

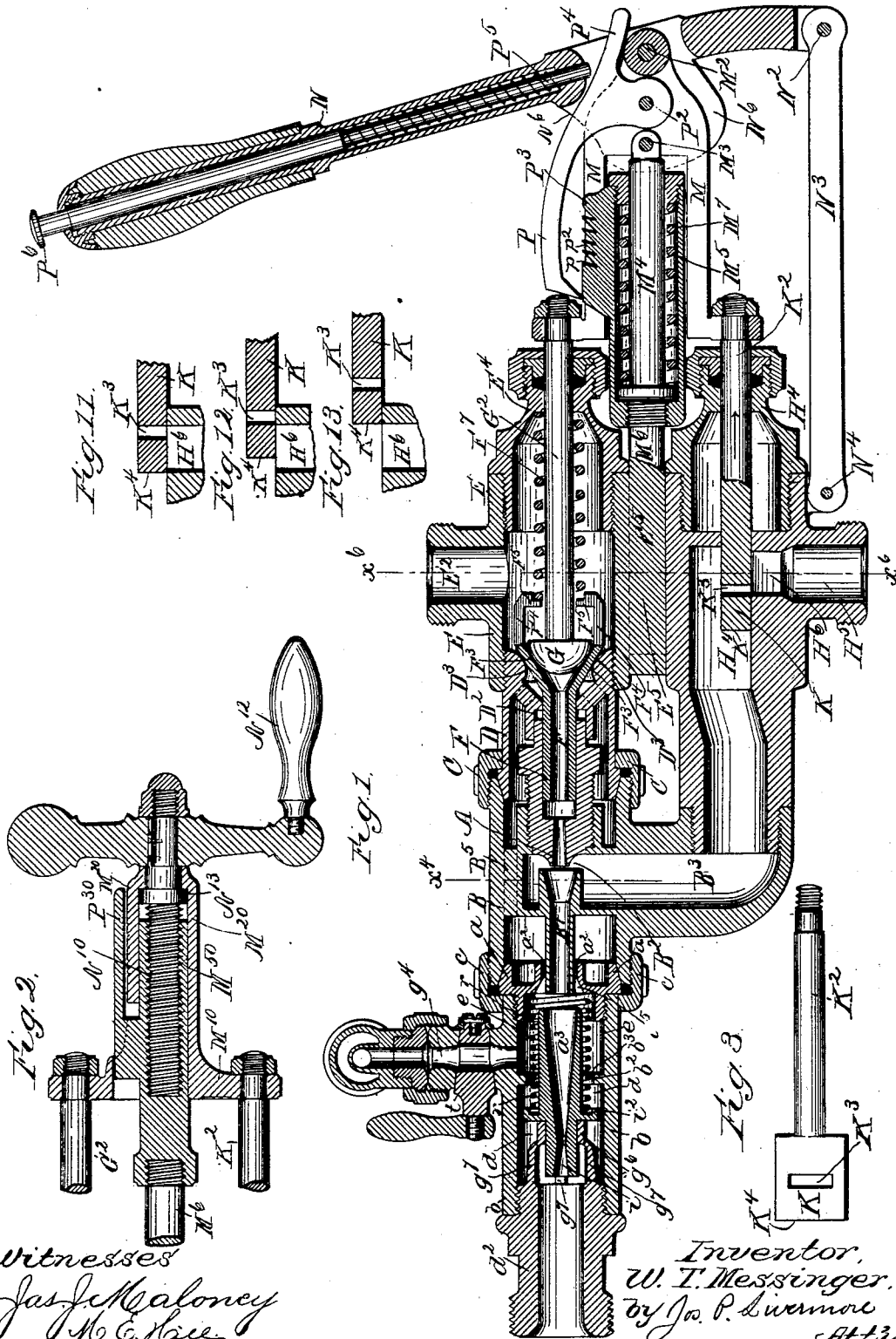
(Model.)

2 Sheets—Sheet 1.

W. T. MESSINGER.
INJECTOR.

No. 587,843.

Patented Aug. 10, 1897.



UNITED STATES PATENT OFFICE.

WILLIAM T. MESSINGER, OF BOSTON, MASSACHUSETTS.

INJECTOR.

SPECIFICATION forming part of Letters Patent No. 587,843, dated August 10, 1897.

Application filed May 8, 1893. Serial No. 473,347. (Model.)

To all whom it may concern:

Be it known that I, WILLIAM T. MESSINGER, of Boston, county of Suffolk, State of Massachusetts, have invented an Improvement in Injectors, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My invention is embodied in an injector and relates mainly to the appliances for controlling the supply of steam and water to the injector, and also to the construction of the overflow and discharge passage, these parts being applicable to injectors of any usual construction, and being for convenience shown and described as embodied in an injector the main fluid-forcing part of which is substantially like that shown in Letters Patent No. 390,031, granted to me September 25, 1888, the overflow and discharge controlling devices of the present invention being an improvement on the ones shown in the said patent. In the operation of the injector as a boiler-feeder there must be a free communication with the water-supply through the suction-pipe when starting the operation of the injector, so that a vacuum can be quickly formed and the water quickly supplied to combine with the steam, and after the combined jet has been formed it is desirable to be able to control the flow of water through the supply-pipe to thereby govern the rate of feed to the boiler. When it is desired to vary the rate of feed, it is not practical to do so by controlling merely the flow of steam to the injector, and, on the other hand, it is generally desirable and it is common practice to continue the steam under maximum flow, but govern the flow of water through the suction-pipe to the injector and thereby control the rate of supply of water by the injector. This has heretofore been commonly done by providing the water-supply or suction-pipe with a valve independent of the valve that controls the admission of steam to the injector, so that the former could be opened more or less widely, according as a greater or less rate of feed was required, this being done without disturbing the latter of the two valves—i. e., the one that controls the steam.

One portion of the present invention consists in providing the injector with a steam-

valve and a water-valve, the former controlling the admission of steam to operate the injector and the latter controlling the admission of water to the injector, and said valves being combined with operating mechanism common to both, whereby the operator by manipulating a single handle can open or close the steam-valve to start or stop the injector and by the same handle can vary the amount of opening of the water-valve to thereby shut off more or less the supply of water while the steam remains turned on with substantially full flow. Thus when said handle is in one extreme position the steam-valve will be closed and the injector not working. The water-valve is so constructed as to afford a sufficient opening when the handle is first moved to admit steam to start the operation and then open a further movement of the handle sufficient to open the steam-valve to maximum capacity the water-valve is brought into position to afford the minimum opening, after which further movement of the handle in the same direction gradually increases the opening of the water-valve, so that the handle may be left at any position of this last part of its movement that may be necessary to open the water-valve such amount as required to afford the water-supply needed to maintain the proper rate of feed. This arrangement of the water-valve is believed to be the most convenient and efficient, but it is not essential to the main invention, which consists in combining with the two valves a common actuating mechanism which can be operated to shut off more or less the supply of water without interfering with the proper flow of steam to operate the injector with the water-supply. As a convenient mechanical arrangement for effecting this actuation of the steam and water valve by a single mechanism common to both said valves are arranged with their stems parallel with one another, and said stems are both connected with a single yoke or carrier preferably provided with an additional guide to that afforded by the valve-stems themselves, said yoke being operated by the controlling-handle, which may be of any convenient construction, preferably a lever provided with a suitable handle and also with a stop mechanism, and by which the handle may be locked in any desired position, and a retract-

ing-spring tending to move the handle so as to close the valves, although it is obvious that a handle having a screw motion may be used, in which case no lock or detent and retracting spring would be required.

The invention also consists in providing an outer chamber or shell around the end of the combining-tube of the injector, having an opening or outlet to the atmosphere and containing a separate internal space or chamber, which may be called the "discharge-chamber" of the injector, as it receives the fluid discharged by the injector and is connected with the delivery-pipe by which the said fluid is conveyed to the boiler or other point at which it is to be delivered. The main shell or chamber that surrounds the end of the combining-tube and communicates with the atmosphere will be called the "overflow-chamber," and it communicates with the discharge-chamber by an opening provided with a valve-seat, which opening is controlled by a valve connected with a movable discharge-tube which is automatically operated by the pressure of the liquid being forced.

Figure 1 is a longitudinal section of an injector embodying this invention; Fig. 2, a longitudinal sectional detail showing a modified construction of the operating mechanism for the steam and water valve; Fig. 3, a plan view of the water-valve detached; Fig. 4, a transverse section on line x^1 , Fig. 1; Fig. 5, an end elevation; Fig. 6, a transverse section on line x^2 , Fig. 1; Fig. 7, a detail showing a portion of the steam and water chambers of the injector in end elevation; Fig. 8, a longitudinal section of the discharge end of the injector, showing a modification of the construction shown in Fig. 1; Fig. 9, a longitudinal section showing the novel form of overflow and discharge appliances used in connection with an injector of substantially the same construction as that shown in Fig. 1, but without the novel steam and water valve operating mechanism shown in Fig. 1; Fig. 10, a longitudinal sectional detail showing another modification in the construction of the overflow and discharge appliances; Figs. 11, 12, and 13, Sheet 1, diagram views showing different positions of the water-valve.

The construction of the injector proper may be substantially the same as shown in Letters Patent No. 350,545, granted to me October 12, 1886, or as shown in Patent No. 390,031, granted to me September 25, 1888, or of any other suitable construction, being herein shown as like the former of said patents in the arrangement of the nozzles or tubes of the injector and like the latter in the arrangement of the steam-valve.

The injector proper comprises a steam-nozzle A, which is screwed into an opening in a casting B, having an internal water-chamber B², provided with a lateral inlet-opening B³, that communicates with the water-supply. The said casting B is also provided with a delivery-nozzle B⁴, which has its mouth or inlet

end in the water-chamber B² and just in front of the delivery-orifice of the first nozzle A of the injector. The said casting B also has longitudinal passages B⁵, (best shown in Fig. 2,) which connect the space in the casting B around the delivery end of the nozzle B⁴ with the source of steam-supply, so that when steam is permitted to pass through the said passages B⁵ it gives a second jet of steam to act upon the jet of water issuing from the nozzle B⁴ and to combine therewith and form a jet issuing with strong pressure so as to enter the boiler. The combining-tube and discharge-tube through which this jet issues is substantially different in construction from that shown in my former patent before referred to and constitutes a part of the present invention, which will be hereinafter described.

In the simpler construction shown in Fig. 9 the casting B, containing the water-chamber, with its delivery-nozzle and the first steam-nozzle attached thereto, (these parts constituting the water-lifting part of the injector,) has connected to it by a coupling-nut C a casting E, provided with an inlet-opening E², adapted to be connected with the steam-supply, said casting E thus constituting a steam-chamber which communicates with and supplies the first nozzle A, the steam from which operates to lift the water to the injector and to deliver it through the nozzle B⁴, and the said steam-chamber also supplies the steam to pass through the passages B⁵ and enter the base of the combining-tube, so as to combine with the water issuing from the water-nozzle B⁴ and form the combined jet to be delivered from the injector.

In the construction shown in Fig. 1 the steam-chamber E, having its inlet-opening E², instead of being coupled directly to the casting B, is connected with an intermediate or connecting piece D, which is coupled to the casting B and surrounds the base of the nozzle A and communicates directly with the passages B⁵, leading to the mouth of the combining-tube. The rear end of the nozzle A enters a recess D² in the connecting-piece D, and said recess, together with the rear portion of the nozzle A, receives a tubular extension F of a part constituting a valve that controls the passage of steam from the steam-chamber E to the mouth of the combining-tube of the injector, which valve will be hereinafter called the "secondary" valve, as it is not opened for the first admission of steam to start the injector. It operates as a valve to control the admission of steam through the mouth of the combining-tube by having an external tapering portion that coöperates with an annular seat D³, so that when the external tapering portion of the secondary valve is engaged with its seat D³, as shown in Fig. 1, it shuts off admission of steam from the steam-chamber to the passage B⁵ and combining-tube. The said secondary valve is also provided with an internal valve-seat F³,

which coöperates with a valve G, which will be called the "primary" valve, which valve G not only controls the flow of steam from the steam-chamber through the tube F into the first nozzle A, but also engages and operates the secondary valve with relation to its seat D³, which is done as follows: The said secondary valve has one or more rearwardly-projecting arms F⁴, provided at their ends with internal projections or fingers F⁵, which stand across the path traversed by the primary valve G in moving from its seat F³. The said valve G is connected with a stem G², working through a bonnet E⁴, which forms one end of the steam-chamber in the casting E. When the valve G is moved from its seat F³, it permits steam to pass through the tube F to the first nozzle A, producing the jet, which tends to exhaust the air from the water-chamber B², and to then lift the water to the injector. As the valve G continues its opening movement it will engage the fingers F⁵, and thus withdraw the secondary valve from its seat D³ and permit the steam to enter the passages B³, pass around the water-tube B⁴, and combine with the water issuing therefrom, this construction and mode of operation being substantially the same as in my former patent and being described here only to make clear the construction and mode of operation of the novel appliances which will now be described. This steam-valve-operating mechanism is combined with the water-valve which operates in a water-chamber H, that connects with the water-inlet B³ to the injector. This chamber H is mainly in the form of a cylinder arranged about parallel with the steam-cylinder and provided with a head or bonnet H⁴, similar to the one E⁴ at the end of the steam-cylinder. The said steam-chamber is provided with a longitudinal external rib E⁵, which, as shown in Fig. 6, rests upon the water-chamber H, and said rib E⁵ is also provided with lateral wings E⁶, (see Fig. 6,) preferably near one end of the steam-cylinder, which rest upon the water-chamber H like a saddle and insure the proper relative positions of said chambers. The end of the water-chamber H nearest the bonnet H⁴ is provided with upwardly-projecting ears or lugs H², (see Fig. 7,) which receive the rib E⁵ of the steam-chamber between them and are provided with internal notches H³, (see Fig. 7,) which receive corresponding lateral projections E⁷ from the rib E⁵, and thus lock the steam and water chambers together. The steam-chamber has to move longitudinally with relation to the water-chamber to interlock the ears H² with the projections E⁷, and this may be done in putting together the injector by first screwing the water-chamber H into the mouth of the water-inlet passage B³ of the injector and then slipping the steam-chamber longitudinally into place and securing it by the coupling-nut C. The water-chamber H is provided with an inlet-opening H⁵, adapted to be connected with the water-

supply pipe, said passage H⁵ communicating with a port H⁶, through a seat in the chamber H on which works the water-valve K. The said water-valve K is a slide-valve provided with a stem K², extending through the bonnet H⁴ of the water-chamber parallel with the stem G² of the steam-valve G. Said valve K is in the form of a plate having an opening K³ sufficiently large to permit free passage of air and water to start the operation of the injector. When steam is wholly shut off and the injector is not running, the opening K³ in the valve lies over the front part of the port H⁶, as shown in Fig. 1, and when the steam-valve (which is operatively connected with the water-valve K, as will be hereinafter described) is moved far enough to open the primary valve without opening the secondary valve—that is, when it is moved until the valve G engages with the fingers F⁵, but has not yet moved the secondary valve from its seat D³—the water-valve K is carried to the position shown in Fig. 11, with its opening K³ over the rear part of the port H⁶, thus still affording a free passage for air and water, so that the steam which has been admitted to the first nozzle A of the injector by the before-mentioned opening of the steam-valve rapidly exhausts the air and causes the water to be drawn into the water-chamber of the injector to combine with the steam issuing from the nozzle A and be delivered therewith through the nozzle B⁴. This first movement of the steam and water valves that causes the water to be drafted and the operation of the injector started brings the end K⁴ of the water-valve just about in line with the front edge of the port H⁶, so that further movement of the water-valve in the same direction will afford an opening between the front edge K⁴ of the valve and the edge of the port H⁶, as shown in Fig. 12, but the first part of such movement, while increasing the opening at the front edge of the port H⁶, correspondingly shuts off the passage at the rear edge of the port through the opening K³ of the valve, and this condition continues while the valve moves from the position shown in Fig. 11 to that shown in Fig. 12, in which movement the opening at the rear edge has been gradually closed and that at the front edge gradually opened, while the total or aggregate opening has remained constant. This movement of the water-valve from the position shown in Fig. 11 to that shown in Fig. 12 is accompanied by a movement of the primary steam-valve G while engaged with the arms of the secondary steam-valve and is sufficient to open the secondary steam-valve to substantially its maximum capacity, so that any further movement of the steam-valves will merely slide the tubular portion F of the secondary valve in the passage at the base of the nozzle A without making any change in the flow of steam through or around the said nozzle A, said steam flowing through both paths at maximum rate. The further move-

ment of the water-valve, on the other hand, from the position shown in Fig. 12 will increase the opening between the edge K^4 of the valve and the front edge of the port, as shown by comparing Fig. 12 with Fig. 13, and by such movement the valve may be brought to any position between that shown in Fig. 12, which gives the minimum opening for supply of water, to the position shown in Fig. 13, in which it is wholly withdrawn from the port H^6 , so that the water is permitted to flow to the full capacity of the port-opening H^6 , which is of proper size to supply the maximum capacity of the injector.

The steam and water valves are both operated by a single operating mechanism, their stems G^2 and K^2 being both connected with a cross-bar or yoke M , pivotally connected at M^2 with a handled lever N , fulcrumed at N^2 on a link N^3 , pivotally connected at N^4 with the water-chamber. The yoke M is shown as a U-shaped piece, the ends of the branches of which are connected with the ends of the valve-stems G^2 and K^2 , said U-shaped piece having a central longitudinal opening, so that it is substantially in the form of two parallel U-shaped plates united at the hub or boss, through which the fulcrum-pin M^2 passes, and at the ends, which embrace the valve-stems. The said double-plate yoke is also connected at M^3 with a rod M^4 , working in a tube or sleeve M^5 , secured at M^6 to the end of the rib E^5 between the steam and water chambers, and the said sleeve M^5 contains a spring M^7 , acting on a shoulder at the end of the rod M^4 , with a tendency to draw the same inward, or, in other words, to move the yoke toward the position at which the valves are closed. Besides thus providing for the retracting or valve-closing spring the rod M^4 and sleeve M^5 also contribute to the guidance of the yoke, but such guidance for the yoke is not absolutely essential, although it tends to relieve the valve-stems from possible lateral strain in the operation of the handle N .

In order to facilitate the determination of the proper positions for the operating-lever N and to hold the same and the connected valves in the desired position to give any required flow of water, the said parts are provided with a locking device or holder, shown as a pawl P , pivoted at P^2 within the double-yoke plate and coöperating with a toothed holder-bar P^3 , secured to or made integral with the sleeve M^5 . The said bar is provided with notches p p^2 , &c., arranged as shown, the said notch p being located in such position as to stop the lever when the yoke is moved far enough to open the valve G , but before the latter has moved far enough to open the secondary valve, so as to permit the steam to pass its seat D^3 . Thus with the hand-lever stopped with the pawl P in the notch p steam is admitted to the first nozzle and the water-valve is brought to the position shown in Fig. 11, so that the steam-jet

issuing from the nozzle A exhausts the air from the water chamber and pipe leading to the water-supply and drafts the water, so as to start the injector, as before described—that is, with the handle N stopped at the first notch the injector is set in operation effectively for lifting the water to the injector, but is not yet started effectively as a forcing apparatus. The movement to the next notch p^2 causes the secondary valve to be opened at D^3 and the steam to be delivered to the mouth of the combining-tube around the orifice of the water-tube B^4 , so as to combine the water and form the forcing-jet, which may be delivered through the combining-tube and into the boiler or elsewhere, as may be required, in the usual manner. This movement carries the valve K to the position shown in Fig. 12, thus permitting the minimum amount of water to pass through the injector that will be required while the injector is running, and by moving the lever to the next notches the water-valve will be opened more and more until finally the maximum flow is permitted. The port H^6 is widened transversely to the line of movement of the valve K , so that a comparatively short range of movement is sufficient to control the flow of water within the desired limits, and the port-opening is rectangular, so that the change in area of opening is proportional to the movement of the valve. If it is desired to again reduce the flow of water after having been turned on the maximum amount, the lever may be moved back by lifting the pawl P from the notch that it is in, and thus the valve K may be caused to cover or close the port H^6 to a greater or less extent.

In the closing movement of the water-valve and accompanying movement of the steam-valves toward their closed position the fingers F^3 of the secondary valve are retained in engagement with the main valve by a spring F^7 , which acts upon the secondary valve with a tendency to close it, and thus retains the seat F^3 of the main valve in advance of the said main valve as the latter moves toward its closed position until the movement is sufficient to seat the secondary valve at D^3 . The water will, however, be cut off to minimum flow before the secondary valve is seated at D^3 , and consequently the flow of water can be regulated to any desired amount between maximum and minimum at any time by moving the handle back and forth, as required, and it is only when the steam is to be wholly cut off and the injector stopped running that the handle is moved far enough inward to first close the secondary valve at D^3 and then close the main valve at F^3 .

To facilitate the disengagement of the pawl P from the teeth of the bar P^3 to permit the return or closing movement of the valves, the said pawl is provided with a projection P^4 , extending into the lever N and lying under a pawl-lifting rod P^5 , extending through the said handle and projecting from the end thereof, as shown at P^6 , in such position that the

said rod can readily be pressed down by the thumb of the hand grasping the handle, and when thus pressed down it bears upon the projection P^4 of the pawl, so as to turn the said pawl on its pivot P^2 and raise its forward end from the notches of the locking-bar. The handle-lever N is recessed to embrace the yoke-plate M where it is connected therewith, and has side wings N^6 , which extend forward at each side of the yoke-plate and across the ends of the pins that connect the pawl P and rod M^4 with the double yoke-plate, so that after the lever is in place and secured by its fulcrum-pin M^2 the said pins at M^3 and P^2 cannot become dislodged, and said pins do not require to be headed or screw-threaded in order to afford a secure connection between the double yoke-plate and parts connected with it by said pins.

Instead of a lever any other suitable device may be employed to operate the two connected valves—as, for example, the screw N^{10} , Fig. 2, working in a threaded bore in the sleeve M^{50} , and provided with a suitable handle N^{12} to rotate it, said screw being provided with a flange or collar N^{13} , engaging a shoulder inside a sleeve extension M^{20} of the cross-bar or yoke M^{10} , connected with the valve-stems $G^2 K^2$. The cross-bar of the handle N^{12} itself engages a shoulder at the outside end of the said sleeve M^{20} to cause the sleeve and the connected yoke and valve-stems to accompany it. In this case no locking device is required, but the sleeve M^{50} is provided with an indicator P^{30} , which in connection with suitable graduations on the sleeve M^{20} shows the position of the valves.

An actuating mechanism, as hereinbefore described, common to the steam and water valves is applicable to valves of various construction and in connection with injectors, which also vary widely in construction, and the arrangement of the combining and delivery tube of the injector with reference to the other parts thus far described may be as shown in either of my former patents hereinbefore referred to, the said combining-tube and overflow-chamber being connected with the forward or delivery end of the casting B by a coupling or in any other suitable manner.

It is necessary in setting the injector in operation that there should be an opportunity for the actuating fluid to escape readily into the atmosphere before the liquid has been raised and has condensed and combined with said actuating fluid, and such escape is commonly provided for by leaving a space between the end of the combining-tube of the injector and the discharge-tube, which space is open to the atmosphere or to a chamber or space in the injector, which is itself open to the atmosphere and may remain open while the injector is in operation, although it is closed by a valve of some kind after the injector has been set in operation. This way of providing for the escape of the steam before the combined jet has been formed is ob-

jectionable for several reasons, among others because the discharge tube and passage leading from it to the boiler often become filled with air while the injector is not at work, and such air owing to its elasticity is not readily dislodged or forced through such discharge tube and passages into the boiler when the combined jet has been formed, but resists the entrance of the combined jet, thus delaying the starting of the proper operation of the injector and causing much waste of water.

One of the objects of the present invention is to provide simple, compact, and efficient means for overcoming these objections to the usual form of overflow-chambers, and the devices forming the subject of this invention may be used in connection with any usual form of injector as an attachment thereto. As shown in this instance, the said devices are all connected with a shell or chamber b , connected with the chamber B of the injector thus far described in any convenient manner, being shown in this instance as connected therewith by a coupling-nut c . The end a of the said shell b that engages with the casting B forms a partition between the spaces in the shell b and the casting B , which partition has, however, an opening a^2 surrounding the water-tube B^4 and a little larger than it, so as to afford an annular passage or opening which is the mouth or inlet to the combining-tube a^3 of the injector when in operation and, if desired, might be extended forward inside the shell b to form a portion of the combining tube or nozzle. Preferably, however, said opening a^2 in the wall a terminates short of the end of the nozzle B^4 or, rather, is flared out around the end thereof, as shown at a^5 , to form a seat for the end of the combining-tube a^3 , which is movable toward and from the said seat, as will be described. The shell b contains both the overflow-chamber and the discharge-chamber of the injector, which in the construction shown in Fig. 1 are separated by a partial partition b^2 , having an opening b^3 , which may connect the overflow-chamber e at one side of said partition and the discharge-chamber d at the other side thereof, this construction being employed when it is desirable to have the overflow delivered laterally from the injector and the water-delivery in line with the injector. The said overflow-chamber e is provided with a lateral outlet g^4 , which may stand open to the atmosphere, but is shown in Fig. 1 as provided with a stop-cock t , which may be closed in case it is desired to use the injector to blow back steam into the water-supply, as is sometimes done with injectors used on locomotives.

The combining-tube a^3 and delivery-tube i are herein shown as made in a single piece which is longitudinally movable in a guide g^6 , contained in the delivery-chamber d , being shown in Fig. 1 as formed in the discharge-pipe d^2 of the delivery-chamber to which the delivery-pipe leading to the boiler or else-

where is connected, the said pipe d^2 being shown in Fig. 1 as a separate piece screwed into the end of the shell b and the guide g^6 being connected therewith by arms g^7 , which
 5 afford free communication between the spaces at the rear and in advance of the said guide. The piece containing the combining-tube a^3 is provided with a valve i^2 , that coöperates with the partition b^2 to close the opening b^3
 10 therein when the said combining-tube is moved rearward to the seat a^5 in the opening a^2 , at which time communication between the the steam-space in the casting B and the interior of the overflow-chamber is cut off by
 15 the end piece a and combining-tube a^3 and communication between the overflow and delivery chamber is cut off at $b^2 i^2$.

The combining-tube a^3 is preferably acted upon by a light spring r , which tends to throw
 20 it forward to the position shown in Figs. 1 and 8, in which position the passage a^2 opens freely into the overflow-chamber. The operation will be described after first describing the modifications in construction shown in Figs.
 25 8, 9, and 10, which are identical in their operation with the construction shown in Fig. 1. Fig. 8 shows the parts in the position occupied when the injector is not working and when the overflow is open, so as to permit free ac-
 30 tion in starting the jet, and Fig. 9 shows the same parts in working position occupied while the jet is being delivered from the injector. In this construction the overflow-outlet g^4 is at the end of the injector and the delivering-
 35 outlet d^2 is at the side of the injector and is integral with the shell b , that contains the overflow-chamber e and delivery-chamber d . The partition b^2 , that separates the overflow and delivery chambers and is provided with
 40 the connecting-passage b^3 , as before described, is extended in the form of a tube b^4 inside the shell b , so that the overflow-chamber e is in the form of an annulus surrounding the deliv-
 45 ery-chamber d instead of said chambers being end to end, as in the construction shown in Fig. 1. The lower end of the annular partition b^4 is engaged by a pocket or cup-shaped piece g , which surrounds the orifice of the deliv-
 50 ery-chamber d , and in this construction the guide g^6 for the combining and delivery tube and the supporting-arms g^7 of said guide are made integral with the cup-piece g or end portion of the delivery-chamber. The said
 55 pocket or end piece g is held in tight engagement with the end of the partition b^4 by a coupling h , which, as shown in Figs. 8 and 9, has the overflow-outlet g^4 made integral with it, suitable passages h^2 being formed to connect the overflow-chamber e with said outlet
 60 g^4 . The construction shown in Fig. 10 is the same as that in Figs. 8 and 9 and is marked with the same reference-letters, the only difference being in the shape of the casting g
 65 forming the end piece of the delivery-chamber and that the overflow-outlet g^4 is cast with the said end piece g instead of with the coup-

ling-nut h . The passages h^2 , that connect the overflow-chamber e with the outlet g^4 , are formed in the part of said casting that lies
 70 below the partition b^4 and at the sides of the pocket g and above the engaging flange of the coupling-nut h .

The operation is as follows: When the injector is not working, the combining and dis-
 75 charge tube a^3 is in the position shown in full lines, Fig. 1, and in Fig. 8, and the steam, air, and water issuing from the water-pipe B^4 pass freely into the overflow-chamber e and escape through the outlet g^4 into the air, as
 80 does also any steam that may at this time pass through the passages B^5 , so as to escape through the annular passage a^2 around the end of the water-tube B^4 . As soon, however, as the draft of water is established, so that a
 85 jet issues from the water-tube B^4 , it passes through the combining-tube and enters the delivery-chamber d and, meeting back pressure therein, tends to flow back through the opening b^3 into the overflow-chamber, in
 90 which operation its pressure reacts upon the combining and discharge tube and valve i^2 thereon and moves the said parts in opposition to the force of the spring r until the said parts bring up on the seats at a^5 and b^2 , as
 95 shown in Fig. 9, when all further communication is cut off and the injector can deliver only through the combining-tube a^3 and delivery-tube i into the delivery-chamber d and thence through the delivery-passage d^2 , and
 100 this condition will be maintained as long as the injector remains working to deliver a jet under pressure. If at any time the injector should fail to operate, owing to a failure of
 105 the water-supply or for other cause, the combining-tube will fall back and the steam will be delivered through the overflow-chamber and, escaping from the overflow-discharge, would show that the injector was not work-
 110 ing properly, or, if failure of the water-supply were but momentary, the parts would resume their normal working position (shown in Figs. 1 and 9) as soon as water was again supplied.

In my former patent, No. 390,031, I showed
 115 an injector having a movable discharge-tube working in a delivery-chamber and having a valve which closed communication between the delivery and overflow chambers when the operation of the injector was fairly started,
 120 such movement also bringing the discharge-tube into engagement with the orifice of the combining-tube, so as to cut off the opening into the air at this usual point of overflow-escape. By having the combining-tube itself,
 125 or a considerable portion thereof, movable, as shown in the present invention, the point of overflow-escape instead of being at the orifice or most contracted part of the combining-tube is brought near the mouth or base there-
 130 of, so that a very free overflow-opening is afforded, which greatly facilitates the starting of the operation of the injector.

The construction of the overflow and de-

livery chambers shown in Figs. 9 and 10 might be employed in connection with a movable discharge-tube cooperating with the combining-tube, as shown in said Patent No. 390,031, where it is desirable to have the overflow-outlet at the end of the injector or to have the overflow-chamber substantially surround the delivery-chamber.

I claim—

1. In an injector a steam-chamber, a water-chamber, and steam-nozzle leading from the former to the latter; a delivery-nozzle leading from said water-chamber, and steam-passage around the same, an overflow-chamber and discharge-chamber in advance of said delivery-nozzle from the water-chamber, and a movable combining and discharging tube having its mouth or inlet end in said overflow-chamber and its delivery end in said discharge-chamber and being adapted when operated by the pressure in the discharge-chamber to seat in and form a continuation of the steam-passage around the delivery-pipe from the water-chamber, and to thereby shut off communication between its mouth and the overflow-chamber, substantially as and for the purpose described.

2. In an injector, the combination with the shell or body of the injector and a guide connected therewith of a yoke guided thereby and steam and water valves connected with said yoke and operating simultaneously in the movement thereof, substantially as and for the purpose described.

3. In an injector the combination with the main body of the injector of a steam-valve and water-valve and valve-stems therefor arranged parallel with one another, a yoke connecting said stems, and means for moving said yoke to simultaneously adjust said valves, substantially as described.

4. In an injector the combination with the main body of the injector of a steam-valve and water-valve and valve-stems therefor arranged parallel with one another, a yoke connecting said stems, and means for moving said yoke to simultaneously adjust said valves, and means for locking the said yoke to hold the valves in any position to which they may be adjusted, substantially as described.

5. In an injector the combination with the working parts of the injector proper of a steam-valve controlling admission of steam to operate the injector and the water-valve controlling the flow of water through the injector and an operating-lever and connections between the same and the stems of the said valves whereby the valves may be simultaneously operated, substantially as described.

6. In an injector the combination with the working parts of the injector proper of a steam-valve controlling admission of steam to operate the injector and the water-valve controlling the flow of water to the injector and operating-lever and connections between the same and the stems of the said valves,

whereby the valves may be simultaneously operated, and means for locking the said lever to hold the valves in different positions, as set forth.

7. The combination with an injector of an overflow-chamber open to the atmosphere and a discharge-chamber inclosed within and surrounded by the said overflow-chamber and provided with an outlet-passage as d^2 and with an opening as b^3 communicating with said overflow-chamber, and a discharge tube and valve working in said discharge-chamber and cooperating with the opening connecting the discharge and overflow chambers, substantially as described.

8. The combination with an injector of a shell surrounding the end of the combining-tube of said injector, and an inner chamber within said shell having an outlet-passage and an opening connecting it with the interior of said shell which contains a passage by the side of but disconnected from the said inner chamber and a removable end piece as g , that forms a portion of said inner chamber and a discharge-tube in said inner chamber provided with a valve as v^2 controlling the opening between said inner chamber and outer shell, substantially as and for the purpose described.

9. The combination with an injector, of a shell around the end of the combining-tube of said injector and an inner chamber within said shell having a lateral outlet-passage and arranged to provide a passage between it and the said shell; an end piece as g which when attached to the shell closes the lower end of the inner chamber and affords an outlet-passage from the shell around said inner chamber to the air, a guide as g^6 supported on said end piece, and a discharge tube and valve working in said guide, substantially as and for the purpose described.

10. The combination with the working parts of an injector of a water-inlet and the sliding valve K controlling the flow of water there-through to the injector and provided with an opening K^3 affording a minimum inlet for the water when said valve is otherwise closed, substantially as described.

11. In an injector the combination with the working parts of the injector proper, of a steam-valve controlling admission of steam to operate the injector and water-valve controlling the flow of water to the injector; the operating-handle and connection between the same and the said steam and water valves; the pawl and locking-bar for governing the position of said handle, and the pawl-lifting rod extending through and accessible at the end of said handle, substantially as described.

12. An injector having a steam-chamber, a water-chamber, and nozzle leading from the former to the latter, a delivery-nozzle from said water-chamber and combining-tube having its mouth or inlet-opening around the said delivery-nozzle combined with the main valve controlling admission of steam to the

first nozzle, a secondary valve governing admission of steam through passages around the first nozzle to the mouth of the combining-tube, and engaged and operated by the said
5 main valve, as described, and a spring acting on said secondary valve with a tendency to close the same, substantially as and for the purpose set forth.

13. In an injector the combination of the
10 main and secondary steam-valves controlling admission of steam to the injector, and a water-chamber and water-inlet, and valve K, controlling the passage of water therethrough to the injector, said valve being provided with
15 an opening K³, affording passage for the water when the main steam-valve is open, substantially as described.

14. In an injector the combination with the working parts of the injector proper of a steam-valve controlling admission of steam 20 to operate the injector, the water-inlet having a rectangular port-opening and the slide-valve working on said port-opening and connections between said slide-valve and the steam-valve of the injector, whereby said valves may be 25 operated simultaneously, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

WM. T. MESSINGER.

Witnesses:

JOS. P. LIVERMORE,
M. E. HILL.