J. S. SWEENY & W. W. GRINDLE.

FEED WATER HEATER.

APPLICATION FILED JUNE 28, 1909.

1,014,919.

Patented Jan. 16, 1912.

FIG. 1.

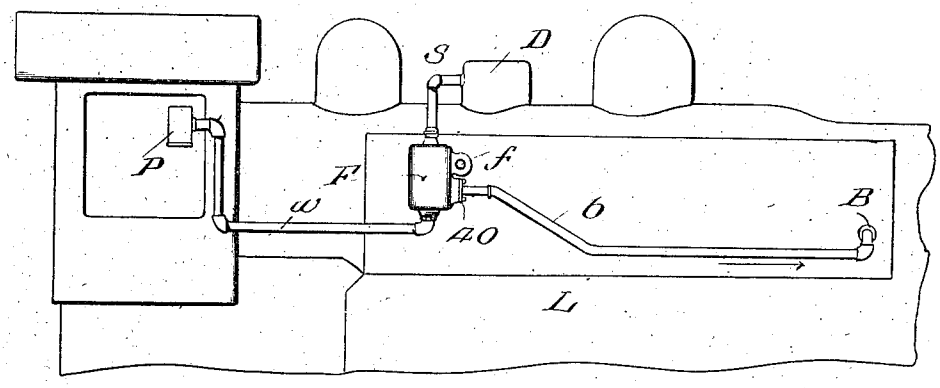

FIG. 2.

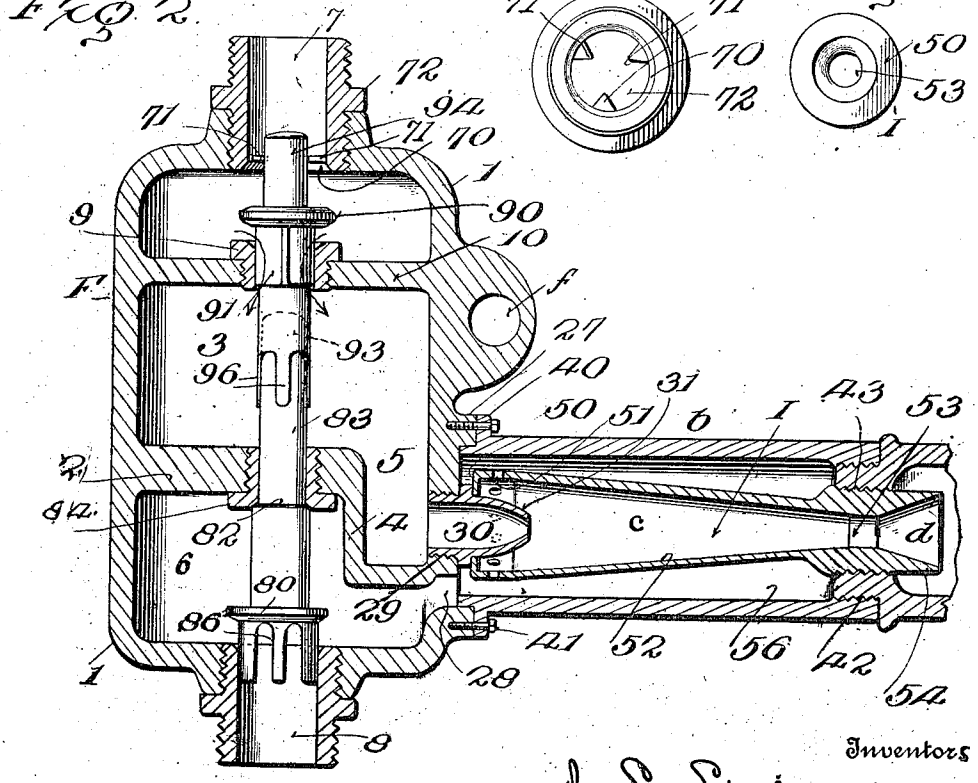

FIG. 3.

FIG. 4.

Witnesses

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FEED-WATER HEATER.

1,014,919. Specification of Letters Patent. Patented Jan. 16, 1912.

Application filed June 28, 1909. Serial No. 504,903.

To all whom it may concern:

Be it known that we, JARED S. SWEENY and WILLIAM W. GRINDLE, citizens of the United States, and residents of Decatur, in the county of Macon and State of Illinois, have invented certain new and useful Improvements in Feed-Water Heaters, of which the following is a specification.

This invention relates to certain improvements in feed water heaters for steam boilers, or the like; and the objects and nature of the invention will be readily understood by those skilled in the art in the light of the following explanation of the accompanying drawings showing what we now consider a preferred embodiment from among other formations and arrangements within the spirit and scope of the invention.

The primary object of the invention is to provide improved means for increasing the temperature of the feed water to a high degree and thus delivering the same into the boiler.

A further object of the invention is to provide certain improvements in details, constructions, and arrangements whereby a highly efficient and comparatively simple and durable feed water heater will be produced.

The invention consists in certain novel features in construction or in combinations and arrangements as more fully and particularly set forth hereinafter.

Referring to the accompanying drawings; Figure 1, is an elevation illustrating to a certain extent diagrammatically the application of the invention to a locomotive boiler. Fig. 2, is a vertical section through the heater shell or casing and the coöperating injector, the various valves being shown open as in normal operation. Fig. 3, is a detail bottom plan of the steam inlet nipple. Fig. 4, is a detail inner end view of the injector.

In Fig. 1, of the drawings, a locomotive boiler L, is somewhat diagrammatically illustrated having steam dome D, and feed water inlet controlled by the boiler check valve B, of any approved or common type. Any suitable means is provided for supplying or forcing feed water, although we have diagrammatically illustrated a feed water supply injector P of any suitable or approved type. The feed water injector P or other water forcing means, delivers the feed water through pipe *w*, to a feed water heater shell or casing F, secured or mounted at *f*. A steam pipe S, delivers feed-water-heating steam from the dome D, or other suitable source, to said heater shell. The feed water or branch pipe *b*, delivers the heated feed water from the shell F, to the check-valve-controlled feed water inlet B, of the boiler.

The hollow shell 1, of the heater F, is internally divided by transverse partitions 2 and 10, into water chamber 6, steam chamber 3, and a valve chamber above the partition 10. The feed water supply pipe *w*, is coupled to a nipple 8, extending through the bottom of the shell and forming the feed water inlet into the water chamber. The upper end of this nipple forms the valve seat for the vertically movable check valve 80, arranged in the water chamber and having guide wings 86, depending into said nipple. The steam supply pipe is coupled to the nipple 7, extending through the upper end of the shell and forming the steam inlet into the valve chamber above partition 10.

The partition 10, is formed with an opening in line with nipple 7, for the passage of steam into the steam chamber 3. A bushing 9, is secured in this opening and at its upper end forms a seat below and for the vertically movable check valve 90. This check valve is formed with guide wings 91, depending and slidable in bushing 9, and spaced apart for the passage of steam through the bushing when the valve is raised. The lower end of nipple 7, forms a valve seat 70, for and above said valve 90, and said valve is formed with an upwardly extending guide stem 94, extending into said nipple. If so desired, said stem can be guided by radial projections 71, in said nipple forming intervening steam passages 72. The valve 90 has a stem depending in the steam chamber 3, and formed with an end socket 93, and depending guide fingers 96, to loosely receive and guide the upwardly extending stem 83, of the water check valve 80. The stem 83, passes vertically through a bushing 84, inserted in partition 2, and is formed with shoulder 82, to engage said bushing and limit the upward movement of the water check valve. This valve arrangement is such that the feed water entering nipple 8, at a higher pressure than that of the steam in nipple 7, (that is,

at a pressure greater than the boiler pressure) lifts the water check valve 80, to the position shown by Fig. 2, and hence lifts the steam valve 90, to its opened position as shown by Fig. 2. This is accomplished through the telescoping ends of the stems of said valves, and yet while the steam valve is thus held elevated in a position between and opening both bushing 9, and nipple 7, yet said valve is free to move upward independently of the water valve stem, to valve seat 70, to close nipple 7.

The partition 2, is deflected downwardly at one end to form a depending steam pocket or passage 5, between vertical portion 4, of said partition and an adjacent vertical wall of the shell. A steam discharge nozzle 30 at its inner end opens into this pocket 5, and extends through said wall of the shell and is formed with a longitudinally contracting or tapered end 31 at the exterior of said wall. The feed water pipe *b*, to the boiler is secured to the shell concentrically around said nozzle. For instance, the inner end of said pipe can be secured in a socket 27 of the shell by bolts 41, passed through a flange 40 of the pipe, although of course the invention is not so limited. The water chamber 6, is provided with a water outlet 28, below the steam pocket 5, and the steam nozzle and into the lower portion of the space or chamber 56, within the inner end of the pipe *b*.

An injector I, is longitudinally arranged within the inner end of the pipe *b*, and consists of a hollow elongated tube-like body having intermediate exteriorly threaded portion 43, screwed into threaded portion of a joint 42, between two sections of pipe *b*. The injector body is thus removably secured in the pipe and closes the pipe except through the injector and forms the chamber 56 in the pipe and around the injector. This elongated tubular member forms the longitudinally tapering or forwardly contracting combining tube or portion 52, the longitudinally and forwardly flaring delivery tube or portion *d*, and the intermediate cylindrical connecting passage between said combining and delivery portions.

The large or receiving end of the combining tube is formed with an end wall 50, with a central opening receiving the steam nozzle 30, so that the tube fits snugly around the nozzle and the nozzle extends longitudinally and centrally a distance into the tube. The large end of the tube is also formed with an annular series of radial water inlet openings 51, around the tapered end of the steam nozzle.

In operation, the feed water enters the water chamber 6, at a high pressure, as hereinbefore stated, and flows into the injector chamber or space 56, and enters the combining tube through the holes or perforations 51, in the form of high pressure radial jets that impinge against the tapered end portion 31 of the steam nozzle and are thereby sprayed and directed outwardly or forwardly in said combining tube of the injector. The steam is discharged from the nozzle 30, in the form of a high speed jet in line with the contracted portion 53 of the injector, and thereby aids in driving the water forwardly through the injector at great speed, and in imparting the necessary velocity to the column of water in the pipe *b*, to deliver said water into the boiler, past the boiler check and against the boiler pressure. The water is heated to a high degree, and material advantages are thereby attained, by introducing the high speed steam jet into the water while in the divided or broken up condition caused by its entrance into and forward deflection in the combining tube, and by introducing this high speed steam jet longitudinally into the combining tube terminating in the contracted passage to the delivery tube whereby also the necessary velocity is imparted to the high pressure column of feed water to overcome the boiler pressure. Under normal working conditions, the feed water injector P, constituting the prime water forcing pump, forces the water into the water heating injector I, at a pressure say of 226 pounds (for example) while the live steam enters I, at a pressure say of 200 pounds (for example). The water under such approximate pressure and the steam under such approximate pressure are so combined and directed in the injector I and through the branch pipe as to overcome the boiler pressure of 200 pounds for instance, at the boiler check. Under normal conditions, when the feed water heater is started the branch pipe *b*, contains a column of dormant water, and the steam admitted through port 7, sets up a high speed jet into and through the tubular or injector member 52, 53, 54, from nozzle 30, which combines in said member with the high speed water jets entering around said nozzle. Said tubular member is so formed and proportioned that the velocity of the steam therein acting on the dormant water in pipe *b*, is sufficient to impart the necessary pressure and initial momentum to the water in pipe *b*, to overcome the boiler pressure and open boiler check B, and set up the flow of water through pipe *b*, and into the boiler. Under normal conditions the water does not back up through the steam nozzle and chamber 3, as such action only occurs under abnormal conditions such as recited herein.

This feed water heater is designed to operate when supplied with water under high pressure, as from the injector P, and the device involving injector I, heats the water to a high temperature by introducing the steam into the cone containing the water without provision for overflow. Where feed water

heaters are provided with an overflow, the water if heated to a point above say about one hundred and twenty to thirty degrees will "spit" out through the overflow and thereby render such device inefficient for the purposes of this invention.

This invention has met with success in long continued practical use in railway service, and by tests it has been found that where the steam in chamber 3, indicates a temperature of about 387° F., and the water in chamber 6, a temperature of about 120° F. the feed water after passing through injector I, enters the boiler at a temperature of about 240° F.

If the boiler check should refuse to work, or the feed water pipe *b*, become otherwise clogged against passage of feed water therethrough, the feed water will back up in said pipe and in the injector therein, and will flow back through the steam nozzle, and up through the bushing 9, under high pressure. This back flow of water will be so rapid or sudden as to flip the valve 90 upwardly against the seat 70 and thereby close the nipple 7, and prevent the back flow of the water into the steam dome. The valve 90, thus constitutes an emergency check valve to prevent back flow of water into the boiler steam dome, under the conditions just recited. When the normal operative conditions are restored, the check valve 90, will drop to its normal position. Under such abnormal conditions as just mentioned, causing the closing of the emergency check valve 90, the water backed up in the shell will exert a pressure on the injector P, of more than the pressure under which the injector P is set to operate, say 226 pounds, thereby causing said injector to "fly off" and thus give warning of the stoppage and abnormal condition, and the necessity for disconnection of the branch pipe or repair or removal of the boiler check valve. After such repair, the device will be ready for normal operation as hereinbefore explained. When the feed water supply through pipe *w*, is cut off the water check valve 80 will drop to its seat, thereby permitting the valve 90, to drop to its seat on bushing 9, and thus automatically cut off the supply of steam to the steam chamber 3, although we do not wish to so limit all features of the invention.

It is evident that various changes, variations and modifications might be resorted to in the forms, arrangements and constructions of the parts described, that features might be omitted, or elements added, without departing from the spirit and scope of our invention, and hence we do not wish to limit ourselves to the exact disclosure hereof.

What we claim is;

1. In a high pressure feed water heater, in combination, a shell having a high pressure water passage with an outlet therefrom and an inlet thereto, a check valve for closing said inlet and normally held open by the water entering the same, said shell having a projecting steam nozzle and an internal steam passage thereto comprising a steam inlet port, a steam check valve adapted to close said port against back flow of water through said passage, said steam check valve being normally held in open position by said first mentioned check valve and adapted to move therewith to position closing said steam passage against forward flow of steam therethrough when said first mentioned valve moves to closed position, substantially as described.

2. A feed water heater comprising a shell having separate steam and water passages, feed water heating and forcing means communicating with said passages, the shell having a steam inlet port and said steam passage comprising a steam port spaced from said inlet port, an oppositely movable check valve arranged between said ports and movable in one direction to close the inlet port against back flow from the shell and movable in the opposite direction to close the steam port against forward flow of steam into said steam passage, said valve being normally in open position with respect to both ports, and means to normally maintain said valve in said position.

3. In a high pressure feed water heater, in combination, a shell having a projecting steam nozzle and formed with a steam passage thereto, an emergency check valve in said steam passage and held open by the passage of steam therethrough, said shell having a high pressure feed water supply inlet port and passage and an outlet passage therefrom adjacent to said nozzle, a check valve for closing said water inlet port and held open by the passage of water therethrough, a boiler-feed-water pipe coupled to said shell around said nozzle and in registration with said outlet passage, and an elongated tubular injector member arranged longitudinally in said pipe and closed against overflow and forming a combining tube receiving high pressure water from said pipe and a delivery tube, the receiving end of the combining tube being enlarged with respect to said nozzle and receiving and inclosing the same and formed to direct the inflowing water thereagainst.

4. A high pressure feed water heater comprising a longitudinally-elongated tubular injector member at its receiving end having a surrounding series of water inlet openings and at its receiving end extremity having a central opening, means forming a water chamber around said body closed at its forward end and into which said water inlet openings open, a feed water pipe receiving the delivery end of said body, means for supplying high pressure feed water to said

chamber, a forwardly tapered steam nozzle projecting through said receiving end opening and arranged within and reduced with respect to said bore, and means for supplying steam to said nozzle, said inlet openings arranged to deliver high pressure jets of water against the tapered portion of said nozzle within said bore, substantially as described.

5. A high pressure feed water heater comprising a longitudinally elongated non-overflow tubular injector body having a combining tube, a delivery tube, and a contracted intermediate cylindrical connecting passage, said combining tube at its inner end formed for the inlet of high pressure feed water, means forming a high pressure feed water chamber around said inlet end of said combining tube, a feed water pipe receiving said delivery tube and extending to the boiler, a forwardly tapered steam nozzle extending forwardly into the water inlet end of said combining tube and reduced with respect thereto to form a water space therein and around said tapered nozzle, and means whereby the high pressure feed water entering said tube is directed against said tapered nozzle and is thereby sprayed forwardly within said tube, substantially as described.

6. A high pressure feed water heater comprising a non-overflow longitudinally elongated injector body forming a combining tube and a delivery tube, the water inlet end of the combining tube being formed with an annular series of radial water inlet openings, a chamber around said combining tube for the reception of high pressure feed water, a feed water pipe extending to the boiler and receiving said delivery tube, a steam nozzle extending into and reduced with respect to said combining tube and arranged within the circle of said inlet openings to receive the high pressure water jets entering therethrough, and means for supplying steam to said nozzle.

7. In a feed water heater, in combination, means having a water passage closed against overflow, to receive feed water under high pressure, and also having a steam passage, a boiler feed water pipe closed against overflow, a non-overflow tubular injector member in said pipe and forming a combining tube receiving high pressure water from a non-overflow water chamber in said pipe around said tube in direct communication with said water passage, and a steam nozzle in communication with said steam passage and projecting forwardly in and closed by said tube, said nozzle exteriorly tapering forwardly within said tube and reduced with respect to the inlet end portion of said tube to form a free water passage around said nozzle and within said tube, means being provided for directing the inflowing high pressure feed water against said tapered nozzle whereby said water is sprayed therefrom forwardly within said tube.

8. A high pressure feed water heater comprising means for supplying high pressure feed water, a feed water connection from said means to a boiler, and a feed water spraying, heating and forcing injector interposed and included in said connection between said means and the boiler and comprising a tubular injector member forming combining and delivery tubes, and a steam nozzle arranged longitudinally of and inclosed within said combining tube and provided with a steam supply, said injector and said connection being closed against overflow, said combining tube and nozzle being coöperatively arranged and formed to spray the high pressure feed water forwardly within said tube for commingling with the steam jet from said nozzle.

9. A feed water heater comprising a shell having a water chamber with a water inlet, means for supplying feed water to said inlet under pressure in excess of the boiler pressure, a feed water connection from said shell to a boiler closed against overflow, a check valve controlling said inlet and held open by the inflowing water, a non-overflow elongated tubular injector member forming a combining tube and open at its delivery end into said feed water connection and at its inlet end to said shell, said shell having a steam passage, a steam nozzle supplied from said passage and arranged longitudinally in and reduced with respect to and inclosed by said combining tube, and an emergency check valve arranged in said steam passage and adapted to close independently of said water inlet valve and normally held open by the passage of steam to said nozzle.

In testimony whereof we sign our names in the presence of two subscribing witnesses, this the 24th day of June, 1909.

JARED S. SWEENY.
WILLIAM W. GRINDLE.

Witnesses:
E. S. McDONALD,
ROSA VOELCKER.