J. L. SPARKS.

VACUUM STEAM HEATING SYSTEM.

APPLICATION FILED OCT. 12, 1908.

929,800.

Patented Aug. 3, 1909.

3 SHEETS—SHEET 1.

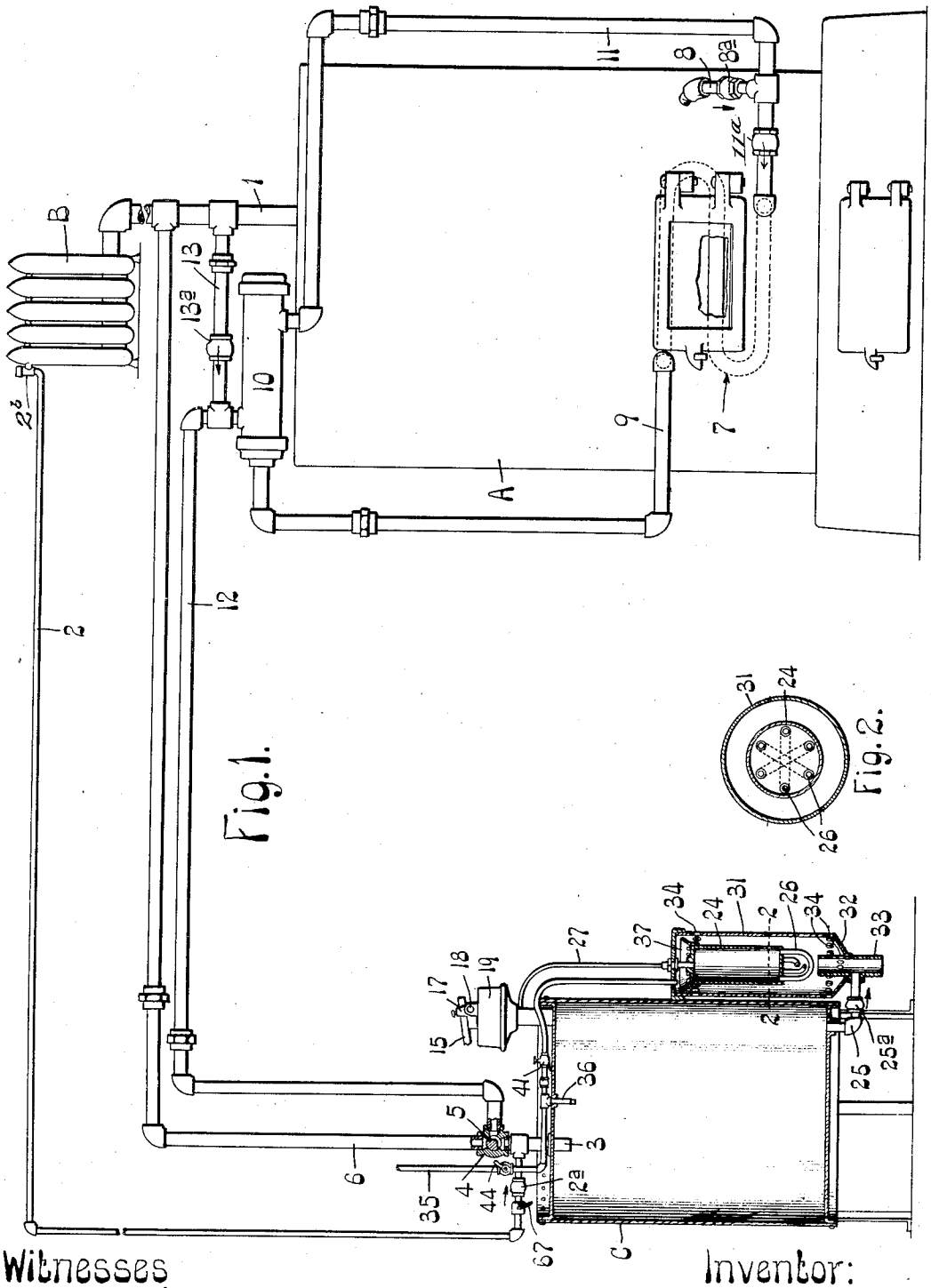


Fig. 1.

Fig. 2.

Witnesses
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Wells L. Church.

Inventor:
James L. Sparks
by Bakewell Cornwall
Atty's.

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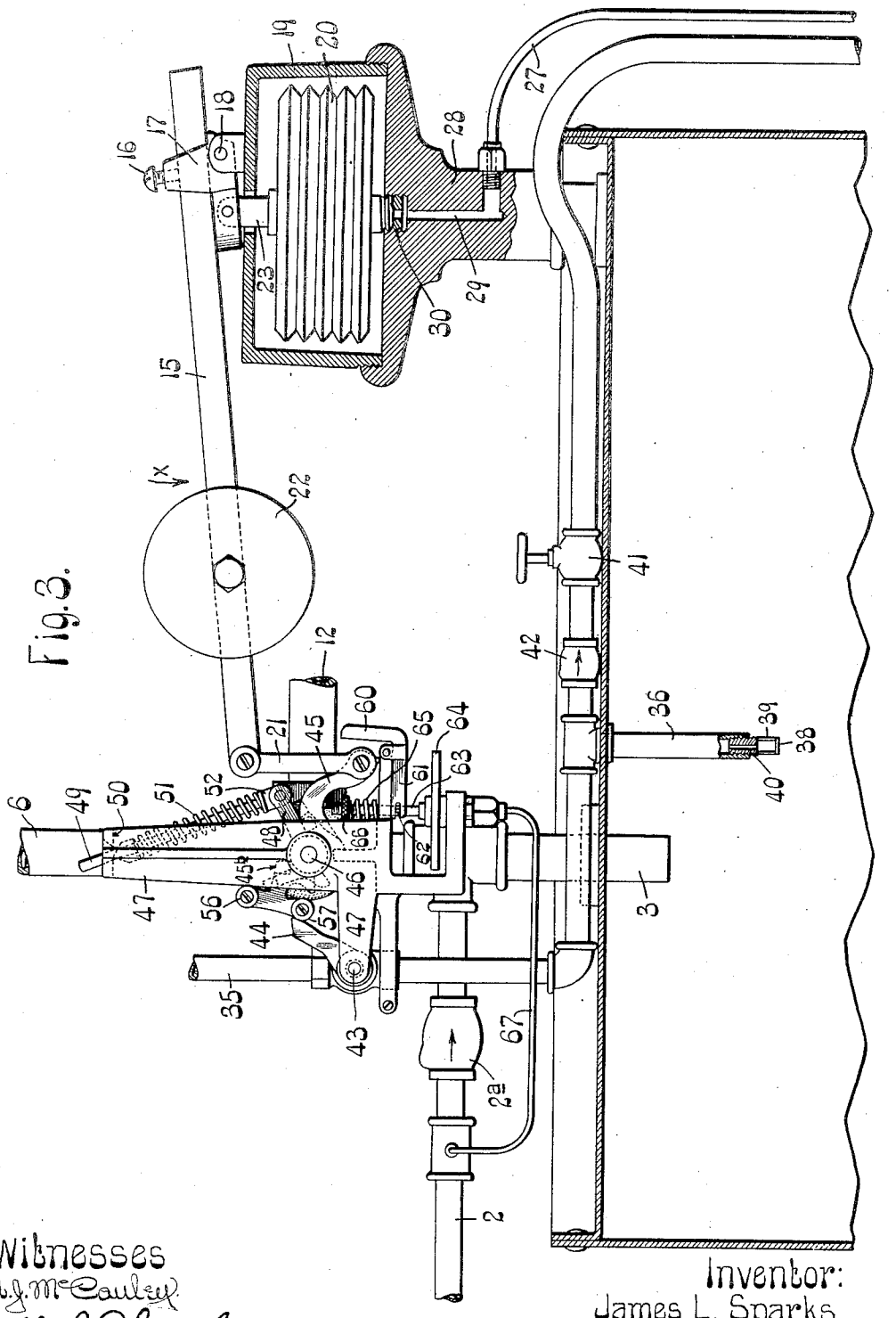


Fig. 3.

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3 SHEETS—SHEET 3.

Fig. 5.

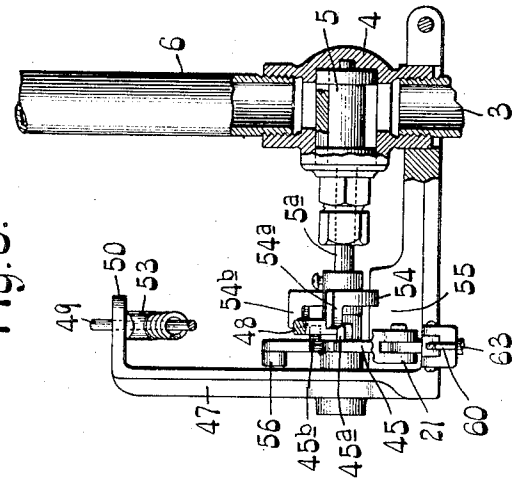
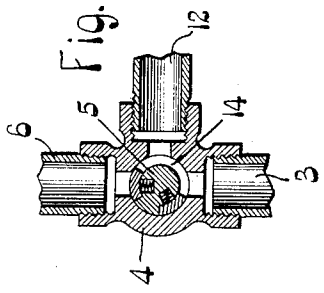


Fig. 7.



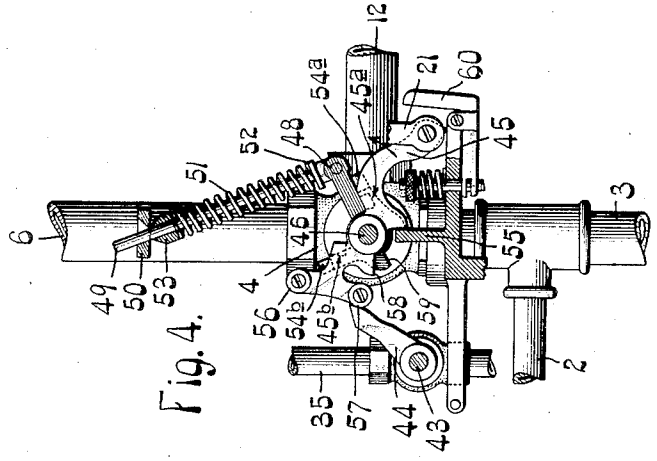


Fig. 4.

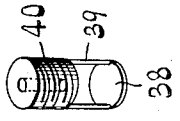


Fig. 6.

Witnesses

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UNITED STATES PATENT OFFICE.

JAMES L. SPARKS, OF ST. LOUIS, MISSOURI, ASSIGNOR TO AUTOMATIC VACUUM PUMP COMPANY, OF ST. LOUIS, MISSOURI, A CORPORATION OF MISSOURI.

VACUUM STEAM-HEATING SYSTEM.

No. 929,800. Specification of Letters Patent. Patented Aug. 3, 1909.

Application filed October 12, 1908. Serial No. 457,303.

To all whom it may concern:

Be it known that I, JAMES L. SPARKS, a citizen of the United States, residing at St. Louis, Missouri, have invented a certain new and useful Improvement in Vacuum Steam-Heating Systems, of which the following is a full, clear, and exact description, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, forming part of this specification, in which—

Figure 1 is an elevational view of a vacuum steam heating system constructed in accordance with my invention; Fig. 2 is an enlarged sectional view taken on approximately the line 2—2 of Fig. 1; Fig. 3 is an enlarged view partly in vertical section of a portion of the vacuum pump and the valve-operating mechanism; Fig. 4 is a front elevational view, partly in vertical section of the valve operating mechanism; Fig. 5 is a side elevational view of said valve-operating mechanism, the steam valve being shown in section; Fig. 6 is a detail perspective view of the water-spraying device; and Fig. 7 is an enlarged vertical sectional view of the steam valve and its casing.

This invention relates to vacuum steam heating systems.

The main object of my invention is to provide a vacuum steam heating system which is so designed that a continuous vacuum will be maintained in the radiators and circulating pipes of the system even after the steam in the boiler has dropped below atmospheric pressure.

Another object of my invention is to provide a system of the character described comprising a steam vacuum pump and means independent of the boiler which supplies the system with steam, for generating steam and introducing it into the cylinder of the vacuum pump. And still another object of my invention is to provide novel means for imparting movement to the valve-operating mechanism which controls the admission of steam to the vacuum pump.

Other objects and desirable features of my invention will be hereinafter pointed out.

Briefly described, my improved system comprises a boiler for generating steam, radiators and circulating pipes for receiving the steam from the boiler, a steam vacuum pump connected to one of the circulating pipes and adapted to exhaust the air from the system so as to create a vacuum therein, and means independent of the boiler for generating steam and introducing it into the cylinder of the vacuum pump to create a vacuum therein when the steam condenses.

In the preferred form of my invention as herein shown, the means independent of the boiler for generating steam and introducing it into the vacuum pump, consists of a coil or similar heating device arranged in the fire-box of the boiler and connected to a valve casing provided with a valve that is operated automatically to admit said steam into the vacuum pump, said valve being so constructed that the steam which is generated in said coil or auxiliary steam generating device is introduced into the circulating pipes and radiators of the system after the vacuum pump has been supplied with a charge of steam. Means is also provided for permitting the steam that is generated in the boiler to flow into the vacuum pump whenever an excessive pressure is obtained in the boiler so as to prevent the water in the boiler from backing up or being forced into the coil or auxiliary heating device that is arranged inside of the fire-box of the boiler. The means for imparting movement to the valve-controlling mechanism consists of a bellows that is adapted to be expanded by gas produced from a volatile liquid contained in a device that is heated by the steam that exhausts from the cylinder of the vacuum pump, and means is also provided for locking the valve-operating mechanism to prevent it from admitting steam to the cylinder of the vacuum pump so long as a certain vacuum exists in the system.

Referring to the drawings which illustrate the preferred form of my invention, A designates a steam boiler of any preferred design, B designates one of the radiators of a vacuum steam heating system, 1 a pipe leading from the boiler A to said radiator for introducing steam into same, and 2 a pipe leading from the radiator or from one of the circulating pipes of the system for exhausting the air therefrom so as to create a vacuum in all of the radiators and circulating pipes of the system.

The reference character C designates the cylinder of a steam vacuum pump into which steam is introduced so as to create a vacuum when the steam condenses, the air exhaust

pipe 2, which leads from the radiators and circulating pipes of the system, being tapped into a pipe 3 that passes into the upper end of the cylinder C of the vacuum pump, a check valve 2^a being arranged in the pipe 2 to prevent steam from entering same. The upper end of the pipe 3 projects into a valve casing 4 inside of which a steam valve 5 is arranged, and one port of said valve casing is connected by means of a pipe 6 with the steam pipe 1 that leads from the boiler A.

Means separate and distinct from the boiler A is provided for generating steam which is introduced into the cylinder of the vacuum pump, and in the preferred form of my invention as herein shown, said means consists of a coil 7 that is arranged inside of the fire-box of the boiler A, as shown in dotted lines in Fig. 1. The water in the boiler A is introduced into the coil 7 by means of a pipe 8, and a pipe 9 leads from the upper end of said coil to a steam dome 10 provided with a drain pipe 11 that leads to the lower end of the coil 7, the water supply pipe 8 from the boiler being tapped into this drain pipe 11. A pipe 12 leads from the upper side of the steam dome 10 to one of the ports of the valve casing 4 of the steam valve, and the steam supply pipe 1 which leads from the boiler A is connected to the steam pipe 12 that leads from the steam dome by means of a pipe 13. Check valves 13^a, 8^a and 11^a are arranged, respectively, in the pipe 13, in the water supply pipe 8 from the boiler, and in the drain pipe 11 from the steam dome, and said check valves are so designed that they open in the directions indicated by the arrows in Fig. 1.

The valve 5 that controls the admission of steam into the cylinder of the vacuum pump is provided with a duct 14, as shown in Fig. 7, that is adapted to always register with two of the admission ports of the valve casing 4, said valve casing being provided with three admission ports, one of which communicates with the pipe 3 that projects into the upper end of the cylinder of the vacuum pump and the other two admission ports communicating with the steam pipes 6 and 12 that lead from the steam supply pipe 1 and the steam dome 10, respectively. The valve 5 is rotatably mounted in the casing 4 and is adapted to receive a quick and sudden stroke by mechanism hereinafter described, said valve-operating mechanism comprising an actuating lever 15 shown in Fig. 3 that has one of its ends adjustably connected by a set screw 16 to a bell crank lever 17 which is pivotally connected at 18 to a stationary support, herein shown as a casing 19, inside of which a bellows or expansible device 20 is arranged. The other end of the lever 15 is connected by means of a link 21 to the operating mechanism for the valve 5, and a weight 22 is adjustably mounted on said lever 15 to move it downwardly or in the direction indicated by the arrow X in Fig. 3. The lever 15 is moved upwardly by means of the bellows 20, the top portion of which is provided with a projection 23 that is pivotally connected to one arm of the bell crank lever 17 to which the lever 15 is secured.

The means herein shown for expanding the bellows 20 consists of a closed reservoir 24 inside of which gas is generated when the steam escapes from the lower end of the cylinder C of the vacuum pump through the exhaust pipe 25 leading therefrom, said reservoir being provided at its lower end with a plurality of approximately U-shaped tubes 26 that contain alcohol or some other volatile liquid. The upper end of the gas reservoir 24 is connected to the bellows 20 by means of a conduit 27 so that the gas which is generated in said reservoir can flow into the bellows and expand same and thus impart movement to the lever 15 which actuates the valve-operating mechanism. Instead of connecting the conduit 27 directly to the bottom of the bellows I prefer to tap said conduit into the support 28 of the housing 19 inside of which the bellows 20 is arranged, said support being provided with a duct 29, as shown in Fig. 3, that establishes communication between the conduit 27 and a perforated lug 30 on the bottom of the bellows that enters a screw-threaded socket in the support 28.

The gas reservoir 24 is arranged inside of a cylindrical-shaped casing 31 provided at its upper end with a cap or cover and having its lower end contracted at 32, as shown in Fig. 1. The exhaust pipe 25 that leads from the lower end of the cylinder C of the vacuum pump is tapped into a pipe 33 which projects into the lower contracted end of the casing 31, and said pipe 33 and also the casing 31 is provided with ports 34 that permit the air and steam which passes out of the vacuum pump into the casing 31 to escape from said casing.

A water supply pipe 35 is provided with a branch 36 that enters the upper end of the cylinder C of the vacuum pump and this pipe 35 terminates adjacent the upper end of the gas reservoir 24 so as to introduce a stream of water onto same to cool it off quickly and thus permit the bellows 20 to contract. Preferably, a flange 37 is arranged at the upper end of the gas reservoir to form a water cup, as shown in Fig. 1 and said flange is provided with a plurality of perforations that permit the water to escape and flow down the sides of the gas reservoir.

The branch water pipe 36 that enters the upper end of the cylinder C of the vacuum pump is provided with a spraying device that consists of a flat plate 38 carried by standards 39 that are connected to a per-

forated plug 40 which is screwed into the lower end of the pipe 36, said spraying device being shown in detail in Fig. 6. The water supply pipe 35 is provided with a cock 41 that can be turned to cut off the flow of water to the gas reservoir, and said pipe is also provided with a check valve 42 which opens in the direction indicated by the arrow in Fig. 3. I also prefer to provide the discharge pipe 25 of the cylinder of the vacuum pump with a check valve 25[a] that opens in the direction indicated by the arrow in Fig. 1 so as to prevent air from entering said cylinder.

The flow of water through the pipe 35 is controlled by a valve, the stem 43 of which is provided with an arm 44 that is adapted to be engaged by the mechanism that controls the operation of the steam valve 5. This valve-operating mechanism is shown clearly in Figs. 3, 4 and 5, and is similar in construction to the valve-operating mechanism disclosed in the pending application of James L. Sparks and Edward R. Eddins, Serial No. 427,600, filed April 17, 1908. Said mechanism consists of a rock arm 45 journaled on a stub shaft 46 that is carried by a stationary frame 47, said stub shaft being arranged in longitudinal alinement with the stem 5[a] of the steam valve 5. This rock arm 45 is connected by means of the link 21 with the free end of the actuating lever 15, and said rock arm is provided with a pair of laterally projecting lugs 45[a] and 45[b] that are adapted to engage and impart movement to an operating member consisting of an arm 48 loosely mounted on the stub shaft 46 and having its upper end pivotally connected to the lower end of a guide rod 49 which passes through a stationary guide 50 on the frame 47. A coiled expansion spring 51 which surrounds the rod 49 is interposed between a stationary collar 52 on the lower end of the rod and a movable collar 53 on the upper end of the rod, said movable collar having its upper side beveled so as to produce a fulcrum tooth which bears against the underneath side of the guide 50 through which the rod 49 extends, as shown in Fig. 4. An approximately V-shaped device 54 is connected to the stem 5[a] of the steam valve 5, and the legs of said V-shaped device are provided with laterally projecting lugs 54[a] and 54[b] that are adapted to be engaged by the arm 48 of the operating member to close and open the steam valve. The frame 47 is provided with a stop 55, and the rock arm 45 and V-shaped device 54 are provided with shoulders that are adapted to coöperate with said stop to limit the movement of said rock arm and V-shaped device. The rock arm 45 is also provided with a pair of friction rolls 56 and 57 that are adapted to engage the arm 44 on the stem 43 of the water valve so as to open and close said valve. When the steam valve is open, as shown in Figs. 1 and 7, so as to permit steam to pass from the pipe 12 into the cylinder of the vacuum pump, the rock arm 45 and the V-shaped device 54 on the stem of the steam valve will occupy the position shown in Fig. 4, and when the steam valve is closed the shoulders 58 and 59 of the rock arm and V-shaped device, respectively, will contact with the stop 55. When the actuating lever 15 is moved upwardly by the expansion of the bellows 20 the rock arm 45 will be moved in the direction of the arrow in Fig. 4, and the lug 45[a] on said arm will engage the arm 48 of the operating member and move it to the left, looking at Figs. 3 and 4. The first portion of the movement of arm 48 moves the rod 49 upwardly and compresses the spring 51 and when said arm passes its dead center the spring 51 will expand and thus complete the movement of the arm 48 to the left, thus causing said arm 48 to strike the lug 54[b] on the V-shaped device 54 and impart a quick movement to the valve stem 5[a] so as to turn the steam valve into such a position that steam cannot enter the cylinder of the vacuum pump. Just before the arm 48 of the operating member strikes the lug 54[b] of the V-shaped device said arm strikes the lug 45[b] of the rock arm 45 and imparts a sudden movement to said arm so that the roll 56 thereon will engage the arm 44 on the stem 43 of the water valve and move it downwardly so as to open the water valve and permit water to flow into the cylinder of the vacuum pump and onto the gas reservoir. When the bellows 20 contracts so that the actuating lever 15 can move downwardly the lug 45[b] of the rock arm 45 will engage the arm 48 of the operating member and move it to the right. The first portion of the movement of said arm 48 will compress the spring 51 and when said arm passes its dead center the spring 51 will expand and complete the movement of said arm in this direction, said arm engaging the lug 54[a] on the V-shaped device 54 so as to open the steam valve quickly and also engaging the lug 45[a] on the rock arm 45 so as to cause the roll 57 on said arm to engage the arm 44 on the stem of the water valve and close same.

Means is provided for locking the valve-operating mechanism in such a position that it cannot operate to open the steam valve, and in the apparatus herein shown said means consists of a bell crank lever 60 that is adapted to be shifted into the path of movement of the rock arm 45. The arm 61 of said bell crank lever has a bifurcated portion that receives a pin 62 on a plunger 63 which is connected to the top side of a bellows 64 formed by a pair of diaphragms that have their peripheral edges connected together, said bellows being adapted to be expanded by a spring 65 interposed between a station-

ary support and an adjustable nut 66 on the plunger 63. The bellows 64 is adapted to be contracted by exhausting the air therefrom, said bellows being connected by means of a pipe 67 with the exhaust pipe 2 which leads from the radiators and circulating pipes of the system to the cylinder of the vacuum pump.

Having described the details of construction of the various devices which constitute my improved vacuum steam heating system I will now describe the operation of same. The boiler A supplies the radiators and circulating pipes of the system with steam and the steam vacuum pump C exhausts the air from the system to create a vacuum therein. A vacuum is created in the pump C by introducing steam into the cylinder of the pump and allowing it to condense, the passage of the steam into said cylinder forcing the air therein out through the discharge pipe 25. Instead of relying on the steam which is generated in the boiler A to operate the pump, I have provided the fire-box of the boiler with a coil 7 so that steam will be generated in said coil whenever there is any fire in the fire-box. Consequently, if the steam in the boiler A falls below atmospheric pressure the pump will not fail to operate for the coil 7 insures a supply of steam above atmospheric pressure in the steam dome 10 at all times. Steam passes from the steam dome through the pipe 12 into the cylinder C of the pump when the steam valve 5 occupies the position shown in Fig. 1, the entrance of said steam into said cylinder driving out the air in same through the discharge pipe 25. The steam expels all of the air from the cylinder of the vacuum pump and some of the steam passes out of the cylinder through the discharge pipe 25 and up into the casing 31 of the gas reservoir. When said steam comes in contact with the tubes 26 at the lower end of the gas reservoir the volatile liquid in said tubes will be heated and thus create a gas which flows through the conduit 27 into the bellows 20, thereby expanding said bellows. The expansion of the bellows 20 moves the actuating lever 15 upwardly and thus imparts movement to the rock arm 45 which moves the arm 48 of the operating member of the valve mechanism to the left, the movement of said arm 48 turning the valve 5 into such a position that the duct 14 therein is brought into registration with the pipe 12 that leads from the steam dome and the pipe 6 that leads from the steam supply pipe 1 so that the steam from the steam dome can flow into the radiators and circulating pipes of the system. This movement of the valve 5 closes the pipe 3 and consequently cuts off the admission of steam to the cylinder of the pump. The steam that has been introduced into the cylinder of the pump condenses and thus creates a vacuum that exhausts the air from the radiators and circulating pipes of the system. I prefer to introduce a spray of water into the cylinder of the pump to cause the steam to condense quickly but this is not absolutely necessary as the steam would condense without introducing water into the cylinder. As previously stated, the water is introduced into the cylinder by means of the branch 36 which leads from the pipe 35 and the valve which controls the passage of water through said pipe is opened by the operating mechanism for the steam valve 5 at approximately the same time said valve is moved to cut off the supply of steam to the cylinder C. Water from the pipe 35 is also discharged onto the gas reservoir 24 to cause it to cool off quickly and as soon as said reservoir cools the bellows 20 will contract and thus permit the weight 22 to move the actuating lever 15 downwardly, the downward movement of said lever actuating the rock arm 45 of the valve mechanism so as to cause said mechanism to close the water valve and also move the steam valve 5 into such a position that the duct 14 therein registers with the steam inlet pipe 3 of the pump cylinder and the supply pipe 12 which leads from the steam dome. These operations are repeated automatically so long as there is any fire under the boiler A, a supply of steam being introduced into the pump cylinder intermittently to create a vacuum which exhausts the air from the system.

When an excessive pressure of steam is obtained in the boiler A the steam will escape through the pipe 13 which is tapped into the supply pipe 12 that leads from the steam dome, thereby eliminating the possibility of the water in the boiler A being forced into the coil 7 and thence into the cylinder of the pump. In other words, no matter how much pressure is in the boiler A the water in said boiler will not back up into the coil 7 for the pipe 13 permits the steam to escape into the cylinder of the pump or the pipe 6 which leads to the circulating pipes of the system.

So long as there is a certain vacuum in the system the valve-operating mechanism will be locked in such a position that it cannot operate to close and open the steam valve intermittently for said vacuum contracts the bellows 64 and thus holds the bell crank lever 60 in the path of movement of the rock arm 45 of the valve-operating mechanism. That is to say, after the actuating lever 15 has moved upwardly to cut off the supply of steam to the cylinder of the pump, the vacuum which is created by the condensation of the steam in said cylinder will contract the bellows 64 and thus move the bell crank lever 60 into such a position that it will prevent the rock arm 45 of the valve-operating mechanism from moving downwardly to open the steam valve. When the

vacuum is destroyed or falls below a certain stage the spring 65 will expand and thus expand the bellows 64, thereby moving the bell crank lever 60 out of the path of movement of the rock arm 45 so that said arm can move downwardly and open the steam valve. By adjusting the nut 66 on the plunger 64 I can vary the tension of the spring 65 and thus accurately govern the operation of the locking device for the valve-operating mechanism.

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

1. In a vacuum steam heating system, a boiler for supplying steam to the circulating pipes of the system, a vacuum pump for exhausting the air from said pipes and comprising a closed tank that is provided adjacent its lower end with a discharge opening, means independent of the boiler for generating steam and introducing it into said tank to create a vacuum therein, a valve for controlling the admission of steam into said tank, means operated by the heat of the steam that exhausts from the discharge opening of said tank after the entire contents of same has been displaced for controlling the operation of said valve, and means for preventing air or any other substance from flowing back into the tank through said discharge opening.

2. In a vacuum steam heating system, a boiler for supplying steam to the circulating pipes of the system, a vacuum pump for exhausting the air from said pipes, said pump having a closed cylinder, means independent of the boiler for generating steam, and means for causing said steam to flow into the cylinder of the vacuum pump for a certain period and thereafter flow into the circulating pipes of the system.

3. In a vacuum steam heating system, a boiler, a pipe leading from said boiler for supplying steam to the circulating pipes of the system, a vacuum pump for exhausting the air from the circulating pipes, said pump comprising a cylinder that is provided adjacent its lower end with a discharge opening, means for preventing air or any other substance from entering the tank through said discharge opening, means independent of the boiler for generating steam and introducing it into the cylinder of the vacuum pump to create a vacuum therein, and automatically operated means adapted to be operated by the steam that escapes through the discharge opening of the pump cylinder after the entire contents of same has been discharged for cutting off the supply of steam to said cylinder and introducing said steam into the pipe that leads from the boiler to the circulating pipes of the system.

4. In a vacuum steam heating system, a boiler for supplying steam to the circulating pipes of the system, a steam vacuum pump for exhausting the air from said pipes and comprising a cylinder that is provided adjacent its lower end with a discharge opening, means independent of the boiler for generating steam and introducing it into the cylinder of the pump to create a vacuum therein, a valve for cutting off the supply of steam to said cylinder, mechanism for operating said valve, means adapted to be operated by the steam that escapes from the discharge opening of the pump cylinder after the entire contents of same has been forced through said discharge opening for imparting movement to said valve mechanism, and means for preventing air or any other substance from entering the pump cylinder through said discharge opening.

5. In a vacuum steam heating system, a boiler, a pipe leading from said boiler for supplying steam to the heat distributing devices of the system, a steam vacuum pump for exhausting the air from said heat-distributing devices, said pump having a cylinder or tank that is provided adjacent its lower end with a discharge opening, means for preventing air or any other substance from flowing into said cylinder through said discharge opening, means independent of the boiler for generating steam, a valve casing having ports that communicate with conduits that lead to the cylinder of the vacuum pump, to said auxiliary steam generating means, and to the steam-supply pipe leading from the boiler, a valve arranged in said valve casing, and automatic means operated by the steam that escapes through the discharge opening of the cylinder after the entire contents of same has been displaced for operating said valve to cause part of the steam which is generated in said auxiliary means to flow into the cylinder of the pump, and part of said steam to flow into the conduit that communicates with the steam-supply pipe that leads from the boiler.

6. In a vacuum steam heating system, a boiler for supplying steam to the circulating pipes of the system, a steam vacuum pump for exhausting air from said pipes, said pump consisting of a cylinder that is provided adjacent its lower end with a discharge opening, means for preventing air or any other substance from flowing into the cylinder through said discharge opening, means independent of the boiler for generating steam, a valve for causing enough of said steam to flow into the cylinder of the pump to discharge the contents thereof and thereafter cause the steam generated by said auxiliary means to flow into the circulating pipes of the system, mechanism for operating said valve, and means adapted to be operated by the heat of the steam that escapes from the discharge opening of the pump cylinder for imparting movement to said valve mechanism.

7. In a vacuum steam heating system, a boiler for supplying steam to the circulating pipes of the system, a steam vacuum pump for exhausting the air from said circulating pipes and comprising a cylinder provided adjacent its lower end with a discharge opening, means for preventing air or any other substance from entering said cylinder through said discharge opening, means independent of the boiler for generating steam, a valve for admitting charges of said steam into the cylinder of the vacuum pump to create a vacuum therein, and means arranged in the path of the steam that escapes from the discharge opening of said pump cylinder after the entire contents of same has been discharged for controlling the operation of said valve.

8. In a vacuum heating system, a boiler for supplying steam to the circulating pipes of the system, a steam vacuum pump for exhausting the air from said pipes, said pump comprising a closed cylinder, means independent of the boiler for generating steam, a valve for admitting said steam into the cylinder of the pump to create a vacuum therein, mechanism for operating said valve, and locking means coöperating with said valve-operating mechanism for causing it to remain at rest so long as a certain vacuum exists in the system.

9. In a vacuum steam heating system, a boiler for supplying steam to the distributing pipes and radiators of the system, a vacuum pump for exhausting air from said pipes and radiators, said pump comprising a closed cylinder, a water-heating device arranged in the fire-box of said boiler, a steam dome for receiving the steam generated in said water-heating device, and means for permitting either the steam that is generated in the boiler or the steam from said steam dome to flow into the cylinder of the vacuum pump to create a vacuum therein.

10. In a vacuum steam heating system, a boiler for supplying steam to the circulating pipes of the system, a vacuum pump for exhausting the air from said pipes, said pump comprising a closed cylinder, a water-heating device arranged in the fire-box of the boiler, a steam dome connected to said water-heating device, a drain-pipe leading from said steam dome back to said water-heating device, a pipe leading from said steam dome for supplying steam to the cylinder of the vacuum pump, and means for permitting the steam in the boiler to flow into said pipe and thus be introduced into the cylinder of the pump when an excessive pressure is obtained in the boiler.

11. In a vacuum steam heating system, a boiler for supplying steam to the circulating pipes of the system, a steam vacuum pump for exhausting the air from said pipes, said pump comprising a cylinder provided with an outlet, means for preventing air or any other substance from entering said cylinder through said outlet, means independent of the boiler for generating steam, a valve for admitting said steam into the cylinder of the pump to create a vacuum therein, operating mechanism for controlling said valve and adapted to be operated by the steam that escapes from said pump, a locking device coöperating with said valve-operating mechanism to retain it in an inoperative position, and means controlled by the vacuum in the system for causing said locking device to become operative.

12. In a vacuum steam heating system, a boiler for supplying steam to the circulating pipes of the system, a steam vacuum pump for exhausting the air from said pipes, said pump having a cylinder that is provided with an outlet, means for preventing air or any other substance from entering said cylinder through said outlet, means independent of the boiler for generating steam, a valve for admitting said steam into the cylinder of the pump to create a vacuum therein, operating mechanism for controlling said valve and adapted to be operated by the steam that escapes from said pump, a locking device coöperating with said valve-operating mechanism to retain it in an inoperative position, and adjustable means controlled by the vacuum in the system for causing said locking device to become operative.

13. In a vacuum steam heating system, a boiler for supplying steam to the circulating pipes of the system, a steam vacuum pump for exhausting the air from said pipes, said pump comprising a closed cylinder that is provided with an outlet, means for preventing air or any other substance from entering the cylinder through said outlet, means independent of the boiler for generating steam, a valve for admitting said steam into the cylinder of the pump to create a vacuum therein, operating mechanism for controlling said valve and adapted to be operated by the steam that escapes from said pump, a locking device coöperating with said valve-operating mechanism to retain it in an inoperative position, a bellows connected to said locking device for imparting movement thereto, yielding means for moving said bellows in one direction, and means for permitting the vacuum in the system to move said bellows in the opposite direction.

14. In a vacuum steam heating system, a boiler for supplying steam to the circulating pipes of the system, a steam vacuum pump for exhausting the air from said pipes, said pump comprising a closed cylinder, means independent of the boiler for generating steam and introducing it into the cylinder of the pump or into the circulating pipes of the system, and means for preventing the steam generated by said auxiliary

means from escaping into the system when it should enter the cylinder of the vacuum pump.

15. In a vacuum steam heating system, a boiler for supplying steam to the circulating pipes of the system, said pump comprising a closed cylinder, a steam vacuum pump for exhausting air from said pipes, means independent of the boiler for generating steam, a valve for causing said steam to flow into the cylinder of the pump for a certain period and thereafter flow into the circulating pipes of the system, and a thermodynamically operated means for controlling said valve.

In testimony whereof I hereunto affix my signature in the presence of two witnesses, this tenth day of October 1908.

JAMES L. SPARKS.

Witnesses:

WELLS L. CHURCH,

GEORGE BAKEWELL.