C. A. BALL.

METHOD OF OPERATING STEAM HEATING SYSTEMS.

APPLICATION FILED NOV. 6, 1902.

1,024,546. Patented Apr. 30, 1912.

3 SHEETS—SHEET 1.

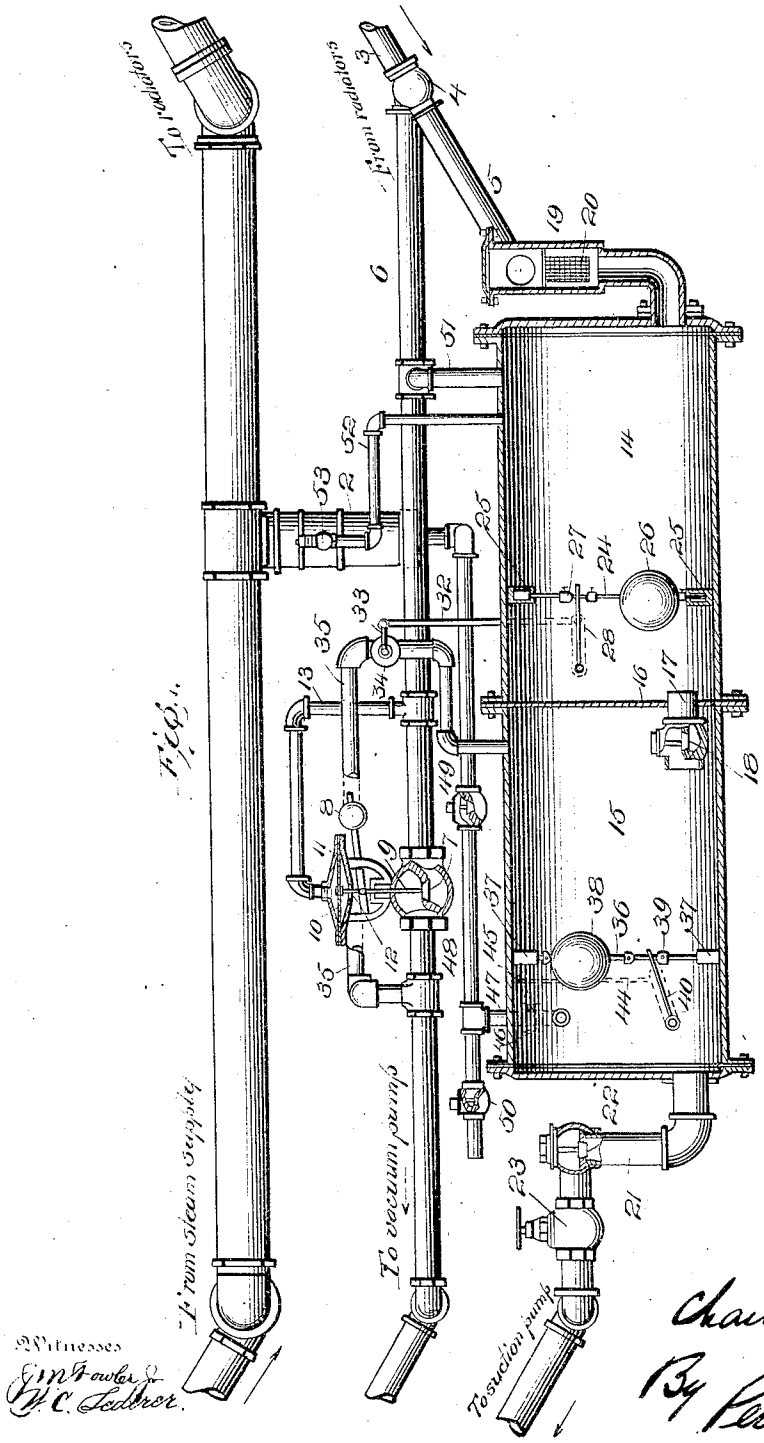

Fig. 1.

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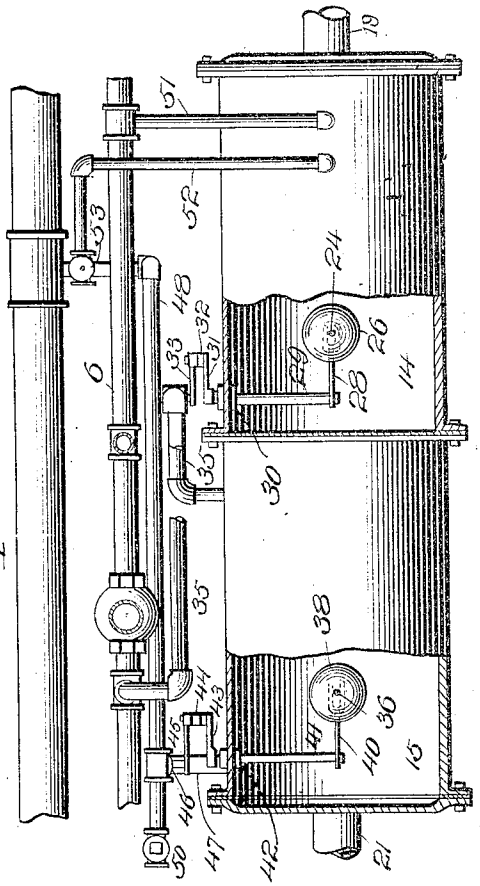
3 SHEETS—SHEET 2.

Fig. 2.



Witnesses

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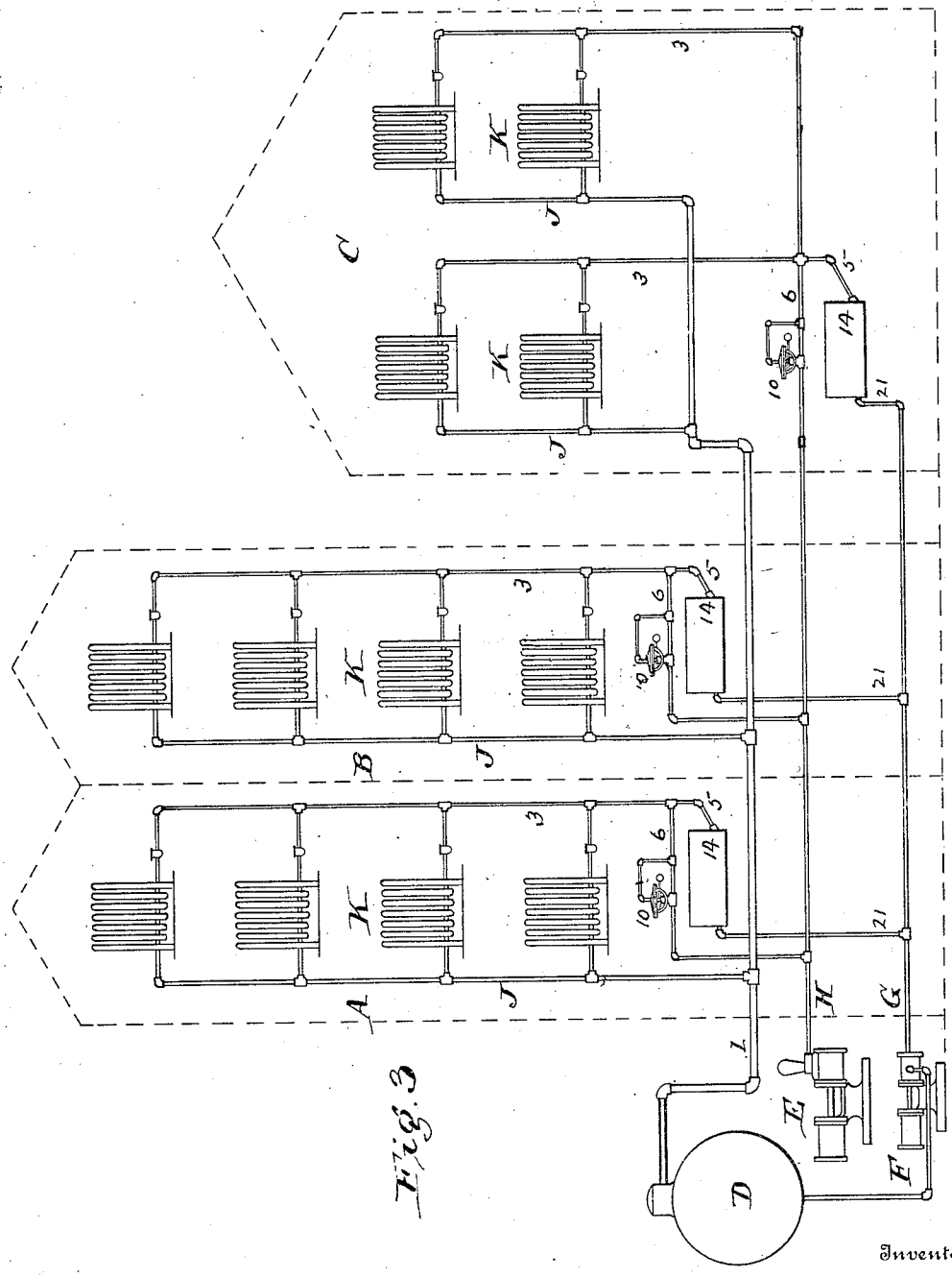

Fig. 3

Witnesses

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UNITED STATES PATENT OFFICE.

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METHOD OF OPERATING STEAM-HEATING SYSTEMS.

1,024,546. Specification of Letters Patent. Patented Apr. 30, 1912.

Application filed November 6, 1902. Serial No. 130,330.

To all whom it may concern:

Be it known that I, CHARLES A. BALL, a citizen of the United States, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented new and useful Improvements in Methods of Operating Steam-Heating Systems, of which the following is a specification.

My invention relates to steam heating systems, and has for its objects certain improvements in the method of operating the same, as follows: First, in providing a new method of removing the air and water of condensation from the return side of the system, consisting in simultaneously extracting the same from the radiators or coils, and then separating the air and water and separately returning the latter to the source of steam supply; secondly, in providing a new method of establishing the desired vacuum at the radiators or coils, consisting in maintaining an excess vacuum at the vacuum pump and automatically reducing the same to the desired degree at a point or points contiguous to the radiators or coils; thirdly, in providing a new method of circulating exhaust steam to points remote from the power fixtures, consisting in maintaining an excess vacuum at the vacuum pump and in the vacuum pipe and automatically reducing the same to the desired degree at points remote from said vacuum pump and contiguous to the radiators or coils; and, fourthly, in providing a novel method of returning the water of condensation to the source of steam supply.

These objects I preferably accomplish in the manner and by the means hereinafter described, reference being had to the accompanying drawings illustrating an apparatus designed to carry the same into effect, and embodied in an application for Letters Patent, filed of even date herewith, Serial No. 130,331, in which:

Figure 1 is a side elevation, partly in section, of a portion of an apparatus for carrying out my invention. Fig. 2 is a top plan view, also partly in section, of the same. Fig. 3 is a diagram illustrating the application of my invention to a series of independent sets of radiators in the same or separate buildings.

Similar numerals of reference denote corresponding parts in the several views.

In the said drawings the reference numeral 1 denotes the steam supply main for the system, the same being adapted to be connected to a boiler direct for receiving a supply of live steam, or to the exhaust side of power fixtures to receive a supply of exhaust steam, it being also understood that these connections may be such that live and exhaust steam may be employed alternately in the same system according to the conditions prevailing. Tapped into the main 1, and extending downwardly therefrom, is a drip pipe 2 adapted to receive any water of condensation from said main.

The main 1 extends at the right to the heating radiators or coils of the system, the return from which is through pipe 3 which divides at 4 into a water return pipe 5 and a vacuum pipe 6, the latter being connected at the left with the usual vacuum pump now commonly employed in systems using exhaust steam for removing the air and water of condensation from the return side thereof. Located in said exhaust pipe 6 is a downwardly opening reducing valve 7, the same having a downward pressure exerted thereon by weight 8, and having its stem 9 connected to a diaphragm 10 in chamber 11, the underside of the latter being exposed to atmospheric pressure through apertures 12, and having its upper side in free communication with the exhaust pipe 6 on the radiator side of valve 7 through pipe 13.

Located below the main 1 are two chambers 14 and 15, divided by a partition 16, in which is located a connecting pipe 17 having a valve 18 therein for permitting a passage from chamber 14 to chamber 15, but for preventing a passage in the reverse direction. The pipe 5 extends into an enlargement 19 containing a removable strainer or sieve 20 for catching any impurities in the condensation water, and said enlargement is tapped into chamber 14, as shown. A pipe 21 extending from the lower portion of chamber 15 is provided with an upwardly opening valve 22, and a cut-off valve 23 and communicates with a force pump of any conventional type located in the boiler room for returning the water to the boiler.

Located in chamber 14 is a rod 24 mounted, but vertically movable, in suitable guides 25, and carrying a float 26 vertically mov-

able thereon. A series of three adjustable stops 27 is also mounted on said rod 24, as shown, and lying between the upper two of these stops is the bifurcated end of an arm 28 embracing rod 24 and forming part of a bell-crank lever 29 extending through a bushing 30 to the exterior of chamber 14, and having its other arm 31 connected, by means of a rod 32 with the operating arm 33 of a valve 34 located in a pipe 35 extending from the pipe 6, on the vacuum pump side of valve 7 therein, to chamber 15, as shown.

Located in chamber 15 is a vertical rod 36 also mounted and vertically movable in guides 37, similar to guides 25, said rod also carrying a vertically movable float 38, and having a series of three adjustable stops 39 thereon, between the two lower ones of which extends the bifurcated end of an arm 40 embracing rod 36 and forming part of a bell-crank lever 41 extending through a bushing 42 to the exterior of chamber 15, and having its other arm 43 connected, by means of a rod 44, with the operating arm 45 of a valve 46 located in a pipe 47 tapped into chamber 15 and connected with a pipe 48 running to the lower end of drip pipe 2. Between the drip pipe 2 and chamber 15 the pipe 48 is provided with a check valve 49 opening toward chamber 15 only, while said pipe 48 is extended beyond pipe 47 and opens to the atmosphere, a check valve 50 opening inwardly only, permitting ingress of air under conditions hereinafter described.

Extending from vacuum pipe 6, on the radiator side of valve 7 therein, is a pipe 51 communicating freely with chamber 14, for a purpose hereinafter to be described; while extending from the side of drip pipe 2 also to said chamber 14 is a pipe 52, a suitable relief fitting 53 for the entrained air and water of condensation from drip pipe 2 being interposed between pipe 52 and drip pipe 2, said relief fitting being preferably of the construction disclosed in Letters Patent No. 702,336, granted to me June 10, 1902.

In order that the system may be adapted to receive alternately live or exhaust steam, I also prefer to employ as the relief for the radiators or coils thereof fittings of the type shown in my above mentioned patent, each radiator or coil being provided on its return side with one of said fittings, the same being in turn connected to its branch of the common return pipe 3 of the system.

As shown in Fig. 1 of the drawings, the steam supply main 1, the vacuum and water return pipes 6 and 21, and the return pipe 3 are all inclined upwardly from the point where the chambers 14 and 15 are located, thereby indicating that said chambers are located at the lowermost point in the system, not only below all the radiators, but also below the steam supply and the vacuum and force pumps, such relative locations being essential to the effective operation of the system, as hereinafter described. It will also be carefully noted that there is a vacuum pump connected with pipe 6 and a force pump connected with pipe 21, these two pumps being entirely separate and distinct.

From the above description the operation of my improved construction will be understood to be as follows: The system being put in operation and steam being admitted to main 1 will flow therethrough to the radiators, all water of condensation in said main gravitating naturally to drip pipe 2, which, as seen, is located at the lowest point in said main, said water building up in said drip pipe until relieved in one of two ways, as hereinafter described. The vacuum and force pumps connected with pipes 6 and 21, respectively, are started simultaneously with the admission of steam to main 1. It will be seen, however, that at this time the valve 7 in pipe 6 is wide open, due to the fact that the pressures on both sides of diaphragm 10 are equal, while the weight 8, being the only operating medium on valve 7, has forced it downwardly and thus open. Assuming that the system will operate perfectly under a vacuum of 10 inches, the vacuum pump is run constantly at a speed to create a much greater vacuum, say, 20 inches, which, by regulating weight 8, can be reduced through valve 7 to remain constant at 10 inches on the radiator side of said valve, it being readily understood that as soon as the vacuum begins to be fall in pipe 6 it will communicate with the upper side of diaphragm 10 through pipe 13, and thus tend to close valve 7, the pressure on the underside of said diaphragm remaining constant at atmosphere. This constant vacuum of 10 inches will thus be communicated to all the radiators or coils of the system through pipe 3 and the usual branch pipes, and will thus rapidly remove the air therefrom to permit the circulation of exhaust steam through main 1, or, when live steam is employed, will aid in its rapid movement to the radiators. Now, by means of pipe 51, the vacuum in pipe 6 is also constantly exerted in chamber 14, the result being that as the pressure or vacuum in pipes 5 and 6 is equal, the combined water of condensation and air returning down pipe 3 will separate at 4, the water flowing by gravity through enlargement 19 into chamber 14, while the air will pass along pipe 6 to the vacuum pump, where it will be discharged to the atmosphere.

It will thus be seen that the vacuum pump performs no function whatever in returning the water of condensation, the flow of the latter to chamber 14 being entirely by gravity. The water flowing into chamber 14

builds up therein, but is prevented from flowing therefrom into chamber 15 because the constant vacuum of 10 inches maintained in chamber 14 will be greater than the suction created in chamber 15 by the action of the constantly running force pump connected with pipe 21. When, however, the water has built up in chamber 14 sufficient to raise float 26, the latter, contacting with intermediate stop 27, will raise rod 24 and with it arm 28 of bell-crank lever 29, thus opening valve 34, through parts 31, 32 and 33, and thus exerting the full vacuum of 20 inches, constantly existing in pipe 6 to the left of valve 7, upon chamber 15. This difference between 20 inches vacuum in chamber 15 and 10 inches vacuum in chamber 14 will cause an instant discharge of the water in chamber 14 through valve 18 into chamber 15, which will continue until float 26, by contacting with the lowermost of the stops 27 on rod 24, forces said rod downward, and, through uppermost stop 27, returns arm 28 to its initial position, thus closing valve 34 and shutting off the vacuum from chamber 15. Now, although the force pump connected with pipe 21 is running constantly, so long as chamber 15 is closed to atmospheric or other pressure the only result will be a limited building up of a leg of water in pipe 21, which is prevented from possible back flow by valve 22. But, when water has discharged into chamber 15 sufficiently to raise the float 38 to the position shown in Fig. 1, the same, by contacting with uppermost stop 39 on rod 36, will have raised said rod, as shown, which will, through lowermost stop 39, raise arm 40 of bell-crank lever 41, and thus, through parts 43, 44 and 45, open valve 46, and thus establish communication between pipe 48 and chamber 15. Now, if live steam is being employed in main 1, the pressure thereof on valve 49 will raise the latter, and an immediate discharge of the water of condensation in drip pipe 2 will take place through pipes 48 and 47 into chamber 15, the same being followed by the live steam, which will afford the necessary pressure in chamber 15 to permit the force pump connected to pipe 21 to receive the water in said chamber and return it to the boiler or feed water heater, said action continuing until float 38 falls in contact with intermediate stop 39 and forces down rod 36 and arm 40, thus again closing valve 46. The steam contained in chamber 15 will now condense and will thus assist in creating a vacuum therein, thus rendering the next intermittent action of chamber 15 more rapid when valve 34 is again opened When, however, exhaust steam is being employed in main 1, the necessary pressure in chamber 15, when valve 46 is opened, will be supplied by atmospheric air entering pipe 48 through valve 50, thus rendering the chamber 15 operative under either condition of steam supply to main 1. It will be understood that should the water of condensation in drip pipe 2 build up therein against valve 49, when it reaches the level of valve 53 it will automatically discharge through pipe 52 into chamber 14, the constant vacuum of 10 inches therein causing said valve to function as will those on the radiators of the system.

This system is intended more particularly to be employed where the building or buildings to be heated are located at a distance from the source of steam supply, even as much as a mile or more apart, for it will be apparent that by maintaining a constant and excessive vacuum in pipe 6 on the boiler side of valve 7, and by regulating said valve to reduce to suit the conditions of the building to be heated, a vacuum may be maintained on the radiator side that will obtain a maximum of efficiency and will operate not only to assist the circulation of live steam in main 1 and through the radiators, but also to draw exhaust steam therethrough, a result not heretofore accomplished.

In Fig. 3, I have shown my invention applied to independent sets of radiators or coils in the same or in separate buildings. In Fig. 3, A, B and C represent different buildings, or A and B may be considered as different parts of the same building. K are the radiators, J are the steam supply pipes and 3 are the return pipes. The radiators are provided as usual with automatic valves at their connection with the returns to prevent free passage of steam, while allowing the air and water to pass through the returns. D is the boiler or other source of steam supply such as the exhaust of an engine; E is the vacuum pump; F is the force or boiler feed pump; H is the vacuum return pipe for air, and G is the pipe for returning the water of condensation. Where A and B are in the same building, the source of steam supply may be equally distant from both and their heating equipments. In Fig. 3, the extents of vacuum in the return pipes in the several buildings or parts of the buildings may be the same or different according to predetermined adjustment but in all cases the operation is with a degree of vacuum which is less than the initial degree of vacuum in the pipe H created by the vacuum pump E or other device.

It will also be understood that a plurality of separate buildings more or less remote from each other and from the boilers, power fixtures and vacuum and suction pumps may be heated simultaneously, by providing one of my improved apparatus for each building, there being a common steam supply main, vacuum return pipe and water return pipe connected to all of said apparatus, each apparatus being constructed and having its

valve 7 regulated to suit the conditions of its building.

In using, therefore, in the claims appended hereto the terms "in proximity to" and "remote from" I wish to be understood to refer to a system wherein the source of steam supply is located at a considerable distance from the radiators or coils, in contradistinction to a system wherein the source of steam supply is located in the basement of the building containing the coils or radiators, which in the present use of the term would constitute a source of steam supply "in proximity to" the radiators or coils.

By having the pipe 6 porcelain or tin lined from the boiler room to the valves 7 I reduce the friction therein to a minimum, and, in the case of each building to be heated, practically bring the vacuum pump to its valve 7 and provide accurate means for regulating the vacuum to the conditions required at any point, whether more or less remote.

The merit of the present invention when extended over great areas lies in the fact that two or more independent groups of radiators, coils or heating apparatus of any form, whether under one roof or two or more roofs, whether relatively close together or far apart, may be employed to supply heat under different conditions or requirements and yet receive the initial energy, both thermal and kinetic, from one general source, thereby providing capacity for extended heating operations at a minimum cost. It frequently happens in large factories including a series of buildings that the several buildings require different conditions of heating and that some will have greater difficulty of circulation than others, and hence by my improved system the extent of vacuum in the return pipe which provides a difference in pressures between the supply and return sides may in each case be made to suit the requirements by merely adjusting the automatic valves 7 to dictate the degree of constant vacuum to be maintained in the respective returns. Where this system is employed in large buildings, independent sets of radiators or coils may be supplied by independent sets of steam supply and return pipes, but all receiving their thermal and kinetic energy from a common source, and each set independently controlled by apparatus hereinbefore described to maintain predetermined degrees of vacuum in the respective returns to cause the steam to enter the radiators by reason of the difference in pressure between the supply and return pipes of each heating unit or of the supply and return pipes of each set of radiators or heating coils. By this means proper heating of enormous buildings may be accomplished with accurate and perfect regulation consistent with the requirements.

It will be observed that the water of condensation first passing down pipe 5 into chamber 14 is retained for a time in the latter, thus losing some of its heat units therein by radiation, and said water is again retained for a time in chamber 15, thus losing more of its heat units therein. Finally, the intermittent action of the force pump on the water in chamber 15 causes the water to build up in a leg in the pipe 21 on its way back to the boiler and to have periods of quiescence in said pipe 21 while the chamber 15 is filling up, thus causing a further loss of heat units to the water, the result being that the water will reach the source of steam supply in a comparatively cool condition, thus rendering unnecessary the employment of a jet condenser with the same, such as is usually found necessary to employ, especially where a vacuum pump is employed. If found to be too cool, the water before being returned to the boiler may be passed through the usual feed water heater.

While I have shown and described the above apparatus as particularly well adapted to carry into effect my improved methods, I do not wish to be understood as limiting myself to said construction, as the same may be varied within wide limits without departing from the spirit of my present invention.

In this application no claim is made to the apparatus herein shown, the same forming the subject matter of other pending applications, more particularly my application Ser. No. 130,331, filed November 6, 1902, hereinbefore referred to.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In a steam heating system, the method of operating the same, which consists in supplying steam to the supply side thereof, maintaining a vacuum in the return side thereof in excess of the requirements, maintaining a lesser vacuum of the desired degree at a point contiguous to the heating point, said lesser vacuum being controlled by the greater vacuum, utilizing the said lesser vacuum to withdraw air and water of condensation from the heating point, and utilizing said greater vacuum to aid in returning the water of condensation to the source of steam supply.

2. In a steam heating system, the method of operating the same, which consists in supplying steam to the supply side thereof, maintaining a vacuum in the return side thereof in excess of the requirements, maintaining a lesser vacuum of the desired degree at a point contiguous to the heating point, said lesser vacuum being controlled by the greater vacuum, utilizing said lesser vacuum to withdraw air and water of con-

densation from the heating point, separating the water and air by gravity, discharging the air by means of one of the vacuums, utilizing said greater vacuum and the steam supply to aid in returning said water to the source of steam supply, and applying a constant suction distinct from the vacuums as the primary means of return for said water.

3. In a steam heating system, the method of operating the same, which consists in supplying steam to the supply side thereof, maintaining a vacuum in the return side thereof in excess of the requirements, maintaining a lesser vacuum of the desired degree at a point contiguous to the heating point, said lesser vacuum being controlled by the greater vacuum, utilizing said lesser vacuum to withdraw air and water of condensation from the heating point, separating the water and air by gravity, discharging the air by means of one of the vacuums, intermittently moving the water on its return by means of the greater vacuum to a position to be returned to the source of steam supply, applying a constant suction distinct from the vacuums as the primary means of return for said water, and intermittently controlling the operation of said suction by means of the steam supply or the atmospheric air.

4. The herein described method of steam heating, which consists in supplying steam from a common source to a plurality of separate heating units each consisting of a large number of radiators or coils in multiple between the supply and return pipes, maintaining a source of high vacuum in excess of the requirements of the heating system, maintaining a lower vacuum in each of the return pipes connecting with the radiators or coils of the respective heating units, automatically and independently maintaining the conditions of lower vacuum in each of the return pipes substantially constant by automatically controlling the communication between the source of high vacuum and low vacuums in the return pipes in accordance with variations in the extent of vacuum in the said return pipes, causing the water of condensation in each heating unit to flow to a separate receiver therefor under the influence of the low vacuum, and causing the water of condensation to flow from the receivers of each of the heating units under the influence of the common high vacuum.

5. The herein described method of steam heating, which consists in supplying steam from a common source to a plurality of separate heating units each consisting of a large number of radiators or coils in multiple between the supply and return pipes, maintaining a source of high vacuum in excess of the requirements of the heating system, maintaining a lower vacuum in each of the return pipes connecting with the radiators or coils of the respective heating units, automatically and independently maintaining the conditions of lower vacuum in each of the return pipes substantially constant by automatically controlling the communication between the source of high vacuum and low vacuums in the return pipes in accordance with variations in the extent of vacuum in the said return pipes, causing the water of condensation to flow to a separate receiver therefor under the influence of the low vacuum, causing the water of condensation to flow from the receivers of each of the heating units under the influence of the common high vacuum, and independently controlling the discharge of the water from the respective receivers by the level of the water therein.

6. The herein described method of steam heating, which consists in supplying steam from a common source to a plurality of separate heating units each consisting of a large number of radiators or coils in multiple between the supply and return pipes, maintaining a source of high vacuum in excess of the requirements of the heating system, maintaining a lower vacuum in each of the return pipes connecting with the radiators or coils of the respective heating units, automatically and independently maintaining the conditions of lower vacuum in each of the return pipes substantially constant by automatically controlling the communication between the source of high vacuum and low vacuums in the return pipes in accordance with variations in the extent of vacuum in the said return pipes, said communication being above the level where the water of condensation collects, causing the water of condensation in each heating unit to flow to the lowest point in the heating unit and to a separate receiver therefor under the influence of the low vacuum, causing the water of condensation to flow from the receivers of each of the heating units under the influence of the common high vacuum simultaneously with the maintaining of the action of the high vacuum on the low vacuum in the return pipes at a higher level than where the water collects in the receiver, and independently controlling the discharge of the water from the respective receivers by the level of the water therein.

7. The herein described method of steam heating which consists in supplying steam to the heating system, maintaining a source of high vacuum in excess of the requirements of the heating system, maintaining a lower vacuum in the return pipe of the heating system, automatically and independently maintaining the conditions of the low vacuum in the return pipe substantially

constant by automatically controlling the communication between the source of high vacuum and low vacuum in said return pipe, causing the water of condensation in the heating system to flow to a receiver therefor under the influence of the low vacuum, causing the water of condensation to flow from the receiver of the heating system under the influence of the high vacuum, and controlling the water discharge caused by the high vacuum by the level of the water in the receiver.

In testimony whereof, I have hereunto set my hand in the presence of two subscribing witnesses.

CHARLES A. BALL.

Witnesses:
HARRY T. STODDART,
L. C. OTTO.