No. 662,459.

Patented Nov. 27, 1900.

H. T. NICE.

INJECTOR.

(Application filed Sept. 7, 1899.)

(Model.)

2 Sheets—Sheet 1.

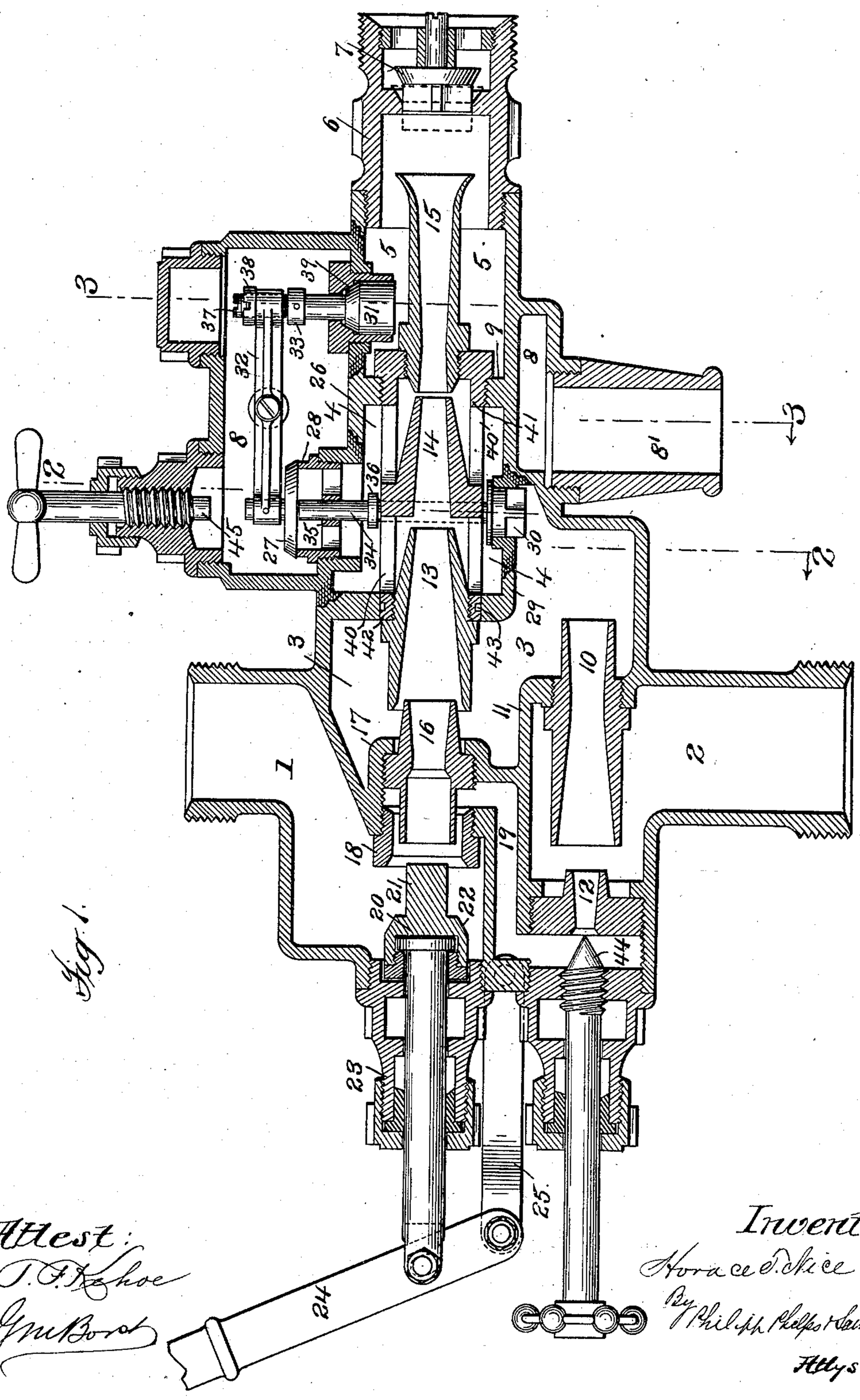

Fig. 1.

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(Model.) 2 Sheets—Sheet 2.

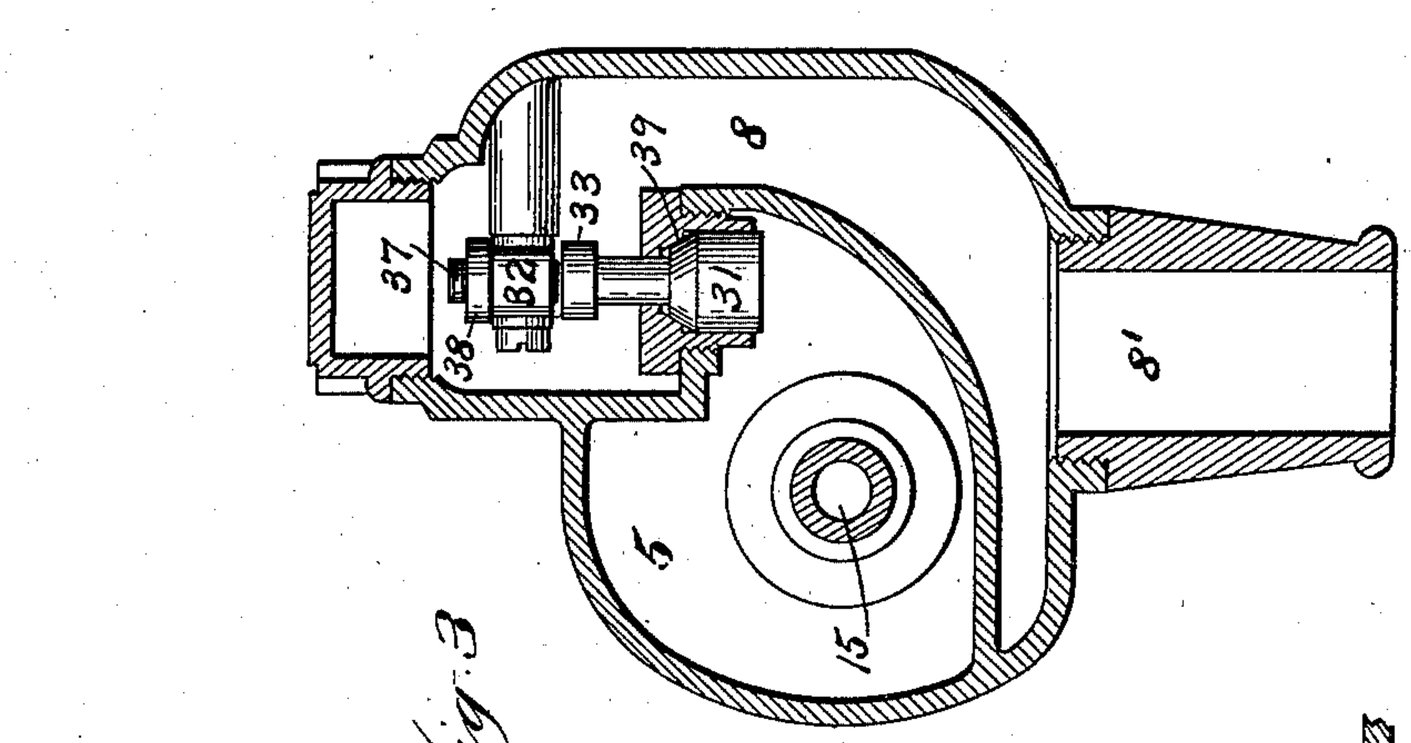

Fig. 3.

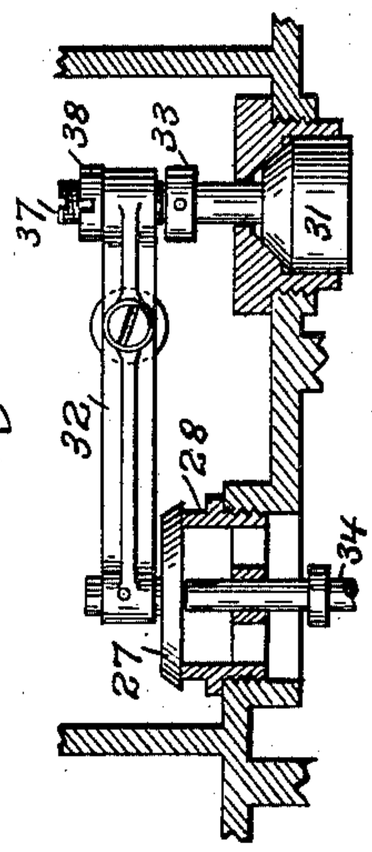

Fig. 4.

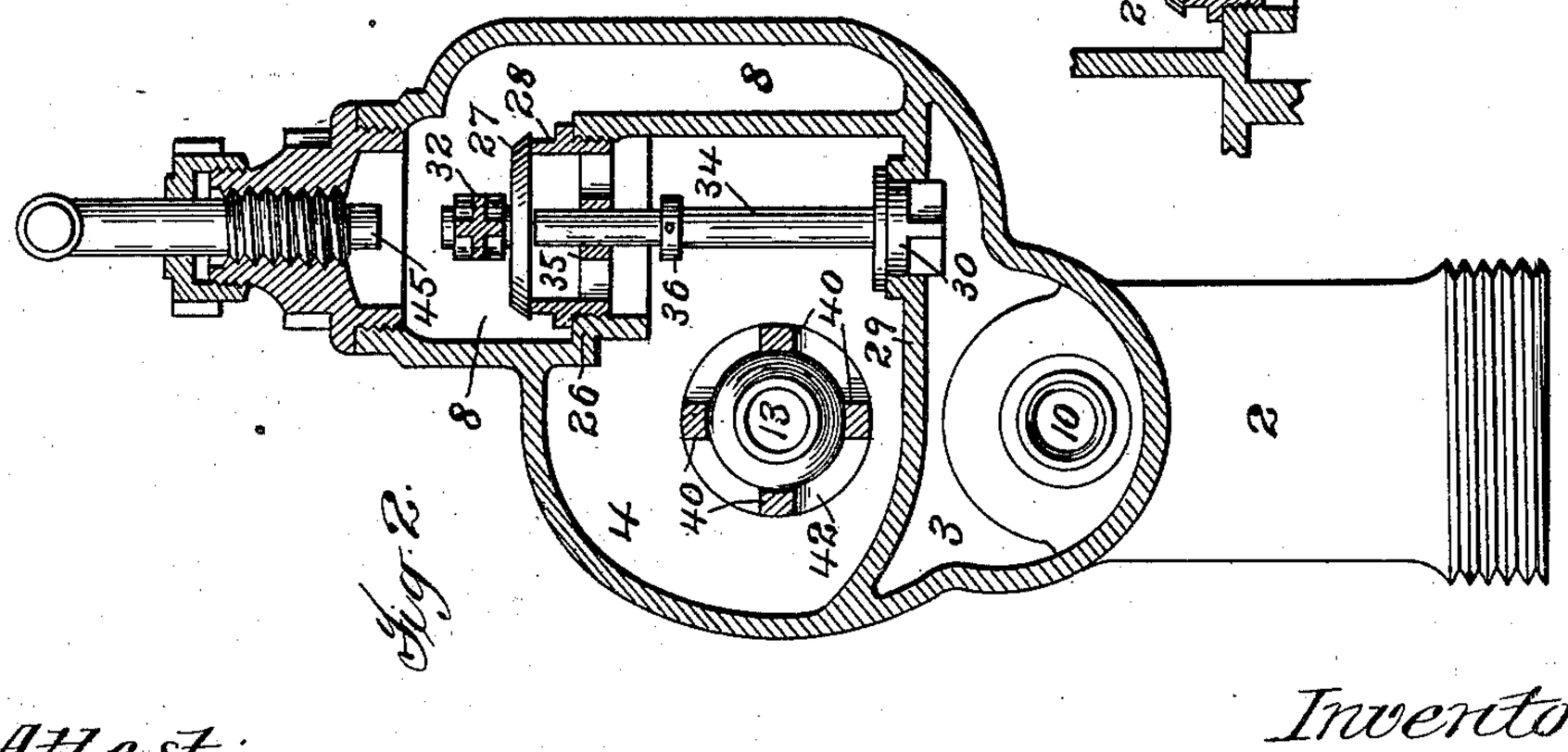

Fig. 2.

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UNITED STATES PATENT OFFICE.

HORACE T. NICE, OF WADSWORTH, OHIO.

INJECTOR.

SPECIFICATION forming part of Letters Patent No. 662,459, dated November 27, 1900.

Application filed September 7, 1899. Serial No. 729,689. (Model.)

To all whom it may concern:

Be it known that I, HORACE T. NICE, a citizen of the United States, residing at Wadsworth, county of Medina, and State of Ohio, have invented certain new and useful Improvements in Injectors, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

This invention relates to improvements in injectors, it being the object of the present invention, generally stated, to provide an injector capable of handling extremely hot water, such as required for locomotive use, and which will operate and maintain the stream or jet of steam-forced water under extreme conditions of feed-water and steam, and, further, to so simplify the construction of the forcer-tube and its arrangement in the injector-casing as to greatly facilitate the assemblage of its parts and its introduction into and withdrawal from the casing.

The improvements of the present invention are applicable to injectors of both the single-jet and double-jet type; but as they have been designed with particular reference to injectors of the double-jet type and as they have peculiar advantages in such injectors they will, for convenience, be hereinafter described in detail in that connection, it being understood, however, that the invention, broadly considered, is not to be so limited.

In the accompanying drawings, Figure 1 is an irregular sectional elevation of an injector of the double-jet type embodying the several features of the present invention in their preferred forms, certain parts of the casing being broken away, so as to include in this view the overflow valve mechanism of the injector. Fig. 2 is a cross-section taken on the irregular line 2 2 of Fig. 1. Fig. 3 is a cross-section taken on the irregular line 3 3 of the same figure, and Fig. 4 is a detail illustrating a modification of the valve mechanism.

Referring to said drawings, 1 represents the steam-inlet, 2 the water-inlet, 3 the water-chamber, to which the water is lifted or delivered from the water-inlet 2, and 4 an overflow-chamber, with which the injector is preferably provided and which, with other features hereinafter referred to, forms part of the present invention, all of these parts being located on what will hereinafter be termed the "receiving" side of the injector. Located on what will be hereinafter termed the "delivery" side of the injector are the delivery-chamber 5 and a removable boiler connection 6, containing the ordinary check-valve 7, shown by dotted lines in its closed position and in full lines in its open position or the position to which it is forced by the jet of water forced into the boiler. The overflow-chamber 4 communicates with an overflow-outlet 8, terminating in a waste-nozzle 8', leading to the atmosphere. The delivery-chamber is separated from the overflow-chamber 4 by a vertical partition 9 and is, as will hereinafter appear, substantially closed to the overflow-outlet 8 and atmosphere, or, in other words, is substantially without overflow, the only overflow occurring in the apparatus shown being from the overflow-chamber 4, which receives the overflow for establishing the lifter and forcer, or, in other words, establishing, respectively, the supply of water in the water-chamber 3 and the jet of steam-forced water through the forcer-tube, as will more fully hereinafter appear. The water-inlet 2 and water-chamber 3 (the injector shown being of the double-jet type) are connected by a lifter-tube 10, secured in the vertical wall of a partition 11, separating said chamber and water-inlet, said tube 10 being provided with a steam-nozzle 12, similarly secured in position in the injector-casing. The water-chamber 3 and delivery-chamber 5 are connected by a forcer-tube provided with side openings preferably by making the tube in sections 13 14 15, through which openings said tube communicates with the overflow-chamber 4 for the escape from said tube of overflow and for the withdrawal from said chamber 4 of the overflow remaining therein when the forcer is established, and thereby creating a partial vacuum in said chamber, which materially assists in maintaining the supply of water and otherwise in the proper operation of the injector. This forcer-tube and the means by which it is introduced into and supported in the injector-casing constitute a feature of the present invention and will be hereinafter more fully described. The forcer-tube 13 14 15 is provided with a steam-nozzle 16, secured in a screw-threaded opening in the partition

17, separating the water-chamber 3 from the steam-inlet 1 and inclosed at its tubular receiving end, which opens into the steam-inlet 1 by valve-seat ring 18, an annular space being provided between the two, forming a continuation of the passage 19, through which the lifter steam-nozzle 12 communicates with the steam-inlet 1. Communication between the lifter and forcer steam-nozzles 12 16 and the steam-inlet 1 is controlled by a spindle-valve 20, provided with a plug 21, adapted to enter the tubular receiving end of the forcer steam-nozzle 16, and with a béveled shoulder 22, adapted to engage a correspondingly-shaped seat formed in the valve-seat ring 18, the spindle of this valve projecting through a stuffing-box 23 and being connected at its outer end by a pin-and-slot connection, with a hand-lever 24 fulcrumed in a bracket 25, by which hand-lever the valve 20 is opened and closed. The plug 21 and shoulder 22 of the valve 20 and the forcer steam-nozzle 16 and valve-seat ring 18 are so constructed and arranged relatively to each other that during the first part of the rearward or opening movement of the handle 24 the shoulder 22 will be withdrawn from its seat in the valve-seat ring 18, thereby opening communication between the lifter steam-nozzle 12 and the steam-inlet. The plug 21 of the valve, however, still remains in the tubular receiving end of the forcer steam-nozzle 16, and thus continues to shut off communication between that steam-nozzle and the steam-inlet 1, communication between nozzle 16 and the steam-inlet not being established until the handle 24 has been moved to substantially its rearmost position and the handle not being so moved until after the lifter has been established, or, in other words, until the water-chamber has been supplied by the operation of the lifter with the required quantity of water for the operation of the forcer.

The overflow-chamber 4 communicates with the overflow-outlet 8 through an opening in the partition 26, separating said chamber and outlet, communication between said chambers being controlled by an overflow-valve 27, which in its closed position is seated against a valve-seat ring 28, threaded in said opening. This overflow-valve 27 is designed to be opened and held open until the forcer has been established by the primary overflow from chamber 3 for establishing the lifter, and also by the secondary overflow from the forcer-tube 13 14 15 for establishing the forcer, and is also designed to be closed and held closed, as the forcer is established, by the pressure of the steam-forced water in the delivery-chamber 5 through connections which will presently be described. Part of the overflow from the chamber 3 may enter said overflow-chamber 4 through the openings in the sectional forcer-tube 13 14 15; but the main portion thereof will enter said overflow-chamber through an opening in the bottom of the partition 29, separating said chambers, communication between said chambers through said opening being controlled by piston-valve 30. This valve 30 is opened and held open by the overflow from the water-chamber 3 until the forcer is established, and like the overflow-valve 27 is closed and held closed as the forcer is established by the pressure of the steam-forced water in the delivery-chamber 5 through connections which will also presently be described, the connections preferably being such that as the piston-valve 30 is opened it will also open the overflow-valve 27, and as the latter is closed it will in turn close and hold closed the piston-valve 30. The valve 30, with its connections, forms part of the present invention; but its presence is not essential to other features of the invention. In single-jet injectors it will be dispensed with, as in such cases the opening between chambers 3 4 and the valve 30 therein would be unnecessary.

The means for closing the overflow-valve 27 consists of a valve-controller 31, located in the delivery-chamber 5, and a lever 32 of the first class interposed between said valve-controller and the overflow-valve 27. The valve 27 is preferably connected to one end of the lever 32, the connection being such as to provide the requisite amount of looseness to insure proper seating of the valve. The valve-controller 31 is preferably disconnected from the opposite end of the lever 32, but occupies such a position in relation thereto that as said valve-controller is actuated by the pressure of steam-forced water in the delivery-chamber 5 it will engage the end of the lever 32, and thereby rock the same and close the valve 27, and as the overflow-valve 27 is opened by the overflow and the lever 32 rocked thereby said lever will in turn engage the valve-controller 31 and move it in the opposite direction or downwardly if it has not already assumed such position, as it may by gravity. When, as in the present case, the valve-controller or piston 31 is not connected with the lever 32, it will be provided with means, as a collar 33, for limiting its downward movement. By reason of these connections the overflow-valve 27 is closed and held closed positively by the pressure on the delivery side of the injector and is not affected by variations which may occur in the pressure or temperature of steam and water upon the receiving side of the injector. This is of peculiar advantage in double-jet injectors, as in such injectors the overflow-valve mechanism when closed is constantly subjected to the pressure of the lifter, which has a tendency to unseat the overflow valve or valves.

The means whereby upon the opening of the piston-valve 30 by the overflow from the chamber 3 the overflow-valve 27 is opened by the valve 30 and by which also said valve 30 is closed by the overflow-valve 27 when the latter is closed by the pressure in the delivery-chamber 5 consists, preferably, of a rod 34, connected with the piston-valve and discon-

nected from the overflow-valve 27, its upper end, however, projecting through a guide 35 in the valve-seat ring 28 into position for engagement with the under face of the valve 27. From this it results that as the piston-valve 30 is opened and held open by the overflow from chamber 3 the valve 27 will be opened and held open thereby and by the overflow within the overflow-chamber 4, and as the valve 27 is closed it will by engagement with rod 34 in turn close the piston-valve 30, thereby shutting off communication between the water-chamber 3 and overflow-chamber 4. By reason also of this connection between the overflow-valve 27 and piston-valve 30 both of said valves in their closing movement are closed against the pressure of the water in the water-chamber 3, which thus acts as a cushion, preventing the jar and shock which would result from a sudden closing of either of these valves, and particularly the overflow-valve 27.

For the purpose of limiting the upward movement of the piston-valve 30, so that it will be maintained in proper relation to its seat, its rod 34 is provided with a collar 36, adapted to engage with the guide 35.

Means are provided whereby the relative positions of the valve 27, valve-controller 31, and lever 32 may be adjusted to compensate for wear in any of these parts or for other purposes, the means employed consisting, preferably, of a set-screw 37, threaded in that end of the lever 32 which engages and is engaged by the valve-controller 31, and which set-screw may be adjusted to any desired position with relation to said valve-controller and held in such adjusted position by means of a jam-nut 38.

As the delivery-chamber 5 is designed to be substantially without overflow, the valve-controller 31 for this reason performs the single function of controlling the overflow-valve and is in substance simply a piston; but it is to be understood that it may, if desired, perform other functions without departing from the invention so long as the functions performed include that of controlling the overflow-valve. To prevent leakage as far as possible and also interference with the movement of the piston 31 by the collection of grit or the like between it and its seat, the piston has plane sides and a conical top and its tubular seat 39 is correspondingly shaped.

As the pressure on the receiving and delivery side at starting and restarting are equal and as the pressure on the delivery side upon the establishment of the forcer is many times in excess of that on the receiving side of the injector, it is necessary that the overflow-valve 27 and valve-controller 31 should be so constructed or arranged relatively to each other that the overflow-valve may be opened and be maintained open against the pressure on the delivery side of the injector until the forcer is established and be closed and held closed by the valve-controller 31 when the forcer is established against the pressure existing on the receiving side of the injector. With the overflow confined to the receiving side of the injector and the valve 27 closed by the pressure on the delivery side, as in the present case, but one thing need be taken into consideration in so constructing or arranging these parts—namely, the relative pressures on opposite sides of the injector—whereas in injectors having overflow-valves on opposite sides of the injector there must be taken into consideration in addition to this the amount of overflow which must take place on each side to establish the lifter and forcer. In other words, the valves must be of a certain size relatively to each other and must also be each of a size to permit the required amount of overflow. The overflow-valve 27 and valve-controller 31 of the present case may be adapted for operation at the proper time by the pressures on the receiving and delivery sides of the injector either by varying the size of the overflow-valve and controller relatively to each other, as illustrated in Figs. 1 to 3, or where the connections between the two include lever 32, as in the present case, by locating the fulcrum of the lever at one side of the center thereof and toward the controller 31, the overflow-valve 27 and piston 31 in the latter case exposing to pressure substantially the same surface area. Broadly considered, it is immaterial to the present invention whether the fulcrum of the lever 32 be located centrally, as in Figs. 1 to 3, or at one side, as illustrated in Fig. 4, or at any other desired point, the position of the fulcrum depending upon the surface areas of the overflow-valve and valve-controller exposed to pressure.

The operation of the apparatus is as follows: Normally the piston-valve 30 and overflow-valve 27 will be closed and the valve controller or piston 31 in its lowermost position, which it may assume by gravity if it be disconnected from the lever 32, as in the present case. Normally, also, the valve 20 will be engaged with the forcer steam-nozzle 16 and the valve-seat ring 18, thus shutting off communication between the lifter and forcer steam-nozzles 12 16 and the steam-inlet 1. To start the apparatus, the hand-lever 24 is moved slightly to the left, Fig. 1, to disengage the shoulder 22 of the valve 20 from the valve-seat ring 18, thus opening communication between the steam-inlet and the lifter steam-nozzle 12. Communication still remains cut off, however, between the steam-inlet and the forcer steam-nozzle 16 by the plug 21. The steam passing through the lifter steam-nozzle and lifter-tube 10 will enter the water-chamber 3, and raising the piston-valve 30 and overflow-valve 27 will pass into the overflow-chamber 4, and thence escape to the overflow-outlet 8 and to the atmosphere, part of the steam passing into the forcer-tube 13 14 15 and escaping through the overflow-openings therein into the overflow-

chamber 4. As soon as water appears at the waste-nozzle 8′, thus indicating that the lifter is established, the attendant in charge will move the hand-lever 24 farther rearward, thus opening communication between the steam-inlet and forcer steam-nozzle 16. Steam issuing from steam-nozzle 16 and entering the forcer-tube will at first overflow at the openings between the sections 13 14 15 of the forcer-tube and enter the overflow-chamber 4, passing thence into the overflow-outlet and nozzle 8′, the overflow-valve 27 and piston-valve 30 being maintained in their raised positions by the overflow and the water beneath the piston-valve 30. This overflow from tube 13 14 15 will continue until the forcer is established, such forcer by reason of the overflow-openings in the forcer-tube being established in sections. When the forcer is thus established, the pressure of the steam-forced water in the delivery or pressure chamber 5, exceeding many times the pressure in the water and overflow chambers 3 4, will raise the piston or valve-controller 31 into the position in which it is illustrated in Fig. 1, and as the latter is thus raised it will by engagement with the lever 32 rock said lever so as to close the overflow-valve 27 and through it the piston-valve 30, thus shutting off communication between the water-chamber 3 and overflow-chamber 4 and between the overflow-chamber 4 and overflow-outlet 8, the water in the chamber 3, as before stated, serving as a water check or cushion for the valves 27 30 and piston 31 as they are thus moved. As soon as the valve mechanism is moved to this position the injector will operate in the usual way to force the water from the delivery or pressure chamber 5 into the boiler, the forcer taking its water-supply from the chamber 3 and also by reason of the openings between the sections of the forcer 13 14 15 draining off any water which may have remained in the overflow-chamber 4 or may leak in under valve 30. As the water is thus withdrawn from chamber 4 a partial vacuum is produced therein, which materially aids the operation of the injector. During the subsequent operation of the injector the overflow-valve 27 will be held positively in its closed position by the pressure within the delivery or pressure chamber 5, there being no liability of the overflow-valve 27 becoming unseated by reason of temporary changes in pressure within the water-chamber 3 or by reason of any jars or shocks such as injectors in locomotives, steamboats, &c., are subjected to. Should the supply of water within the water-chamber 3 or the supply of steam at any time fall below the required quantity for proper operation of the injector, so that the injector will "break" or "fly off," overflow will take place at the openings in the forcer-tube 13 14 15 and will reopen the overflow-valve 27, which will remain in this position until the proper conditions have been reëstablished, when the apparatus will automatically restart. To stop the apparatus, all that is necessary to be done is to return the valve 20 into engagement with the forcer steam-nozzle 16 and valve-seat ring 18.

The foregoing description of the operation of the injector is equally applicable to an injector supplied with valve mechanism such as illustrated in Fig. 4.

The sectional forcer-tube heretofore briefly described is of novel construction and will now be described in detail. The several sections 13 14 15 of this tube are carried by a skeleton frame consisting of longitudinal ribs 40, connected at opposite ends by rings 41 42 and having formed integrally therewith the central tube 14 of the forcer, the end sections 13 and 15 of said forcer being removably attached thereto by screw-threaded connections with the rings 41 42. Cored openings are provided in the walls of the overflow-chamber 4 for the reception of this forcer-tube frame, which is secured in position in said openings by exterior screw-threads on the ring, 41 engaging a correspondingly-threaded cored opening in the vertical partition or wall 9 of the overflow-chamber, the outer surface of the other ring 42 being preferably plain, but closely fitting the cored opening in the opposite wall of the overflow-chamber 4 and preferably provided with a circumferential groove 43, adapted to receive ring-packing for the purpose of forming a tight joint. The boiler connection 6 is removably connected with the casing, so that upon the removal of such connection the forcer-tube frame, with the several sections carried thereby, may be readily inserted or withdrawn from the delivery end of the injector-casing. At the time of the insertion or withdrawal of the frame it may have connected therewith the tube 15, or such tube may be secured in position after the insertion of the frame or be disconnected therefrom before its withdrawal.

The injector will preferably be provided with a spindle-valve 44 for regulating the supply of steam to the lifter steam-nozzle 12. It may also and preferably will be provided with a valve 45 for engaging and locking the overflow 27 in its closed position when it is desired to use the injector as a heater, the steam entering the injector in such case passing down through the water-inlet 2.

What I claim is—

1. In an injector, the combination of an overflow-valve adapted to be opened by overflow on the receiving side of the injector, a device adapted to be actuated by the pressure of the delivery side to close said valve as the forcer is established, and lever connections between said device and valve, substantially as described.

2. In an injector, the combination of an overflow-valve adapted to be opened by overflow on the receiving side of the injector, a device adapted to be actuated by the pressure of the delivery side to close said valve as the forcer is established, and a lever of the first

class between said device and valve, substantially as described.

3. In an injector having a delivery side substantially without overflow, the combination of an overflow-valve adapted to be opened by overflow on the receiving side of the injector, a piston adapted to be actuated by the pressure of the delivery side to close the valve as the forcer is established, and lever connections between said piston and valve, substantially as described.

4. In an injector having a delivery side substantially without overflow, the combination of an overflow-valve adapted to be opened by overflow on the receiving side of the injector, a piston adapted to be actuated by the pressure of the delivery side to close the valve as the forcer is established, and a lever of the first class between said piston and valve, substantially as described.

5. In an injector having a delivery side substantially without overflow, the combination of an overflow-chamber on the receiving side and an overflow-valve therefor, a forcer-tube opening at its side into the overflow-chamber, a piston adapted to be actuated by the pressure of the delivery side to close the valve as the forcer is established, and lever connections between said piston and valve, substantially as described.

6. In an injector having a delivery side substantially without overflow, the combination of an overflow-chamber on the receiving side and an overflow-valve therefor, a forcer-tube opening at its side into the overflow-chamber, a piston adapted to be actuated by the pressure of the delivery side to close the valve as the forcer is established, and a lever of the first class between said piston and valve, substantially as described.

7. In an injector having a delivery side substantially without overflow, the combination of a lifter-chamber, an overflow-chamber and an overflow-valve therefor, a valve between said chambers, a forcer-tube opening at its side into the overflow-chamber, a piston adapted to be actuated by the pressure of the delivery side to close said valves as the forcer is established, and lever connections between said piston and valves, substantially as described.

8. In an injector having a delivery side substantially without overflow, the combination of a lifter-chamber, an overflow-chamber and an overflow-valve therefor, a valve between said chambers, a forcer-tube opening at its side into the overflow-chamber, a piston adapted to be actuated by the pressure of the delivery side to close said valves as the forcer is established, and connections between said piston and valves including a lever of the first class between the piston and overflow-valve, substantially as described.

9. In an injector having a delivery side substantially without overflow, the combination of a lifter-chamber, an overflow-chamber and an overflow-valve therefor, a valve between said chambers, a forcer-tube opening at its side into the overflow-chamber, a piston adapted to be actuated by the pressure of the delivery side to close said valves as the forcer is established, lever connections between said piston and overflow-valve, and means interposed between said valves for operatively connecting them, substantially as described.

10. In an injector having a delivery side substantially without overflow, the combination of a lifter-chamber, an overflow-chamber and an overflow-valve therefor, a valve between said chambers, a forcer-tube opening at its side into the overflow-chamber, a piston adapted to be actuated by the pressure of the delivery side to close said valves as the forcer is established, a lever of the first class interposed between said piston and overflow-valve, and means interposed between said valves for operatively connecting them, substantially as described.

11. In an injector, the combination of an overflow-valve adapted to be opened by overflow on the receiving side of the injector, a device adapted to be actuated by the pressure of the delivery side to close said valve as the forcer is established, and adjustable connections between said device and valve, substantially as described.

12. In an injector, the combination of an overflow-valve adapted to be opened by overflow on the receiving side of the injector, a device adapted to be actuated by the pressure of the delivery side to close said valve as the forcer is established, and adjustable lever connections between said device and valve, substantially as described.

13. In an injector, the combination of an overflow-valve adapted to be opened by overflow on the receiving side of the injector, a device adapted to be actuated by the pressure of the delivery side to close said valve as the forcer is established, a lever of the first class between said device and valve but disconnected from said device, and adjustable engaging means between said device and lever, substantially as described.

14. In an injector, the combination of an overflow-valve adapted to be opened by overflow on the receiving side of the injector, a device adapted to be actuated by the pressure of the delivery side to close said valve as the forcer is established, and a lever of the first class between said device and valve but disconnected from said device, and adjustable means borne by the lever for engaging said device, substantially as described.

15. In an injector having a delivery side substantially without overflow, the combination of an overflow-valve adapted to be opened by overflow on the receiving side of the injector, a piston adapted to be actuated by the pressure of the delivery side to close

the valve as the forcer is established, and adjustable connections between said piston and valve, substantially as described.

16. In an injector, having a delivery side substantially without overflow, the combination of an overflow-valve adapted to be opened by overflow on the receiving side of the injector, a piston adapted to be actuated by the pressure of the delivery side to close the valve as the forcer is established, and adjustable lever connections between said piston and valve, substantially as described.

17. In an injector having a delivery side substantially without overflow, the combination of an overflow-valve adapted to be opened by overflow on the receiving side of the injector, a piston adapted to be actuated by the pressure of the delivery side to close the valve as the forcer is established, a lever of the first class between said piston and valve but disconnected from said piston, and adjustable engaging means between said piston and valve, substantially as described.

18. In an injector having a delivery side substantially without overflow, the combination of an overflow-valve adapted to be opened by overflow on the receiving side of the injector, a piston adapted to be actuated by the pressure of the delivery side to close the valve as the forcer is established, a lever of the first class between said piston and valve but disconnected from said piston, and adjustable means borne by the lever for engaging said piston substantially as described.

19. In an injector having a delivery side substantially without overflow, the combination of an overflow-valve adapted to be opened by overflow on the receiving side of the injector and connected with the delivery side and adapted to be closed by the pressure thereof as the forcer is established, substantially as described.

20. In an injector having a delivery side substantially without overflow, the combination of an overflow-valve adapted to be opened by overflow on the receiving side of the injector, a piston adapted to be actuated by the pressure of the delivery side to close the valve as the forcer is established, and connections between said piston and valve, substantially as described.

21. In an injector having a delivery side substantially without overflow, the combination of an overflow-chamber on the receiving side, a forcer-tube opening at its side into the overflow-chamber, and an overflow-valve for said chamber connected with the delivery side and adapted to be closed by the pressure thereof as the forcer is established, substantially as described.

22. In an injector having a delivery side substantially without overflow, the combination of an overflow-chamber on the receiving side, a forcer-tube opening at its side into the overflow-chamber, an overflow-valve for said chamber, a piston adapted to be actuated by the pressure of the delivery side as the forcer is established, and connections between said piston and valve, substantially as described.

23. In an injector having a delivery side substantially without overflow, the combination of a lifter-chamber, an overflow-chamber and an overflow-valve therefor, a valve between said chambers, and a forcer-tube opening at its side into the overflow-chamber, said valves being connected with the delivery side and adapted to be closed by the pressure thereof as the forcer is established, substantially as described.

24. In an injector having a delivery side substantially without overflow, the combination of a lifter-chamber, an overflow-chamber and an overflow-valve therefor, a valve between said chambers, a forcer-tube opening at its side into the overflow-chamber, a piston adapted to be actuated by the pressure of the delivery side as the forcer is established, and connections between said piston and valves, substantially as described.

25. In an injector having a delivery side substantially without overflow, the combination of a lifter-chamber, an overflow-chamber, an overflow-valve therefor, and a valve between said chambers, said valves being connected with the delivery side and adapted to be closed by the pressure thereof as the forcer is established, substantially as described.

26. In an injector having a delivery side substantially without overflow, the combination of a lifter-chamber, an overflow-chamber and an overflow-valve therefor, a valve between said chambers, a piston adapted to be actuated by the pressure of the delivery side as the forcer is established, and connections between said piston and valves, substantially as described.

27. In an injector having a delivery side substantially without overflow, the combination of a lifter-chamber, an overflow-chamber, an overflow-valve therefor connected with the delivery side and adapted to be closed by the pressure thereof as the forcer is established, a valve between the lifter and forcer chambers, and means for operatively connecting said valves, substantially as described.

28. In an injector having a delivery side substantially without overflow, the combination of a lifter-chamber, an overflow-chamber, an overflow-valve therefor, a piston adapted to be actuated by the pressure of the delivery side to close said valve as the forcer is established, connections between said piston and valve, a valve between the lifter and forcer chambers, and means for operatively connecting said valves, substantially as described.

29. In an injector having a delivery side substantially without overflow, the combination of a lifter-chamber, an overflow-chamber, a valve controlling communication be-

tween said chambers and connected with the delivery side of the injector and adapted to be closed by the pressure thereof as the forcer is established, substantially as described.

30. The combination in an injector-casing, of an overflow-chamber and a skeleton forcer-tube frame bearing a sectional forcer a portion whereof is detachably secured in the frame, said casing, overflow-chamber and tube-frame being so constructed as to permit the introduction and removal of said frame at the delivery end of the injector, substantially as described.

31. The combination, in an injector-casing, of an overflow-chamber and a skeleton forcer-tube frame bearing a sectional forcer having end sections detachably secured in the frame, said casing, overflow-chamber and frame being so constructed as to permit the introduction and removal of said frame at the delivery end of the injector-casing, substantially as described,

32. The combination of an overflow-valve on the receiving side of an injector, a closing device for the valve adapted to be actuated by the pressure of the delivery side as the forcer is established, and a lever of the first class interposed between said closing device and the valve, the fulcrum thereof being located at one side of its center and toward said closing device, substantially as described.

33. The combination of an overflow-valve on the receiving side of an injector, a piston adapted to be actuated by the pressure of the delivery side to close the valve as the forcer is established, and a lever of the first class connecting said piston and valve, the fulcrum thereof being located at one side of its center and toward the piston, substantially as described.

34. The combination of overflow-valve 27, delivery-chamber 5, piston 31, and lever 32, substantially as described.

35. The combination of overflow-valve 27, delivery-chamber 5, piston 31, and lever 32 provided with set-screw 37, substantially as described.

36. The combination with overflow-chamber 4 and delivery-chamber 5, of valve 27, piston 31, lever 32, and sectional forcer-tube 13, 14, 15, substantially as described.

37. The combination with lifter-chamber 3, overflow-chamber 4 and delivery-chamber 5, of valve 27, piston 31, lever 32, valve 27, and rod 34 interposed between said valves, substantially as described.

38. The combination with overflow-chamber 4 and delivery-chamber 5, of valve 27, piston 31, lever 32, valve 30, rod 34 interposed between said valves, and sectional forcer 13, 14, 15, substantially as described.

39. The combination with overflow-chamber 4, of sectional forcer-tube 13, 14, 15 borne by skeleton frame 40 provided with screw-threaded ring 41 for securing it in position, substantially as described.

40. The combination with overflow-chamber 4, of sectional forcer-tube 13, 14, 15 borne by skeleton frame 40 provided with screw-threaded ring 41 for securing it in an opening in one wall of the overflow-chamber and with ring 42 for engaging an opening in the opposite wall of said chamber, substantially as described.

41. In an injector of the double-jet type, the combination of a forcer-tube opening at its side into the receiving side of the injector, an overflow-valve adapted to be opened by the overflow on the receiving side of the injector, and a device adapted to be actuated by the pressure of the delivery side to close said valve as the forcer is established, substantially as described.

42. In an injector of the double-jet type, the combination of a forcer-tube opening at its side into the receiving side of the injector, an overflow-valve adapted to be opened by the overflow on the receiving side of the injector, and a device adapted to be actuated by the pressure of the delivery side to close said valve as the forcer is established and to be in turn actuated in the opposite direction by said valve as the latter is opened by the overflow, substantially as described.

43. In an injector of the double-jet type, the combination of a forcer-tube opening at its side into the receiving side of the injector, an overflow-valve adapted to be opened by the overflow on the receiving side of the injector, and a device disconnected from the valve and adapted to be actuated by the pressure of the delivery side to close said valve as the forcer is established, substantially as described.

44. In an injector of the double-jet type, the combination of a forcer-tube opening at its side into the receiving side of the injector, an overflow-valve adapted to be opened by the overflow on the receiving side of the injector, and a device disconnected from the valve and adapted to be actuated by the pressure of the delivery side to close said valve as the forcer is established, and to be in turn actuated in the opposite direction by said valve as the latter is opened by the overflow, substantially as described.

45. In an injector of the double-jet type, the combination of a forcer-tube opening at its side into the receiving side of the injector, an overflow-valve adapted to be opened by the overflow on the receiving side of the injector, a device adapted to be actuated by the pressure of the delivery side, and means interposed between said device and valve whereby when the former is thus actuated it will close the latter, substantially as described.

46. In an injector of the double-jet type, the combination of a forcer-tube opening at its side into the receiving side of the injector, an overflow-valve adapted to be opened by the overflow on the receiving side of the injector, a device adapted to be actuated by the

pressure of the delivery side, and means interposed between said device and valve whereby when the former is thus actuated it will close the latter and when said valve is opened by the overflow it in turn actuates said device in the opposite direction, substantially as described.

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

HORACE T. NICE.

Witnesses:
CHAS. AMMERMAN,
W. H. NICE.