J. W. GAMBLE.

STEAM SYSTEM.

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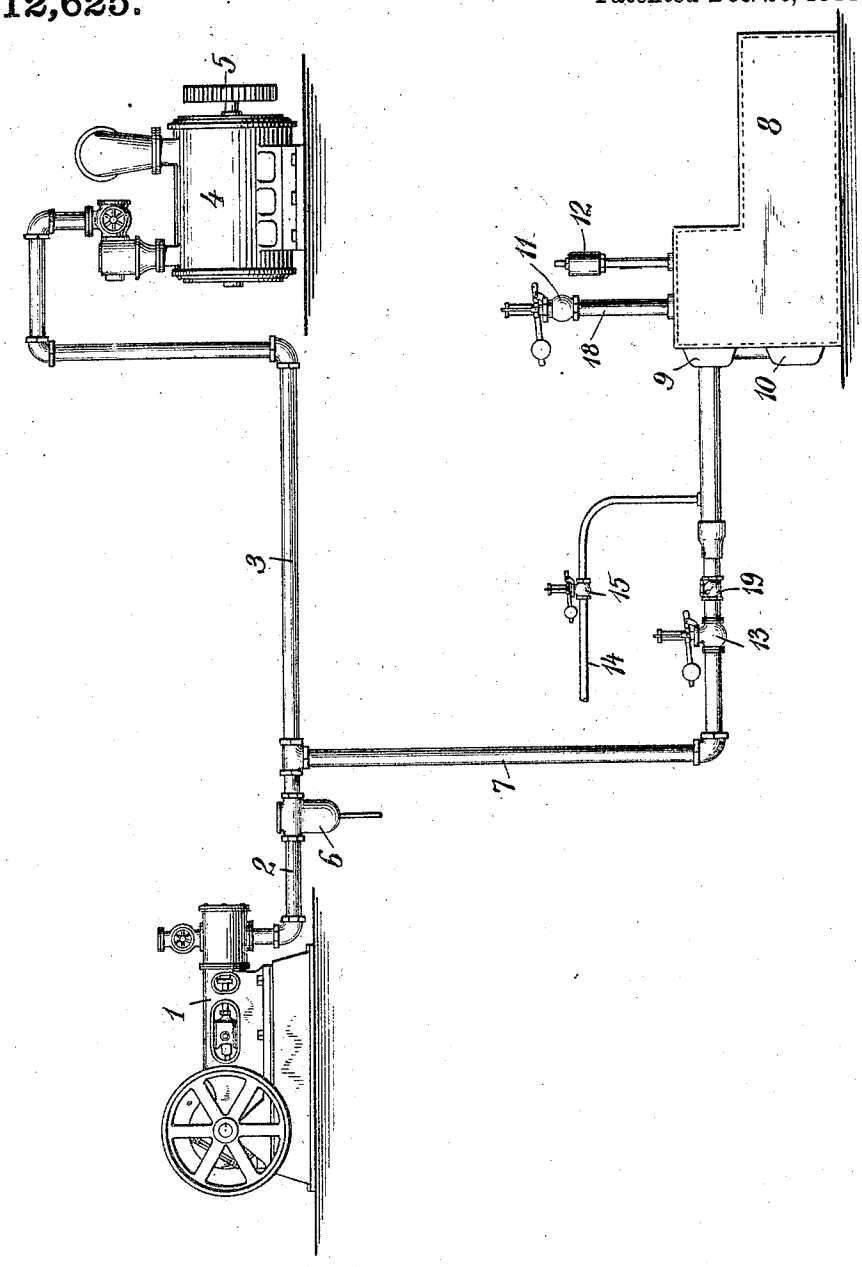
1,012,625. Patented Dec. 26, 1911.



WITNESSES:

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STEAM SYSTEM.

1,012,625. Specification of Letters Patent. Patented Dec. 26, 1911.

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To all whom it may concern:

Be it known that I, JOSEPH W. GAMBLE, a citizen of the United States, residing in the city and county of Philadelphia and State of Pennsylvania, have invented certain new and useful Improvements in Steam Systems, of which the following is a specification.

This invention relates to steam systems in which are employed apparatus for utilizing exhaust steam from any suitable source, as for instance from one or more reciprocating engines. Heretofore exhaust steam from an engine has been carried to and utilized in a prime mover, such as a low-pressure steam-turbine: also, it is common to employ such exhaust steam in a feed-water heater for heating water which is afterward fed to the boilers supplying steam to the engine. The present invention is directed to the provision of a system in which the exhaust steam from one or more engines is employed in part in a low-pressure prime mover and in part in a feed-water heater or other heating or drying system, both of these devices being supplied with steam from the same source.

When a steam engine of the reciprocating type is operated without employing a condenser in the exhaust line, the steam exhausted from the cylinder is at a pressure considerably above atmospheric pressure. This steam passing from the engine, in addition to being substantially above atmospheric pressure, is supplied practically constantly during the operation of the engine in an amount dependent upon the work being done by the engine. It therefore represents a very considerable amount of power and this power may be developed by utilizing the steam in devices specially adapted for use with low-pressure steam. In such a system, a feed-water heater may be employed to advantage utilizing exhaust steam for heating water to be returned to the boilers, but in many cases only a portion of the exhaust steam would be required for this purpose. The remainder of the steam is therefore available for other uses and may be profitably utilized in a steam turbine specially designed to operate on low-pressure steam.

In accordance with the invention, a low-pressure turbine and a feed-water heater or other heating or drying device are connected to the exhaust of a steam system, as the exhaust pipes leading from one or more reciprocating engines, and in combination with these devices, means are employed for insuring proper operation thereof. The pressure of the steam in the exhaust line changes considerably from time to time due to various causes but it is important that the supply of steam to the heater be maintained at all times and under all conditions. To this end, a source of supply of live steam is connected to the heater and provided with automatic controlling devices, whereby the steam supply is opened whenever the exhaust steam supplied to the heater is insufficient. When live steam is supplied to the heater in this manner, it should not be allowed to pass through the connections for carrying exhaust steam to the heater and thus be utilized in the low-pressure turbine, as it would be undesirable to operate that turbine with live steam. Means are therefore provided which operate automatically to close the connections for carrying exhaust steam to the heater under predetermined conditions, such closure of the exhaust steam passage occurring at a pressure slightly higher than that at which the connection for carrying live steam to the heater opens.

The preferred embodiment of the invention is illustrated in the accompanying drawing which shows the several devices in elevation together with the piping connecting them.

Referring to the drawing, 1 indicates a steam engine whose cylinders exhaust into the exhaust line 2. The engine here shown is illustrative only as it may be of any suitable construction, and usually a number of engines will be connected to the same exhaust line 2. This exhaust pipe 2 is connected by a pipe 3 to a low-pressure steam turbine 4 so that a portion of the exhaust steam is carried to the turbine 4 to operate the latter, the turbine delivering power in any suitable manner, as by means of a gear 5 on the shaft thereof. An oil separator 6 is connected in the pipe leading to the turbine so as to clear the steam of water, cylinder oil and other foreign substances. A branch pipe 7 leading from the exhaust pipe 2 also carries steam to a feed-water heater 8. This heater may be of any suitable construction and of either the open or closed type so that the steam is mingled with or carried adjacent to the incoming water and caused

to impart its heat thereto. I have shown a heater of large size to contain a substantial quantity of heated water; it is provided with an oil separator 9 through which the steam passes to the heater and a trap 10 for carrying off to waste oil and excess water. When the oil separator 6 is located as shown, the separator 9 may be omitted and when the separator 9 is provided as shown attached to the wall of the heater, the separator 6 may be placed in the pipe 3 between pipe 7 and the turbine 4. The heater 8 is provided with an exhaust pipe 18 in which is a relief valve 11, and also with either a thermostatic or a manually-operated vent 12 for permitting the escape of air from the heater 8. In the pipe 7 leading to the heater 8 is a pressure-reducing valve 13 set to reduce the pressure of the steam flowing through it to a predetermined point so that this steam may be safely utilized in the heater 8 and will give the desired heating of the water therein. Furthermore, this pressure-reducing valve 13 is so constructed that it will close when the pressure in pipe 7 falls below a predetermined point. If desired, however, these two functions of reducing the pressure of the steam and closing the passage 7 need not both be placed upon the valve 13; instead, that valve may be used as a pressure-reducing valve solely and a separate check-valve 19 may be provided in pipe 7 for closing that passage when the pressure of the steam flowing therein falls below that desired for the steam to be admitted to the heater 8. Furthermore, if the heater 8 be of sufficient strength and the relief-valve 11 thereof be properly adjusted, the pressure-reducing valve 13 may be dispensed with and the check-valve 19 only employed, the latter being arranged to close pipe 7 when the pressure therein drops to a predetermined point. A pipe 14 leads from a source of supply of live steam to the pipe 7 at a point in the latter between the heater 8 and valve 13 and in this pipe 14 is a pressure-reducing valve 15 which reduces the pressure of the live steam flowing therethrough to a pressure low enough to permit of the utilization of the steam in the heater 8; also, valve 15 remains closed when the pressure on the heater side thereof exceeds a predetermined amount. Instead of the pressure reducing valve 15, a valve controlled by a thermostat projecting into the water in the heater may be employed.

Such a system as that above described may be operated with the engine exhausting steam at a pressure of ten pounds per square inch and this steam will pass through the pipes 2, 3 and 7 to the turbine 4 and heater 8. The valve 13 may be set to reduce the pressure of the steam passing therethrough and through pipe 7 to heater 8 to three pounds so that however the pressure of the exhaust steam in pipe 2 may vary, the steam entering the heater 8 through pipe 7 will never be above three pounds pressure. If this be done, an economy will be possible in the construction of the heater 8 since the latter will not be subjected to an excessive pressure. As a further protection for the heater, the relief valve 11 in the exhaust outlet 18 may be set to open on a pressure of four pounds within the heater, in which case the heater may be constructed with a view to withstanding a maximum pressure of five pounds with entire safety.

When the pressure of the steam flowing in pipe 7 falls below that desired for the steam to be used in the heater 8, the pipe 7 will be automatically closed by the check-valve 19. Thus, this valve may be so set that it will close when the pressure in pipe 7 falls to one pound. The closure of pipe 7 in this way in response to a fall of the pressure therein cuts off the heater from the exhaust line. The supply of steam to the heater 8 will, however, be maintained at all times for when the check-valve 19 closes, live steam will be admitted to the heater through the pipe 14 due to the opening of valve 15 when the pressure on the side thereof toward the heater drops below a predetermined point. The adjustments of these valves should be such that valve 15 will open immediately after valve 19 has closed. When the pressure in the exhaust line rises at any time, the valve 13 will be automatically opened and the exhaust steam will pass into the heater, raising the pressure therein, and this increase of pressure acting on valve 15 will close it so that the supply of live steam will not be drawn on for a longer time than is necessary. It will thus be seen that in the system described, the exhaust steam is utilized in heating the feed-water in heater 8 to such extent as is required for that purpose and that the surplus of steam above that amount is utilized in the turbine 4 to develop power; that if ever the supply of exhaust steam falls below that necessary for heating purposes in heater 8, live steam will be automatically supplied to the heater to maintain the temperature of the water therein; that the supply of live-steam will be cut off automatically as soon as the exhaust steam again becomes capable of properly heating the water in the heater; and that the turbine is protected against the entrance of air therein from the heater through the steam connection between them by the provision of either or both the valve which closes that connection when the pressure therein falls below a predetermined point, and the means for maintaining the supply of steam to the heater under all conditions.

It will of course be understood that the pressures mentioned above at which the system is operated and at which the valves open

and close are selected only in describing the construction and operation of the apparatus and such changes in these and other respects as may be made desirable by the conditions of a particular system will be apparent. Thus, if desired, the pressure-reducing valve 3 may be omitted and the check-valve 19 only utilized for closing the steam passageway leading to the heater 8, the function of the check-valve being to close pipe 7 when live steam is being supplied to the heater through pipe 14. In this case, it may be necessary to construct the heater so that it is capable of withstanding a greater pressure, that is, the maximum pressure that would be carried in the exhaust main 2 under normal operation of the system. If the pressure in the heater ever exceeded this, it would be relieved by the valve 11 and if the pressure in pipe 7 fell to or below atmospheric pressure, the check-valve 19 would close. It will be seen that the supply of steam to the heater is maintained at all times, this steam being exhaust steam when such steam at the proper pressure is available and live-steam at other times. In this way, not only is proper operation of the heater at all times insured, but furthermore during such operation in the manner described, air cannot gather in the heater, which air might be drawn through pipes 7 and 3 and into the low-pressure turbine and cause inefficient operation of the turbine.

These and other departures from the construction and operation of the system as above described may be made while still retaining the invention and such modifications I aim to include within the scope of the claims appended hereto.

Having described my invention, what I claim as new therein and desire to secure by Letters Patent of the United States is:

1. In a steam system, the combination of apparatus employing steam, an exhaust line leading therefrom, a low-pressure prime-mover and a heater connected to the exhaust line, a live-steam connection to the heater, a valve therein opening automatically when the pressure in the heater falls to a predetermined point, and a valve in the connection for carrying the exhaust steam to the heater, which valve closes automatically when the pressure within said connection is slightly higher than that at which the valve in the live-steam connection opens, substantially as set forth.

2. In a steam system, the combination of apparatus employing steam, an exhaust line leading therefrom, a low-pressure prime mover and a heater connected to the exhaust line, a live-steam connection to the heater, a valve therein operated automatically under predetermined conditions, and a valve in the steam passageway between the heater and said prime-mover operated automatically under predetermined conditions, substantially as set forth.

3. In a steam system, the combination of apparatus employing steam, an exhaust line leading therefrom, a low-pressure prime mover and a heater connected to the exhaust line, a live-steam connection to the heater, means for automatically closing and opening said connection, and means for closing the exhaust-steam connection to the heater when the said live-steam connection is open, substantially as set forth.

4. In a steam system, the combination of apparatus employing steam, an exhaust line leading therefrom, a low-pressure prime mover and a heater connected to the exhaust line, a live-steam connection to the heater, means for automatically closing and opening said connection, and means for closing the exhaust-steam connection to the heater when the said live-steam connection is open, said last-named means being automatically opened when the pressure in the exhaust line rises to a predetermined point, substantially as set forth.

5. In a steam system, the combination of apparatus employing steam, an exhaust line leading therefrom, a low-pressure prime mover and a heater connected to the exhaust line, a live-steam connection to the heater, a valve therein and a valve in the pipe carrying exhaust steam to the heater, said valve operating automatically under predetermined conditions, substantially as set forth.

6. In a steam system, the combination of apparatus employing steam, an exhaust line leading therefrom, a low-pressure prime mover and a heater connected to the exhaust line, and a valve in the connection for carrying exhaust steam to the heater operated automatically under predetermined conditions to close said connection, substantially as set forth.

7. In a steam system, the combination of apparatus employing steam, an exhaust line leading therefrom, a low-pressure prime mover and a heater connected to the exhaust line, a pressure-reducing valve in the connection for carrying exhaust steam to the heater and means for closing said connection under predetermined conditions, substantially as set forth.

8. In a steam system, the combination of apparatus employing steam, an exhaust line leading therefrom, a low-pressure prime mover and a heater connected to the exhaust line, a valve in the connection for carrying exhaust steam to the heater operated automatically under predetermined conditions, a live-steam connection to the heater and a pressure-reducing valve in said live-steam connection, substantially as set forth.

9. In a steam system, the combination of apparatus employing steam, an exhaust line leading therefrom, a low-pressure prime

mover and a heater connected to the exhaust line, a pressure-reducing valve in the connection for carrying exhaust steam to the heater, means for closing said connection when the pressure therein falls to a predetermined point, a live-steam connection to the heater, and a pressure-reducing valve in the live-steam connection arranged to open the connection automatically when said first-named valve is closed, substantially as set forth.

10. In a steam system, the combination of apparatus employing steam, an exhaust line leading therefrom, a low-pressure prime mover and a heater connected to the exhaust line, so that the exhaust steam flows from said apparatus to both the prime mover and the heater, and means for closing the connection to the heater when the pressure therein drops to a predetermined amount, substantially as set forth.

11. In a steam system, the combination of apparatus employing steam, an exhaust line leading therefrom, a low-pressure prime mover and a heater connected to the exhaust line, so that the exhaust steam flows from said apparatus to both the prime mover and the heater, means for closing the connection to the heater when the pressure therein drops to a predetermined amount, and automatically-operated means for supplying live-steam to the heater when the connection for carrying exhaust steam thereto is closed substantially as set forth.

12. In a steam system, the combination of apparatus employing steam, an exhaust line leading therefrom, a low pressure prime mover and a heater connected to the exhaust line, means for closing the connection of the exhaust line to the heater, a live steam connection to the heater, and means for opening the said live steam connection when the connection of the exhaust line to the heater is closed to maintain the supply of steam to the heater under all conditions, substantially as set forth.

13. In a steam system, the combination of apparatus employing steam, an exhaust line leading therefrom, a low-pressure prime mover and a heater connected to the exhaust line, and means for preventing the formation of a vacuum in the passage for carrying exhaust steam to the heater, substantially as set forth.

This specification signed and witnessed this 19th day of May, 1910.

JOSEPH W. GAMBLE.

Witnesses:

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W. ATWOOD MEHARG.