

July 7, 1936.

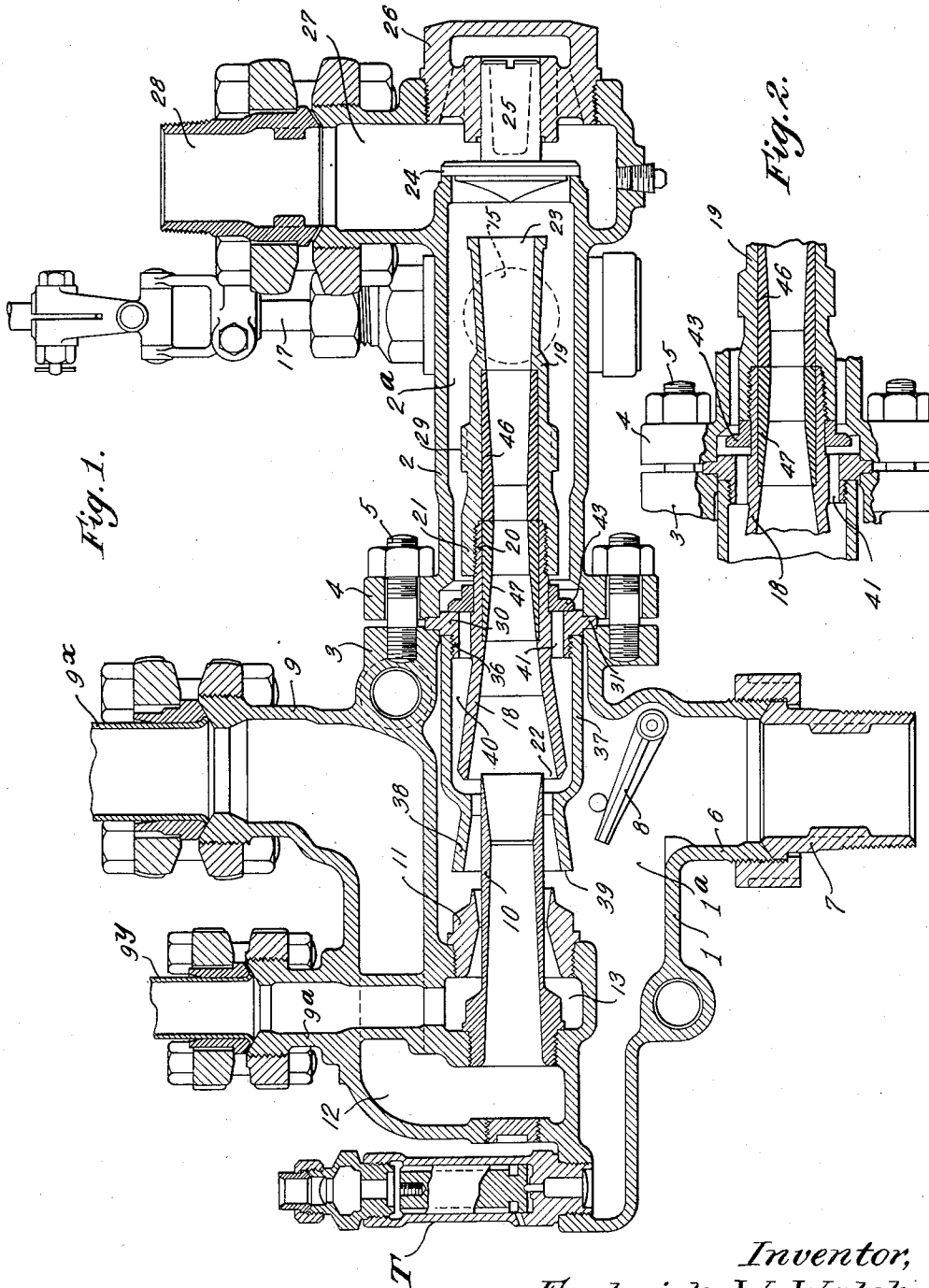
F. W. WALCH

2,046,887

INJECTOR

Filed March 11, 1936

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig. 4.

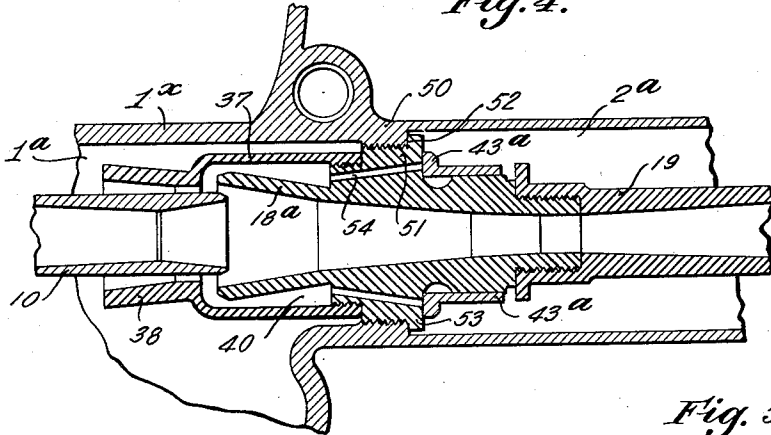


Fig. 5.

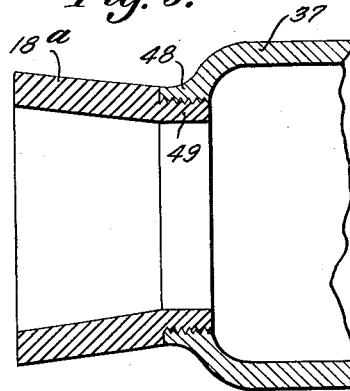


Fig. 3.

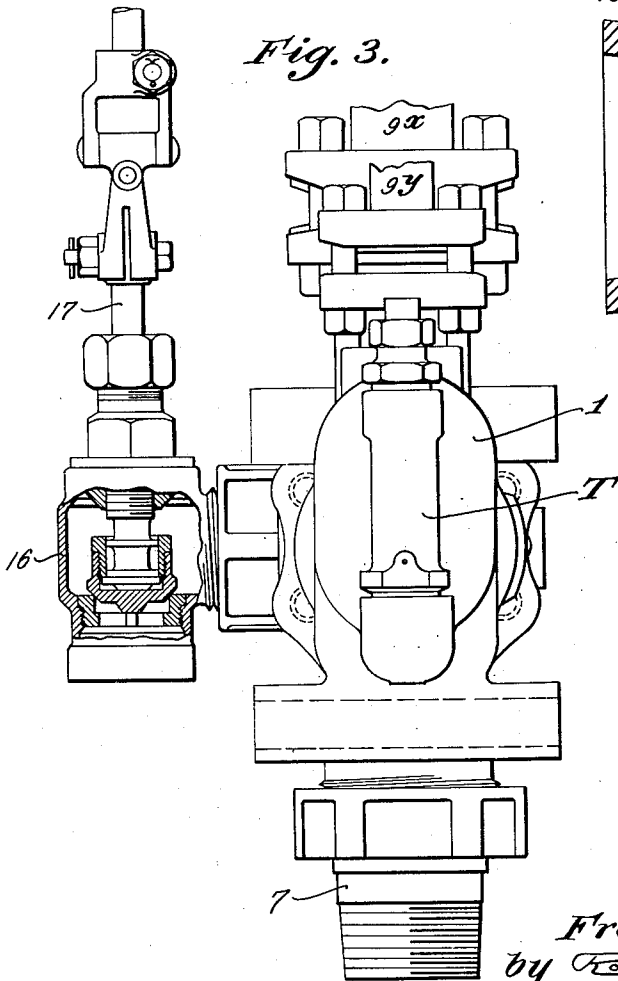
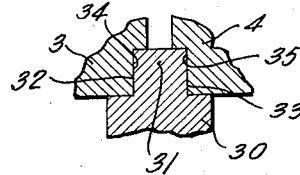


Fig. 6.



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UNITED STATES PATENT OFFICE

2,046,887

INJECTOR

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Application March 11, 1936, Serial No. 68,225

9 Claims. (Cl. 103—267)

This invention pertains to steam jet pumps of the class commonly known as injectors or inspirators, wherein the heat energy of steam is directly converted into mechanical energy for the purpose, for example, of forcing feed water into a boiler against a pressure which may be as great or greater than that of the steam supplied to the injector,—the invention relating more particularly to an improved tube structure for use in such injectors or inspirators and constituting an improvement upon that disclosed in my Letters Patent of the United States No. 2,032,674, dated March 3, 1936. In said patent I disclosed an improved tube structure comprising combining and delivery tube members normally united in end-to-end axial alignment (although separable one from the other) and defining a fluid passage devoid of lateral outlets from one end of the tube structure to the other,—together with means whereby such tube structure, as a unit, may be mounted in an injector casing or removed therefrom without disturbing the usual steam nozzles, controlling valves or other operative parts at the inlet end of the injector casing. The tube structure there disclosed also had provision for resisting rapid internal wear, and for ready replacement of worn parts.

While the tube structure of my aforesaid patent represents a very substantial advance in the art, as compared with prior constructions, particularly with respect to its ability to operate reliably over a long period of use and its ability to deliver against higher pressures (without frequent breaking) than prior injectors, I have found as the result of further experiment that the operation and durability of the tube structure may be further improved by the employment of certain additional features constituting the present invention.

Injectors are sometimes classified as "lifting" and "non-lifting" injectors, respectively, and the advantages of the tube structure of my prior patent were described with particular reference to its use in a non-lifting type of apparatus (although it is equally useful in substitution for the usual tubes of injectors of the lifting type). However, while injectors are thus classified, and while injectors employed, for example, in steam locomotive practice, are quite commonly of the non-lifting type,—being located below the level of the water in the tender tank, yet it is a fact that for best and most certain results, an injector, even in such a location, is most reliable if it has some capability for lifting or developing suction at the water inlet.

When an injector breaks, steam enters the water inlet and heats the water in the feed pipe, and when it is attempted to restart the injector, particularly if the water in the tank be low, the vapor, which accumulates in the space above the level of the hot water in the inlet, presses back the water into the feed pipe so that it is not available to condense the steam in starting, thus causing difficulty unless a substantial suction action is available to draw out such vapors and pull the water into the injector casing as soon as the steam valve is opened. While the tube structure of my aforesaid patent permits delivery against unusual pressures and is effective for longer periods of use than prior injector tubes known to me, it sometimes happens, either through careless operation, continued use after the tube structure has actually begun to wear, or otherwise, that the injector will break more or less frequently, which results in undue heating of the feed water, making restarting abnormally difficult (as above referred to) and with a progressive increase in such difficulty as the feed water becomes hotter and hotter. The requisite suction or lifting action may be obtained by the use of an auxiliary lifting tube in advance of the usual combining tube, but ordinarily the employment of such a lifting tube necessitates the provision of a special partition or other support for the tube in the injector casing, and thus a lifter tube can not ordinarily be installed in an injector casing not especially designed for it.

One object of the invention is to provide a tube structure embodying the advantages of that of my aforesaid patent but such that the injector may be started readily even with very hot feed water, but without necessitating the use of auxiliary controls or undue complication of the injector parts.

More specifically, the present invention contemplates the use of a tube structure generally similar to and having all of the advantages of that disclosed in my prior patent, but having in association therewith, all in one unitary device, a lifter tube designed to furnish the requisite lifting or suction action when circumstances made such action desirable, but without requiring, for its installation, any change in the injector casing or in the steam nozzles or other associated operative parts.

In my aforesaid patent it was pointed out that wear of the inner surface of the tube results in ineffective operation and causes breaking and difficulty in starting, and it was suggested that a selected portion of the tube might be made

wear-resistant in order to extend the effective life and efficiency of the apparatus. However, if one part only of the tube be made wear-resistant, it is found that eventually wear will take place at other points, and in accordance with the present invention, it is proposed to furnish the tube structure with a wear-resistant lining, either integral or in the form of a removable insert or inserts, not only at the point where wear usually first becomes apparent, but, if desired, throughout the entire length of the passage, including both the combining and delivery tubes, and also in the same way, if desired, to make the lifter tube wear-resistant.

Other objects and advantages of the invention will be made manifest in the accompanying more detailed description and by reference to the accompanying drawings, wherein

Fig. 1 is a vertical section lengthwise of an injector casing having the improved tube structure constituting the present invention mounted therein, and showing the parts in the position which they occupy after the injector has started;

Fig. 2 is a fragmentary longitudinally vertical section similar to Fig. 1, but omitting certain elements, and with the parts in the position which they occupy when the injector is being started;

Fig. 3 is an end elevation looking from the left-hand side of Fig. 1;

Fig. 4 is a fragmentary vertical section through an injector casing having a tube structure of slightly modified form mounted therein;

Fig. 5 is a fragmentary vertical section illustrating a wear-resistant lifter tube; and

Fig. 6 is a fragmentary section, on the same plane as Fig. 1, showing certain details to larger scale.

Fig. 1 of the drawings illustrates a two-part injector casing comprising the rear member 1 and the forward or delivery end member 2. The casing members 1 and 2 are provided with flanges 3 and 4, respectively, which are clamped together by bolts 5 so as to form a unitary structure. The rear member 1 of the casing is furnished with a downwardly directed nipple 6 for the reception of a connection 7 designed to receive the end of a hose or other suitable conduit leading to the water supply. A water check valve 8 is disposed within the water inlet chamber 1^a of the casing, immediately above the delivery end of the passage through the nipple 6, for the purpose of preventing water from being driven back into the supply pipe.

The rear member 1 of the casing is also furnished with upwardly directed nipples 9 and 9^a for the attachment of steam supply pipes 9^x and 9^y respectively, leading from an injector control valve, for example, of the kind disclosed in my copending application for Letters Patent Serial No. 21,933, filed May 17, 1935.

Within the rear or inlet end of the casing there is arranged the forcer nozzle 10 and, in concentric relation thereto, the annular priming nozzle 11. The rear end of the forcer nozzle 10 is open to the steam inlet chamber 12 which freely communicates with the supply pipe 9^x, while the rear end of the priming nozzle 11 is open to a steam inlet chamber 13 supplied with steam by pipe 9^y.

At its extreme rear end the casing is provided with an attachment T (having an interior chamber which communicates with the water inlet chamber 1^a) to which a pipe is connected leading up to a telltale in the locomotive cab to notify the engineer when the injector breaks.

The forward member 2 of the casing is fur-

nished with an overflow opening 15 which leads from the delivery chamber 2^a into a valve casing 16 (Fig. 3) wherein is an overflow valve controlled by the valve stem 17. This overflow valve and its actuating device is of a type familiar to those skilled in the art and need not be further described herein.

The improved tube structure forming the more specific subject matter of the present invention comprises the rear or combining tube member 18 and the forward or delivery tube member 19. The member 18 is furnished, adjacent to its smaller end, with an externally screw-threaded nipple 20, while the member 19 is provided adjacent to its smaller end with an internally screw-threaded socket 21 whereby the tube members may be detachably secured together.

The interior of the combining tube converges from its entrance end 22 toward its smaller end while the delivery tube flares in diameter from its smaller end to its delivery end 23, the two tubes collectively providing an uninterrupted passage devoid of lateral outlets from its entrance end 22 to its delivery end 23.

The passage through the tube structure is substantially coaxial with a check valve 24 arranged to close an opening at the delivery end of the casing member 2, such check valve having a stem 25 sliding in a guide carried by a removable cap 26 screw threaded into an opening in the extreme forward end of the casing member 2, the opening controlled by the check valve 24 being of sufficient diameter to permit removal therethrough of the delivery member 19 of the tube structure when desired. The check valve opens into a chamber 27 which in turn is connected with a passage 28 leading to the boiler which is to be fed. Preferably the delivery tube member 19 is provided with a hexagonal flange 29 or equivalent means for application of a wrench or other appropriate tool, whereby the delivery tube may be screwed onto or unscrewed from the combining tube without disturbing the latter.

The combining tube is provided, adjacent to its smaller end, with an external annular enlargement or annulus 30 furnished at its outer edge with a flange member 31 (Fig. 6) having finished radial faces 32 and 33 respectively, which are designed to be clamped in leakproof contact between complementary surfaces 34 and 35 of the respective flange members 3 and 4. When thus clamped in position, the annulus 30 forms a support for the tube structure and a fluid-tight partition between the inlet chamber 1^a and the outlet chamber 2^a.

The annulus 30 is also provided with a rearwardly extending, externally screw-threaded sleeve portion 36 with which normally engages the internally screw-threaded rear end portion of a tubular skirt member 37 radially spaced from but concentric with the tube member 18 and integral at its forward end with the rear end of a lifter tube member 38, the latter having an internal passage which converges forwardly from the rear end 39 of the lifter tube. This lifter tube embraces the forward end of the forcer nozzle 10, being radially spaced from the latter, the forward end of said nozzle preferably being disposed just within the rear end of the combining tube 18, while the rear end 39 of the lifter tube is preferably spaced a short distance forwardly of the forward end of the priming nozzle 11. The space between the skirt member 37 of the lifter nozzle and the exterior of the combining tube member 18 constitutes an intermediate chamber 40. From

this chamber one or more passages 41 lead through the annulus 30 in a forward direction and into the rear end of the delivery chamber 2^a.

The exterior surface of the combining tube 5 just forwardly of the annulus 30 is preferably substantially cylindrical to form a guide for a sliding annular valve 43, adapted at times to close the passage or passages 41. This valve may slide to a limited extent in a front-to-rear direction, 10 being limited in its rearward movement by contact with the annulus 30 and in the forward direction by contact with the rear end of the delivery tube 19.

In accordance with a preferred construction, 15 the delivery tube is provided with a wear-resistant lining sleeve 46 which extends forwardly from the smaller end of the tube and which is adapted to resist the wear which ordinarily takes place quite rapidly at the point where the passage 20 through the tube structure first begins to increase in diameter. Likewise, if desired, the combining tube may be provided with an internal lining sleeve 47 of wear-resistant material. These sleeves 46 and 47 fit in recesses in the delivery 25 and combining tubes, respectively, the inner surfaces of the sleeves constituting the wall of the passage through the tube structure at those points at which they are located, and preferably meeting with a flush joint so that there are no appreciable crevices either at their junctions with 30 each other or at their junctions with the tube members 18 and 19. These sleeves, if eventually worn, may be slipped out of the respective tube members 18 and 19 when the latter are disconnected and replaced by new ones.

As illustrated in Fig. 5, the lifter tube may also, if desired, be made wear-resistant, as for example by providing the rear end of the skirt 37 with an internally screw-threaded nipple portion 43 40 which receives a screw-threaded nipple 49 forming the forward end of the lifter tube 18^a, the latter with its nipple portion 49 being of wear-resistant material. Instead of employing wear-resistant sleeves 46 and 47 it is contemplated that 45 either or both of the tube members 18 and 19 may be made wholly of wear-resistant material and it is further contemplated that instead of making the entire lifter tube, as shown in Fig. 5, of wear-resistant material such tube may be 50 provided with a removable wear-resistant lining sleeve in the same way as the delivery and combining tubes illustrated in Fig. 1.

In the arrangement illustrated in Fig. 4 the casing 1^x is of unitary construction (not divided 55 into two parts like that of Fig. 1) and has within it the inlet chamber 1^a and the delivery chamber 2^a. However, in this modified arrangement the wall of the casing is provided with an interior flange 50 which is internally screw threaded for the reception of an externally screw-threaded annulus 51 carried by the combining tube, the flange 60 50 being furnished with a forward, radial, finished surface 52 for leak-proof contact with a radial rear face of a flange portion 53 of the annulus 51. The annulus 51 is furnished with passages 54 leading from the intermediate chamber 40 forwardly into the delivery chamber 2^a, and these passages are controlled by the sliding annular valve member 43^a similar to the valve member 43 above described.

The operation of the device illustrated in Fig. 1 is substantially as follows: When the injector is to be started and steam is first admitted preferably in gradually increasing quantities through 75 one or the other of the nozzles 10 and 11, the

lifter tube 38 immediately exerts a substantial suction effect effective to draw out from the inlet chamber 1^a any vapor or air which may have accumulated therein, or if the water in the supply be low, to induce the flow of water into the chamber 1^a. During the initial entry of steam into the injector any back pressure which develops, and which would ordinarily tend to force water and steam back into the feed pipe, merely opens the valve 43 so that the steam and/or water is freely 5 delivered through the passages 41 directly into the delivery chamber 2^a and thence through the overflow passage 15. When the injector has thus been properly cleared of air and vapor, and as soon as the inlet chamber 1^a has been filled with 15 water so that a proper condensation of the steam from the nozzle takes place within the combining tube, pressure is built up within the passage through the combining and delivery tubes sufficient to open the check valve 24 and force water 20 into the chamber 27 against the boiler pressure. As soon as the normal operation commences, the pressure in the delivery chamber 2^a causes the valve 43 to be closed and thus the injector continues to operate, the operator regulating the 25 amount of water by proper manipulation of the steam control valve (not shown).

If at any time it became necessary to repair or replace any of the tube members 18, 19 or 38, it is only necessary to disconnect the casing members 1 and 2 by removal of bolts 5, whereupon the entire tube structure may be removed as a unit from the casing. Any one of the tube members may then readily be separated from the others for inspection, repairs, or replacement, and the parts 35 all reassembled, without necessitating any disturbance of the setting of the nozzles, inlet valves, water supply pipe, or other parts associated with the rear member 1 of the casing.

On the other hand, the delivery tube member 40 19, which is usually the first to wear, may be removed and replaced, without disturbing the other members of the composite tube structure, merely by removing the check valve housing 26 and the valve 24, and by means of a suitable tool disengaging the tube member 19 from the member 18, or reengaging therewith.

In the construction of Fig. 4, the entire tube structure may be removed as a unit through the check valve opening, without disturbing the casing 50 or any of the connections leading to or from the latter, and without interference with the nozzles.

While certain desirable embodiments of the invention are herein illustrated by way of example, 55 it is to be understood that the invention is not necessarily limited to the precise details shown, but is broadly inclusive of all equivalents as defined by the appended claims.

I claim:

1. A tube structure for use in injectors, said tube structure comprising a combining tube member, a delivery tube member, and a lifter tube member, all of said members being in axial alignment, the combining and delivery tube members 65 being normally united at their smaller ends, the combining tube having an external annulus provided with a substantially cylindrical, externally screw-threaded portion, the lifter tube member having a tubular skirt coaxial with and embracing but radially spaced from the combining tube thereby to form an intermediate chamber between said tube members, the forward end of the skirt member being screw threaded for engagement with the cylindrical portion of the flange 75

and the latter having a passage leading forwardly from said intermediate chamber, and valve means for closing said passage.

2. A tube structure for use in injectors, said tube structure comprising a combining tube member, a delivery tube member and a lifter tube member, said members being in axial alignment, the combining and delivery tube members being normally united at their smaller ends, the lifter tube member having a tubular skirt portion coaxial with and embracing the rear portion of the combining tube but radially spaced from the latter to form an intermediate chamber, the forward end of the skirt portion of the lifter tube member normally being united to the combining tube member, means providing a passage leading from the intermediate chamber beyond the forward end of the skirt portion, and valve means for closing said passage.

3. A tube structure for use in injectors, said tube structure comprising a combining tube member, a delivery tube member and a lifter tube member, said members being in axial alignment, the combining and delivery tube members being normally united at their smaller ends, the combining tube member having an annular external supporting flange designed to form a transverse leak-tight partition across an ejector casing and to position the tube structure in said casing, the flange having a substantially cylindrical externally screw-threaded portion, the lifter tube member having a tubular skirt which embraces the rear part of the combining tube and which has screw-threaded engagement with the cylindrical screw-threaded portion of the flange, said flange having a passage therethrough, and valve means for closing said passage.

4. A tube structure for use in injectors, said tube structure comprising a combining tube member, a delivery tube member and a lifter tube member, said members being in axial alignment, the combining and delivery tube members being normally united at their smaller ends, the combining tube having an annular external positioning flange designed to form a transverse partition across an injector casing and to position the entire tube structure in said casing, the lifter tube member having a tubular skirt portion embracing the rear part of the combining tube member and forming therewith an intermediate chamber, the flange having a passage leading forwardly from said chamber, and an annular valve coaxial with the combining tube member and movable axially of the latter to close or uncover said passage.

5. A tube structure for use in injectors, said tube structure comprising a combining tube member, a delivery tube member and a lifter tube member, said members being in axial alignment, the combining tube having an integral annular supporting flange adjacent to its smaller end, said flange being designed to form a transverse leak-tight partition in an injector casing and having a surface designed to be clamped firmly against a complementary surface of the casing, said flange having a rearwardly extending externally screw-threaded sleeve portion, the lifter tube having a tubular skirt screw threaded to engage said sleeve portion of the flange and which houses the entrance end portion of the combining tube and which is radially spaced from the latter tube to form an intermediate chamber, the flange having passages through it leading forwardly from said chamber, an annular valve coaxial with the combining tube for closing said passages, and means

constituting a guide on which said annular valve may slide toward and from the flange.

6. A tube structure for use in injectors, said tube structure comprising a combining tube member, a delivery tube member and a lifter tube member, the combining and delivery tube members being normally united at their smaller ends, the combining tube having an integral annular supporting flange adjacent to its smaller end, said flange being designed to form a transverse leak-tight partition in an injector casing and having a surface designed to be clamped firmly against a complementary surface of the casing, said flange having a rearwardly extending sleeve portion, the lifter tube having a tubular skirt which fits over and is united to said sleeve portion and which houses the entrance end portion of the combining tube and cooperates with the latter tube to form an intermediate chamber, the flange having passages through it leading forwardly from said chamber, an annular valve coaxial with the combining tube for closing said passages, and means constituting a guide on which said annular valve may slide toward and from the flange, said valve being removable by separation of the combining and delivery tubes.

7. A tube structure for use in injectors, said tube structure comprising a combining tube member, a delivery tube member and a lifter tube member, said members being in axial alignment, the combining tube having an integral annular supporting flange adjacent to its smaller end, said flange being designed to form a transverse leak-tight partition in an injector casing and having a surface designed to be clamped firmly against a complementary surface of the casing, said flange having a rearwardly extending externally screw-threaded sleeve portion, the lifter tube having a tubular skirt which houses the entrance end portion of the combining tube and which cooperates with the latter tube to form an intermediate chamber, the flange having passages through it leading forwardly from said chamber, an annular valve coaxial with the combining tube for closing said passages, and means constituting a guide on which said annular valve may slide toward and from the flange, the smaller end of the delivery tube normally constituting a limiting stop for said valve.

8. A tube structure for use in injectors, said tube structure comprising a combining tube member, a delivery tube member, and a lifter tube member, said members being in axial alignment, the combining and delivery tube members being separably united at their smaller ends and being devoid of lateral outlets, the lifter tube member having a tubular skirt portion coaxial with and embracing the rear portion of the combining tube and being radially spaced from the latter to form an intermediate chamber between the inner surface of said skirt portion and the outer surface of the combining tube member, the forward end of the skirt portion of the lifter tube member being separably united to the combining tube member, certain at least of said tube members having wear-resistant inner surfaces, means providing a passage leading from the intermediate chamber to a point beyond the forward end of the skirt portion, and pressure actuated valve means for closing said passage.

9. In combination in an injector having an elongate casing provided at one end with an inlet chamber housing a steam nozzle and having a delivery chamber adjacent to its opposite end, a tube structure comprising a combining tube member,

a delivery tube member, and a lifter tube member, said members being in axial alignment, the combining and delivery tube members being normally united at their smaller ends and being devoid of lateral outlets, the tube structure comprising an annular external positioning flange which forms a transverse partition across the injector casing and which positions the entire tube structure in the casing, the lifter tube member having a tubular skirt portion embracing the rear

part of the combining tube member and forming therewith an intermediate chamber, the flange having a passage leading forwardly from said intermediate chamber to the delivery chamber, and an annular valve coaxial with the combining tube member and movable axially in response to varying pressure conditions within the injector casing to close or uncover said passage.

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