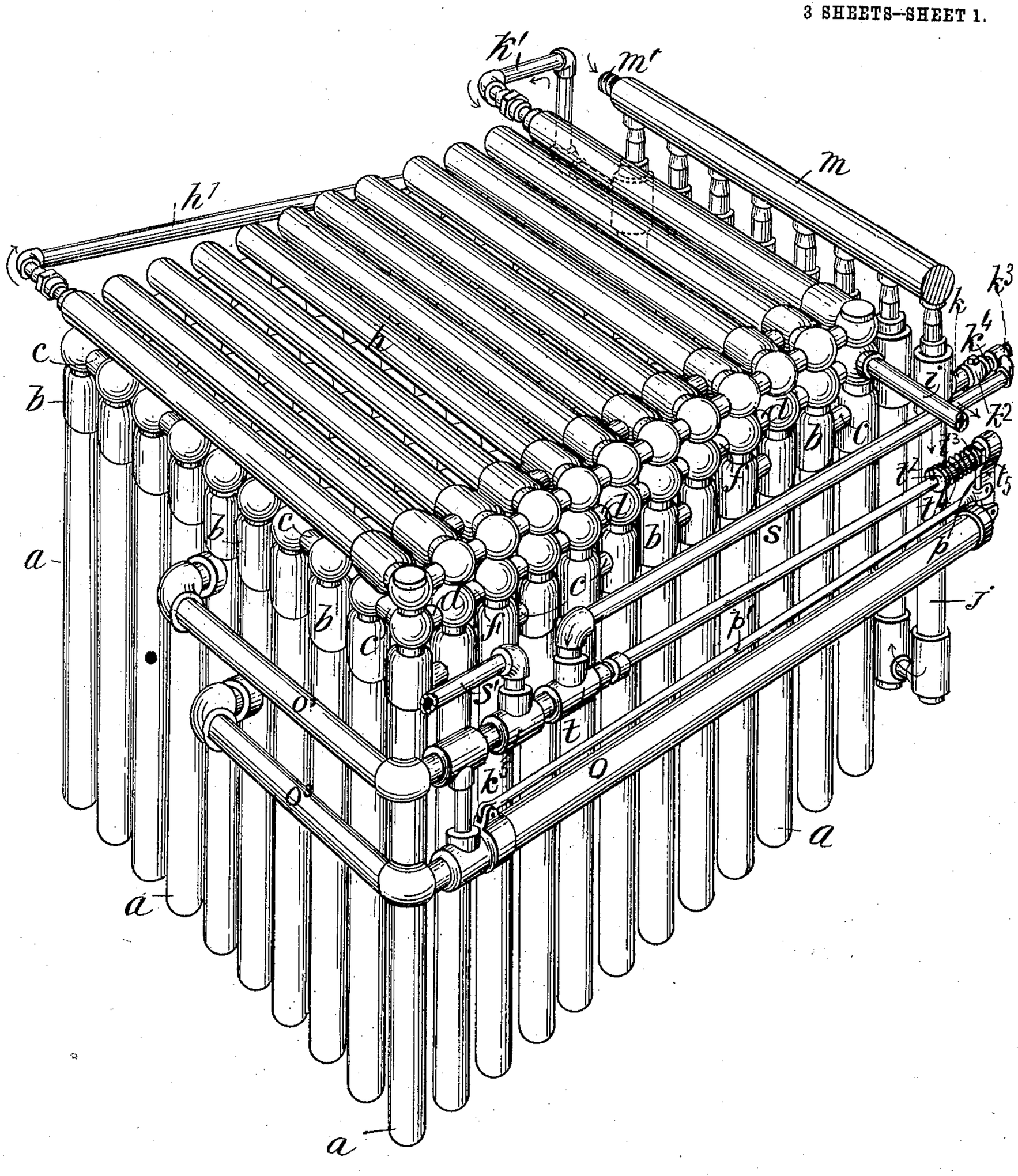


Fig. 1.

Witnesses:
A. D. Thomas
L. M. Stockton

Inventor:
John N. Leach
by N. L. Frothingham,
his attorney.

J. N. LEACH.

STEAM GENERATOR.

APPLICATION FILED AUG. 7, 1905.

983,296.

Patented Feb. 7, 1911.

3 SHEETS—SHEET 2.

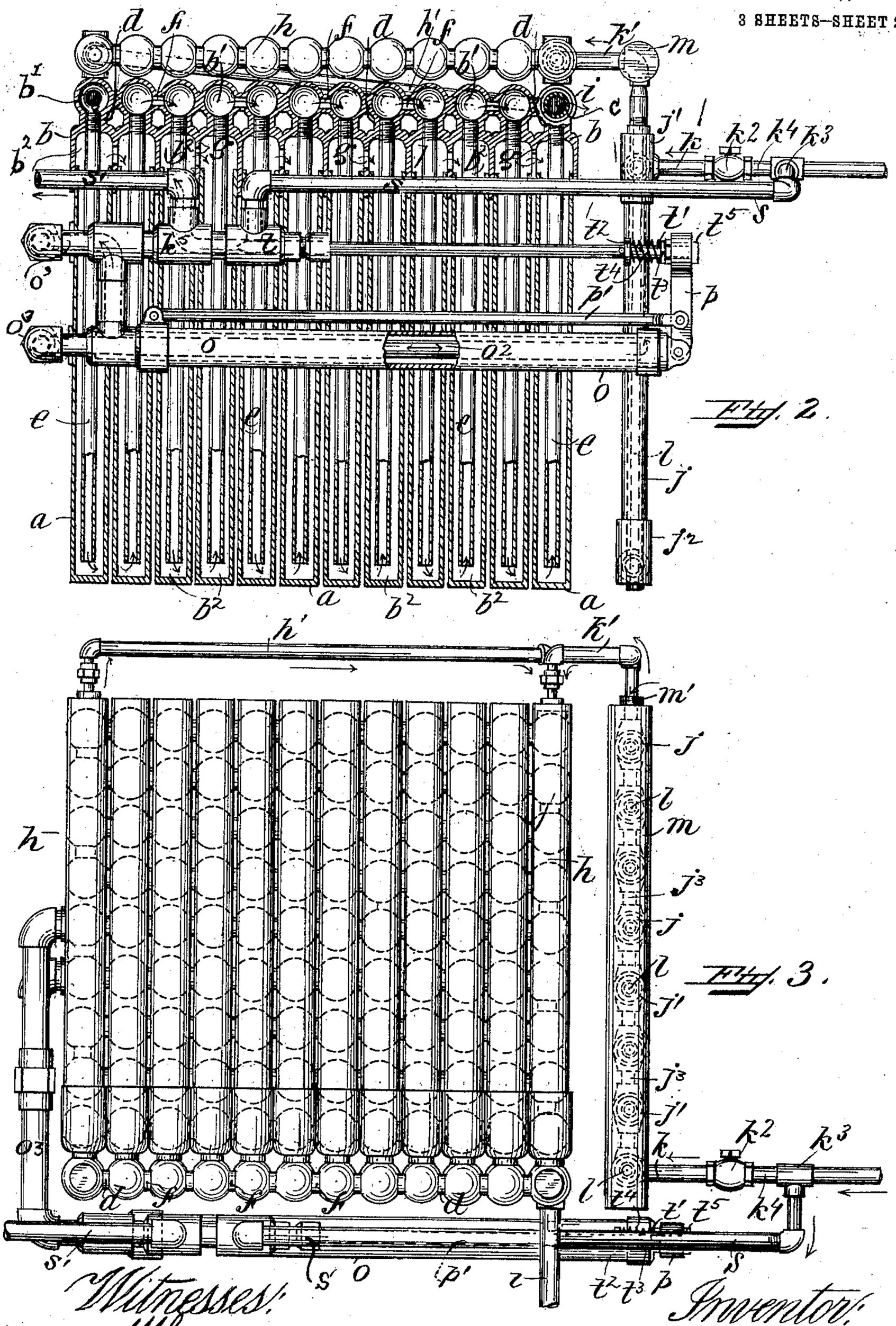


Fig. 2.

Fig. 3.

Witnesses:

A. W. Duncan

L. M. Stockton

Inventor:

John N. Leach

by N. L. Frothingham

his Attorney.

983,296.

J. N. LEACH.

STEAM GENERATOR.

APPLICATION FILED AUG. 7, 1905.

Patented Feb. 7, 1911.

3 SHEETS—SHEET 3.

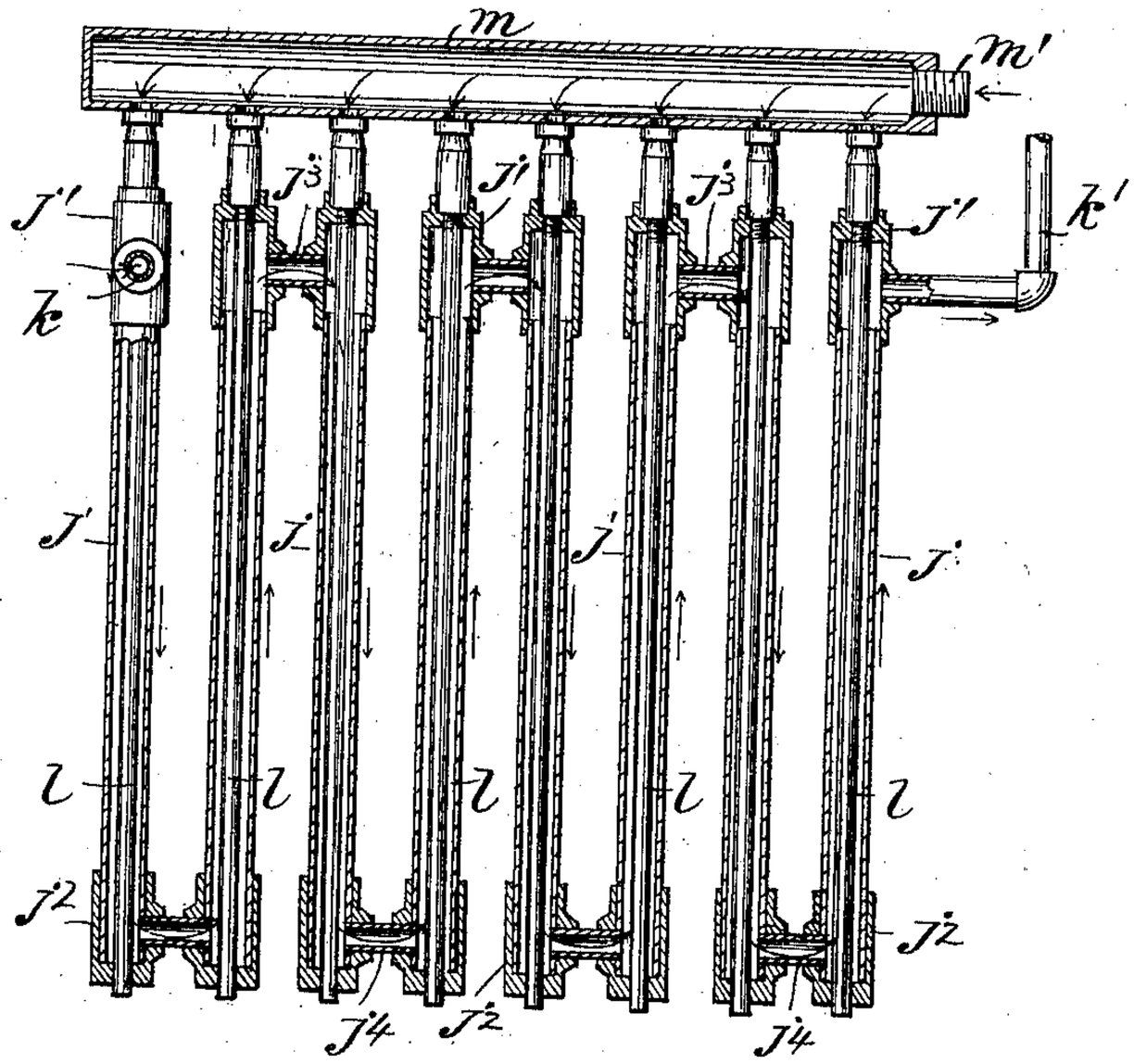
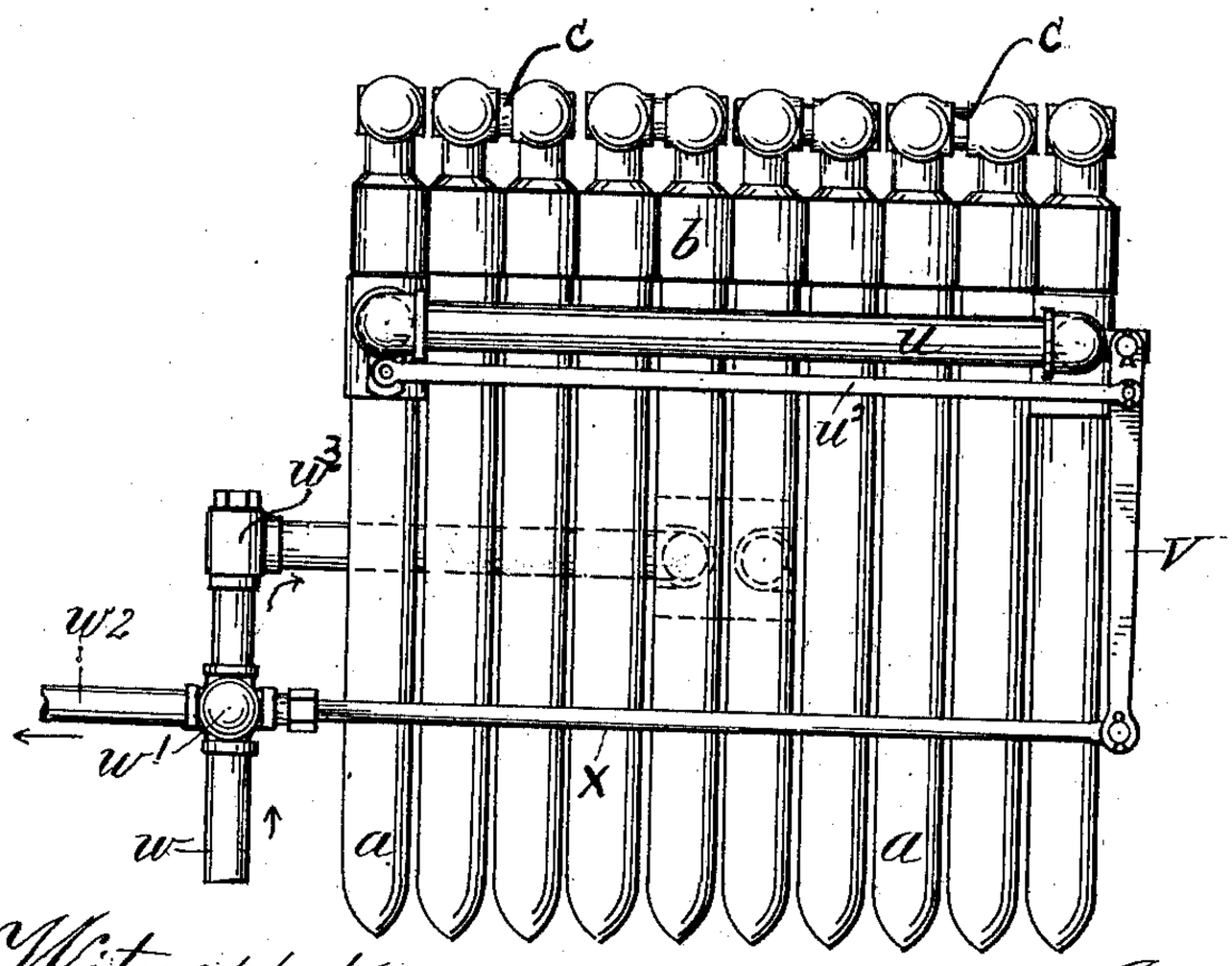


Fig. 4.



Witnesses:

L. M. Stockton

Fig. 5

Inventor:

John N. Leach

by N. L. Frothingham

his attorney.

UNITED STATES PATENT OFFICE.

JOHN N. LEACH, OF MELROSE, MASSACHUSETTS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO JUDSON L. THOMSON MANUFACTURING COMPANY, OF WALTHAM, MASSACHUSETTS, A CORPORATION OF MAINE.

STEAM-GENERATOR.

983,296. Specification of Letters Patent. Patented Feb. 7, 1911.

Application filed August 7, 1905. Serial No. 272,957.

To all whom it may concern:

Be it known that I, JOHN N. LEACH, a citizen of the United States, residing at Melrose, in the county of Middlesex and State of Massachusetts, have invented certain new and useful Improvements in Steam-Generators, of which the following is a specification, reference being had therein to the accompanying drawings, which form a part thereof.

My invention relates to steam generators, and more particularly to that class thereof commonly known as water tube boilers wherein there is a substantially continuous circulation of water and steam within a tube or series of tubes subjected externally to heat, and wherein the water being fed to said tubes is automatically controlled.

The main object of my invention is to provide a generator of this type capable of producing economically steam under high pressures (normally reaching 400 to 500 pounds) without liability of the accumulation of a head of steam sufficient to cause such an explosion as will result in material damage either to the generator or to surrounding objects, and a further object is to provide a generator wherein the volume of feed water maintained in circulation will be automatically controlled by means of a thermostat, and a by-pass actuated thereby, thus insuring the maintenance of the necessary water feed and a substantially uniform degree of saturation of the steam, and to a certain extent controlling the internal pressures.

The invention consists in the novel features of construction and combination of parts hereinafter set forth and described and more particularly pointed out in the claims hereto appended.

Referring to the drawings: Figure 1 is a perspective view of a steam generator embodying my invention; Fig. 2 is a sectional elevation of the generator proper, the thermostatic water feed regulator and its appurtenances being shown in elevation and partly broken away to disclose the arrangement of the thermostat, and the feed water heater, the condenser and feed water heater, and the supplemental water feed control or regulator, being shown in elevation; Fig. 3 is a plan view of the generator; Fig. 4 is a sectional view of the condenser and feed water heater, and Fig. 5 is a side elevation of a modified form of the thermostatic feed water control and its appurtenances.

Like letters refer to like parts throughout the several views.

In connection with a generator of this type, it is necessary to provide a source of water supply, and means drawing water therefrom and forcing it into the generator, ordinarily a feed water pump, which being merely appurtenant to this generator and well known in the art, are not shown in the accompanying drawings. It is also necessary to provide an inclosing casing for the generator, acting as a flue to the fire under said generator, which casing as well as the burner or other means for heating the generator, are likewise omitted from the drawings as tending to obscure the invention, and as being well known in the art and not requiring illustration.

In the embodiment of my invention shown in the drawings, I employ a plurality of sections or units arranged substantially parallel to each other and successively coupled together to form a continuous channel through which the water and steam circulates, by means of nipples at the opposite ends of each section or unit. Each such section or unit is substantially like every other section or unit, and to avoid needless repetition, a description of but one of such will be entered into.

To insure as great a heating surface as possible, I construct each such section or unit of a plurality of tubes *a* closed at the bottom, preferably by being welded together as shown. These tubes are preferably substantially parallel to each other and are so arranged as to project the closed ends thereof into the fire, thus avoiding the presence of fittings at the point subjected to the highest temperatures, and causing the flames to impinge upon all parts of the outside of each said tube, and subjecting all parts thereof equally to the heat. The tubes *a* are fitted to and suspended from a header *b* which is hollow, and provides means whereby said tubes are in communication with each other, to present a continuous channel for the circulation of water and steam

through all the tubes in each section, the adjoining headers being connected by a nipple, as c, to place the tubes in adjoining sections in similar communication with each other to circulate the water and steam throughout the entire generator.

To increase the circulation within a limited boiler space, I divide each header b transversely by a plurality of partitions d forming two distinct chambers b' b^2 to each tube a, the lower b^2 of which is in direct communication with each tube a, and the upper b' of which is in communication therewith through an inner tube e of small diameter nested within each such tube a and extending to a point adjacent to the closed bottom thereof. While the tubes a and e are in communication with the aforesaid chambers, care should be taken that they do not project thereinto to an extent to choke the circulation of water therethrough.

The alternate upper chambers b' are in communication with each other through ports in the webs f connecting the upper parts of said header, and the alternate lower chambers b^2 are similarly placed in communication with each other through ports in the webs g.

Each inner tube e is either screwed into the partition d, or driven thereinto so as to form a direct and a return duct in each tube a and to force the water and steam to circulate through all the tubes a and e, and all the chambers in the headers b in passing through the entire boiler, insuring a material increase in the circulation and presenting a thin film of water to the heated outer tube. This insures a rapid heating of the water in the tubes a and incidentally the maintenance of the high temperature of the water or steam passing thereto or therefrom through the inner tubes e.

The header b is preferably cast in a single piece and of malleable iron, and cored to form the chambers therein, and the various ports heretofore referred to; and the tubes a and e are fitted thereinto either by means of screw threads or by a driving fit.

Arranged across the top of the generator proper is a feed water heating section h constructed in all respects like one of the sections or units of the generator proper, the water passing therethrough being fed to the upper chamber b' at one end of the channel formed by the several sections or units constituting the generator proper, through the pipe h'. A steam pipe i to the engine is in connection with the other end of the said channel.

Water is preferably fed to the said heating section h from a condenser, thus utilizing the heat of the exhaust to impart some heat to the feed water while so condensing said exhaust as to avoid a visible exhaust. This condenser comprises a series of tubes j, the opposite ends of which are provided with fittings j' j^2, the adjoining upper fittings and the adjoining lower fittings being alternately placed in communication with each other by couplings j^3 j^4 respectively, thus permitting a continuous circulation of water through all said pipes. Suitable pipe connections k k' are provided at the opposite ends of this pipe system, whereby feed water is fed thereto from the feed water pump or injector (not shown); and discharge therefrom into the feed water heater above referred to.

Passing through each tube j is a smaller tube l, the upper ends of which are in communication with a header or drum m common to all such, and the lower ends of which open downwardly to discharge the condensed steam. Said tubes l are so fitted to the fittings j' j^2 as to render said tubes j perfectly water tight.

The header or drum m is provided with a nipple m' by means of which connection may be made with the exhaust port of the engine cylinder. The said condenser is so arranged as to be outside of the generator jacket or covering, and the drum m serves both as a muffler and as a distributer of the exhaust.

Arranged in the pipe k is a check valve k^2 beyond which is a three way fitting k^3, the leads of which respectively are in communication with said check valve through the pipe k^4, with a feed water pump or injector, not shown, and with a by-pass system actuated by a thermostat.

The automatic thermostatic control consists of an outer tubular casing o preferably of copper or some metal which readily contracts and expands with a variation in its temperature. This is in communication through the piping o' with one of the sections or units of the generator, and through an inner tube or pipe o^2 and piping o^3 with the next succeeding section or unit, the sole connection between said sections or units being through said thermostat, the connection c not being employed between the headers of these sections or units.

With one arm thereof pivoted to one end of the casing o is a rocking lever p which is mounted on a distance rod p', the other end of which rod is supported in a fixed position to the said casing. It will thus be seen that the lever p, with the expansion and contraction of the casing o, is rocked upon its bearing on said rod p'. Adjacent to the said thermostat is a by-pass system comprising a pipe composed of two sections s s' leading respectively from the fitting k^3 and to the water tank. Arranged in this pipe is a valve t, the stem t' of which is passed through a slightly elongated opening in the long arm of the lever p. Secured to said stem is a collar t^2 between which and a

washer t^3 is located a spring t^4, the function of which is to act as a cushion in starting said valve stem, and to compensate for any movement of the casing o in excess of that required to close the valve. This stem is rendered adjustable with relation to the lever p by means of its screw threaded end, and a nut t^5 bearing upon said lever arm, said nut being set by means of an ordinary jam nut.

In the modification shown in Fig. 5, the construction of the generator proper is substantially identical with that heretofore described except that the water inlet and the steam outlet are arranged in two adjoining sections or units located centrally of the generator, the circulation of water and steam being through a thermostatic casing u extending from one end section or unit to the other. This thermostat differs from the first above described form heretofore described in that the inner tube is dispensed with, there being a direct connection through the tube u. The end fittings for said casing are secured to a tube a of each end section. Mounted on one of said fittings is a rocking lever v, pivoted on a distance rod u', the other end of which is secured to the other end fitting. Feed water is introduced to the generator proper through a pipe system in communication with a tank through a feed water pump or injector (not shown). This system includes a pipe w passing from the said pump or injector to the generator proper, and containing in its length a fitting w' one lead of which is in communication with the by-pass pipe w^2 which is controlled by a valve, and a check valve w^3 between said fitting and said generator. The valve of the by-pass pipe w^2 is normally closed by the the valve stem x, the free end of which is pivotally connected to the lever v, suitable play being allowed in the connection between these parts to compensate for the arc described by said lever in opening and closing said valve.

The operation of the generator is substantially as follows: Water as fed to the generator proper enters the upper chamber b' of the header b at one end of the entire series of sections or units; passes through the inner tube e to the bottom of the outer tube a at one end of said section or unit; up said tube a about the tube e to the lower chamber b^2; through the port g therein to the adjoining chamber b^2; down the outer tube a in communication with said last mentioned chamber b^2 to the bottom thereof; up the inner tube e nested in said last mentioned tube a, to the upper chamber b' immediately above said last mentioned tube a, through the port in the web f to the adjoining chamber b', and through all succeeding tubes a and e of the same section or unit in like manner. This manner of circulating the water causes the water to be repeatedly passed downwardly into those portions of the tubes suspended directly in the flame, thus tending to rapidly heat the water in the tubes a and through said water, that passing through the tubes e, thus substantially increasing the length of tubing through which the water must circulate without corresponding increase of boiler space. The tubes being suspended as shown results in the subjection of the water and steam to the greatest heat at intervals aggregating the greater part of the time during which the same is in the generator, thus not only insuring a rapid steam generation, but the production of a highly superheated steam. This arrangement of tubes also insures the flame and heat passing about and impinging upon the entire periphery of each said tube a, thus utilizing a large percentage of the heat units from the burner or fire in the generation of steam. The circulation of water through the generator being direct and return through the several tubes, there is no tendency for the boiler pressure to distort the several tubes. As the water and steam reach the last tube of each section or unit, they pass through the nipple c to the next section or unit and circulate to and through the successive sections or units in the manner heretofore described. The circulation of water is maintained by a feed water pump or injector, being passed through the tubes j constituting the condenser, and the feed water heating section h before being discharged into the generator proper through the pipe h'. In passing through the tubes j, the water through contact with the tubes l serves to condense the exhaust steam passing to and through said tubes l from the header or drum m, and is also heated to a limited extent. Thus the exhaust is rendered practically invisible, and the otherwise waste heat thereof is utilized as a feed water heater.

As heretofore stated, the feed water heating section h is constructed the same as one of the sections or units of the generator proper, so that the water circulates therethrough in the direct and return channel formed in each tube thereof. Its arrangement above the generator proper is solely with the view of so obstructing the vents between said headers b as to utilize the waste heat or a portion thereof to raise the temperature of the feed water prior to its discharge into the said generator. The water as it enters the generator proper will, therefore, be fairly well heated, and will be rapidly converted into steam therein. When it reaches the section or unit in communication with the casing o through the pipe o', it will ordinarily be in the form of fairly dry steam, which is passed through the said casing and returned through the

inner tube o^2 and piping o^3 to the next succeeding section or unit. The temperature of the steam passing through the casing o causes the metal of said casing to expand, thus forcing the lower arm of the lever p outward and rocking said lever upon the rod p', which rod is not affected by the said heat. This movement acts on the stem t' through the spring t^4, to close the valve t and close the by-pass system comprised of the pipes s s', causing the feed water pump to force water into the generator. So long as the generator steams rapidly, or the water is brought to the required temperature before passing to said casing o, this valve will remain closed; but when the steam passing through said casing becomes saturated, or merely heated water is passed therethrough, the metal of said casing contracts, and reversing the operation of the lever p and the valve stem t', opens said valve and permits the water to be by-passed directly to the water tank until the water or steam in the generator again reaches that temperature required to close said valve. The spring t^4 not only acts as a cushion to relieve the impact of the valve upon its seat, but also permits movement of the lever p in excess of that actually required to close said valve to compensate for a variance in the degree of expansion of the said casing o. The connection between the stem t' and the lever p being adjustable, permits the setting of said valve in assembling the thermostat. The check valve k^2 takes up back pressure from within the generator.

It is found that under ordinary conditions a highly superheated steam is generated in a generator of the type heretofore described, and that there is ordinarily maintained a sufficient head of steam to insure a reserve sufficient to meet all the demands of a small generator; and that while the pressure is ordinarily between 400 and 500 pounds, the individual tubes a and e possess more than sufficient inherent strength to withstand the high pressures.

In case any of the tubes a should blow out or burn out, the nipple c affords a convenient means for removing the section or unit containing the damaged tube, and replacing it by a new section.

The construction, employing straight tubes nested together as described, is an inexpensive structure, and permits the use of materials of substantially uniform strength throughout and capable of withstanding the many severe tests placed upon it in use.

The operation of the modification shown in Fig. 5 is substantially the same as that of the first above described form of the invention, it being merely a simplification of the structure of the entire generator. Water is forced through the pipe w directly into the section of the generator proper, by any desired means as a feed water pump or injector of ordinary and well known construction (not shown), the valve controlling the by-pass pipe w^2 being normally closed. This water circulates through the tubes a and e in the manner above described, passing to the left from section to section until it reaches the outer tube a of the end section, whereupon it enters the tube u and passes to the section at the opposite end of the series. The water prior to its entering said tube u is converted into a more or less saturated steam, and the heat therefrom causes said tube to expand, thus rocking the lever v and closing the valve to the by-pass pipe through the stem x. If through the rapid use of steam, or the shutting off of the fire, water accumulates in the generator, the fluid passing through the tube u will cool said tube, and cause it to so contract as to reverse the movement of said lever v and open the valve to the by-pass pipe w^2, thus causing the water to be returned by the pump through said pipe to the tank until the temperature of the fluid passing through said thermostat reaches the necessary high temperature to again close said valve. The check valve w^3 merely serves to take up back pressure from the generator in the usual and well known manner. The general mode of operation of this thermostat is the same as that of the more complicated and first above described form, and has its field of greatest utility in connection with generators wherein the cost of production and space occupied are important factors.

It is not my intention to claim the generator structure and its arrangement except in so far as such is essential to the operation of the feed water control mechanism, in this application, such being made the subject matter of a separate application.

It is not my intention to limit the invention to the precise details of construction herein shown and described, inasmuch as while in a small steam plant it is desirable to provide the many adjuncts for utilizing the heat units of the burner or fire to the best advantage, still it is apparent that such details may be varied and said adjuncts dispensed with without departing from the spirit and scope of the invention.

Having described the invention what I claim as new and desire to have protected by Letters Patent is:

1. In a steam generator, the combination of a water tube generator proper having a continuous channel therethrough, a water inlet and a steam outlet therefor, means whereby water may be circulated through said channel, a by-pass system leading from said means, a valve controlling said by-pass system, a hollow thermostat forming a part of the continuous channel between the feed water inlet and the point of steam consump-

tion, and connections between said thermostat and said valve whereby the feed of water to the generator is controlled by the temperature of the steam passing through said thermostat.

2. In a steam generator, the combination of a water tube generator proper having a continuous channel therethrough comprising a plurality of sections or units, a water inlet and a steam outlet therefor, a hollow thermostat, connections between the opposite ends of said thermostat, and two successive sections or units, whereby said thermostat forms a part of the channel between said feed water inlet and said steam outlet, means whereby feed water may be circulated through said channel, a by-pass leading from said means, and a valve actuated by said thermostat, whereby said by-pass is automatically controlled.

3. In a steam generator, the combination of a water tube generator proper having a continuous channel therethrough, comprising a plurality of sections or units, a water inlet and a steam outlet therefor, a hollow thermostat, connections between said thermostat and two successive sections or units, whereby said thermostat forms a part of the channel between said feed water inlet and said steam outlet, a multiple way fitting, means whereby the leads of said fitting are respectively in communication with the first of said sections, with a water tank through a pump or injector, and with a by-pass, said by-pass comprising a sectional pipe, a valve therein, a valve stem and connections between said valve stem and said thermostat.

4. In a steam generator, the combination of a water tube generator proper having a continuous channel therethrough, comprising a plurality of sections or units, a water inlet and a steam outlet therefor, a hollow thermostat, connections between said thermostat and two successive sections or units, whereby said thermostat forms a part of the channel between said feed water inlet and said steam outlet, a multiple way fitting, means whereby the leads of said fitting are respectively in communication with the first of said sections, with a water tank through a pump or injector, and with a by-pass, said by-pass comprising a sectional pipe, a valve therein, a valve stem, a distance rod, and a rocking lever mounted thereon, the opposite arms of said lever being connected respectively with said thermostat and said valve stem.

5. In a steam generator, the combination of a water tube generator proper having a continuous channel therethrough, comprising a plurality of sections or units, a water inlet and a steam outlet therefor, a hollow thermostat, connections between said thermostat and two successive sections or units, whereby said thermostat forms a part of the channel between said feed water inlet and said steam outlet, a multiple way fitting, means whereby the leads of said fitting are respectively in communication with the first of said sections, with a water tank through a pump or injector, and with a by-pass, said by-pass comprising a sectional pipe, a valve therein, a valve stem, a distance rod, a rocking lever mounted thereon, the opposite arms thereof being respectively connected with said thermostat and said valve stem, and means whereby said lever is capable of movement in excess of that necessary to close said valve.

6. In a steam generator, the combination of a water tube generator having a continuous channel therethrough comprising a plurality of sections or units, a water inlet and a steam outlet therefor, a hollow thermostat, connections between said thermostat and two successive sections or units, whereby said thermostat forms a part of the channel between said feed water inlet and said steam outlet, a multiple way fitting, means whereby the leads of said fitting are respectively in communication with the first of said sections, with a water tank through a pump or injector, and with a by-pass, said by-pass comprising a sectional pipe, a valve therein, a valve stem, a distance rod, a rocking lever mounted thereon, said lever being connected with said thermostat and said valve stem, a fixed collar on said stem, and a spring seated between said collar and said lever, whereby said lever is capable of movement in excess of that necessary to close said valve.

7. In a steam generator, the combination of a water tube generator proper having a continuous channel therethrough, comprising a plurality of sections or units, a water inlet and a steam outlet therefor, a hollow thermostat comprising an outer metallic tubular casing, an inner metallic tube in communication therewith at one end, and connections between said outer casing and one of said sections or units, and between said inner tube and the next succeeding section or unit, whereby said thermostat forms a part of the channel between said feed water inlet and said steam outlet, a multiple way fitting, means whereby the leads of said fitting are respectively in communication with the first of said sections or units, with a water tank through a pump or injector, and with a by-pass, said by-pass comprising a sectional pipe, a valve therein, a valve stem, a distance rod, and a rocking lever mounted on said rod, and connected with said thermostat and said valve stem.

8. In a steam system, the combination of a generator in two parts, a thermostat having a passage interposed between and communicating with said parts, and a valve controlled by said thermostat adapted to con-

trol the water supply to said generator according to fluctuations of temperature within said thermostat.

9. In a steam system, the combination of a generator in two parts, a thermostat having a passage interposed between and constituting the sole communication between said parts, and a valve controlled by said thermostat adapted to control the water supply to said generator according to fluctuations of temperature within said thermostat.

In witness whereof, I have hereunto affixed my signature, this 2nd day of August, 1905, in the presence of two witnesses.

JOHN N. LEACH.

Witnesses:

N. L. FROTHINGHAM,

A. A. ASHMAN.