

Feb. 4, 1930.

J. F. GRIFFIN

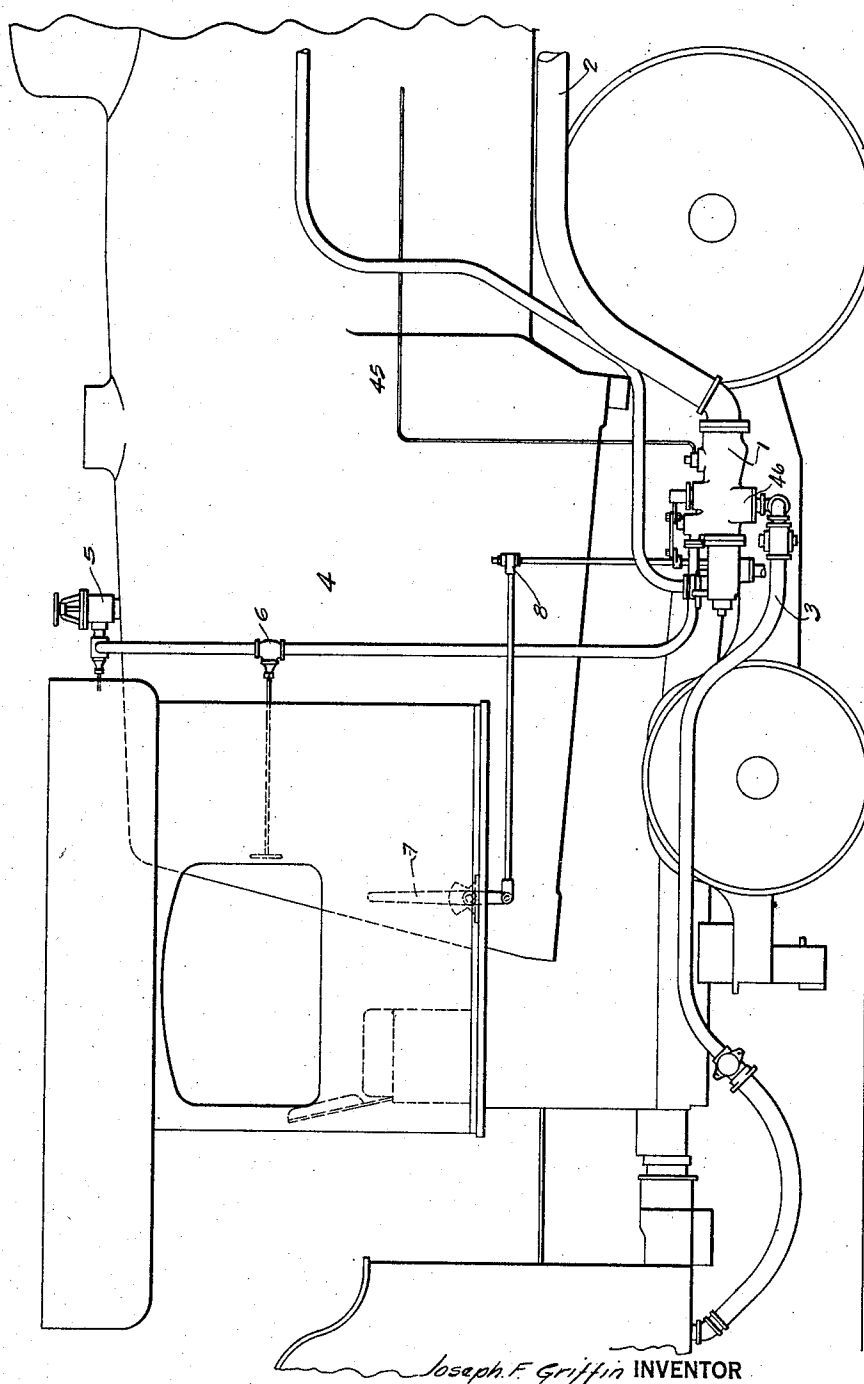
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EXHAUST STEAM INJECTOR

Filed Dec. 28, 1927

4 Sheets-Sheet 1

Fig. 1.



Joseph F. Griffin INVENTOR

BY

O. V. Thiele

ATTORNEY

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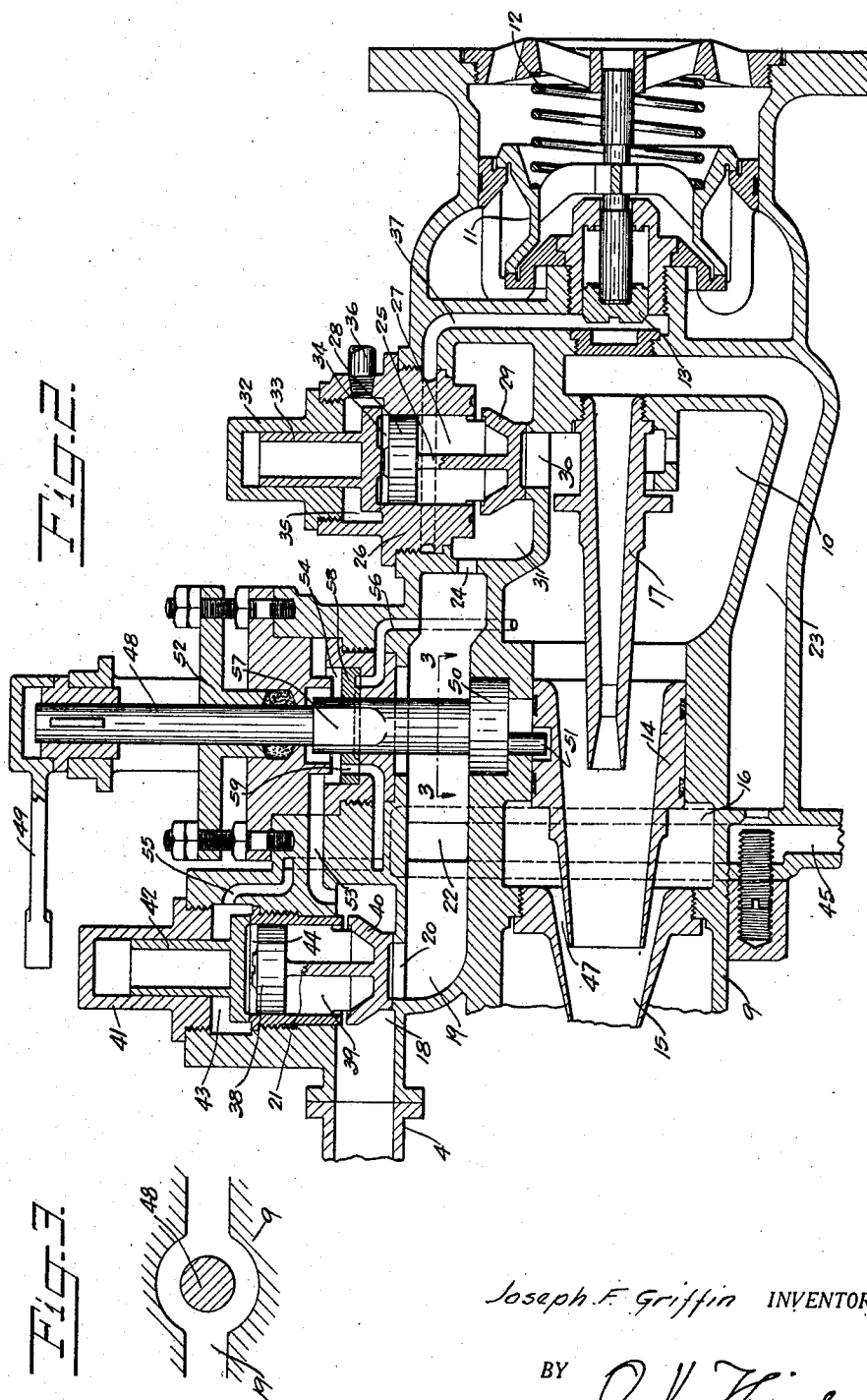
J. F. GRIFFIN

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Joseph F. Griffin INVENTOR.

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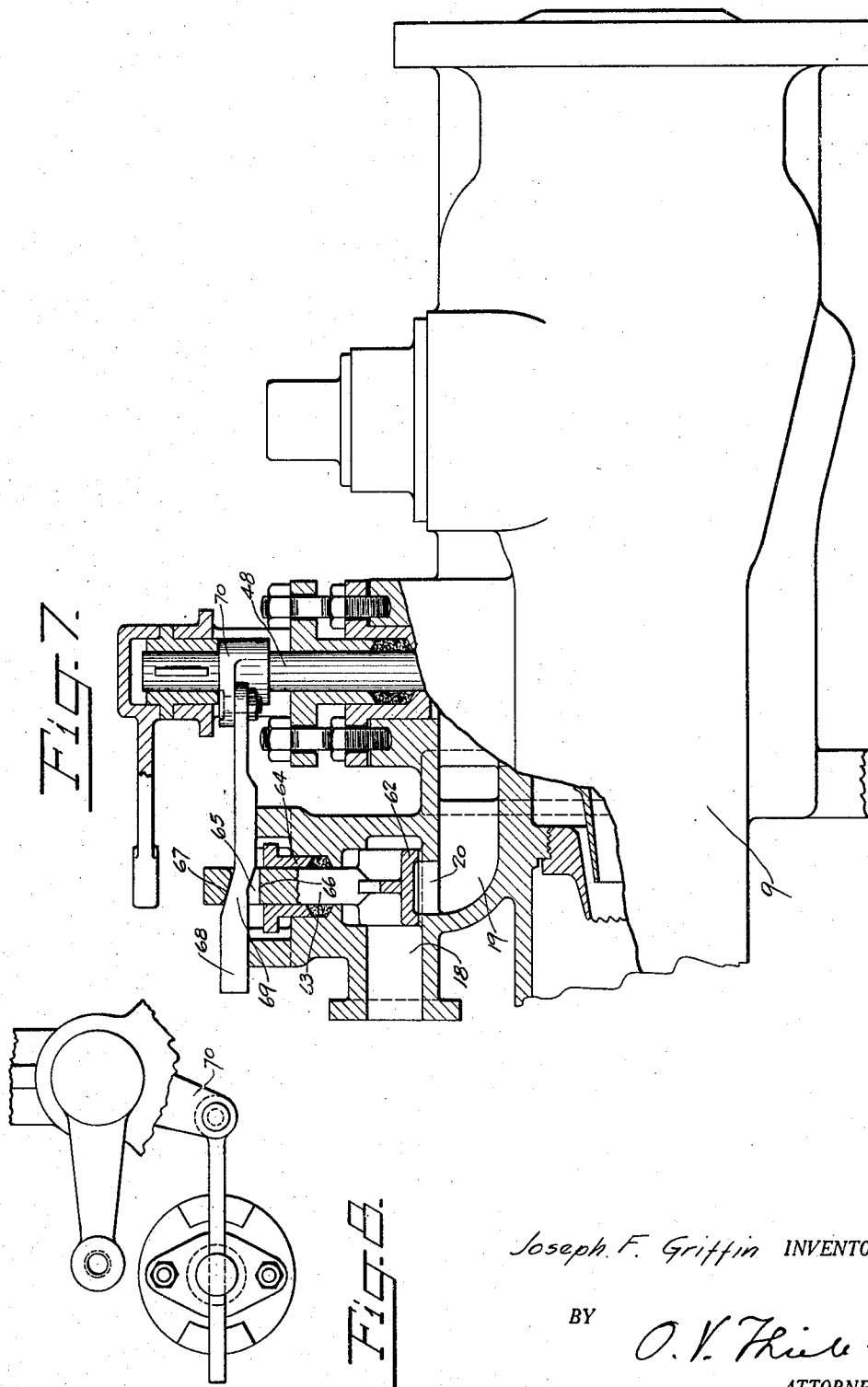
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**1,745,613**

### EXHAUST STEAM INJECTOR

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## UNITED STATES PATENT OFFICE

JOSEPH F. GRIFFIN, OF TEANECK, NEW JERSEY, ASSIGNOR TO THE SUPERHEATER COMPANY, OF NEW YORK, N. Y.

## EXHAUST-STEAM INJECTOR

Application filed December 28, 1927. Serial No. 243,091.

My invention relates to injectors of the type primarily intended to be operated by the exhaust steam from an engine and provided with means whereby they may be operated by live steam when exhaust steam is not available.

Injectors of this type are most frequently used on locomotives where engine conditions vary widely and where it is also necessary that the controls for operating the injector under all engine conditions be made as simple as possible. Various systems have been heretofore developed for simplifying the control of such injectors, but such systems have, so far as I am aware, all required at least two manually operated controls, that is, a control for the live steam supplied to the injector and a control for regulating the amount of water supplied thereto. A principal object of the invention consists in the provision of a control system in which the admission of all steam and water supplied to the injector and the regulation of the quantity of the latter supplied is brought under the control of a single manually operated mechanism.

Control systems heretofore developed provide means by which the operation of the injector is automatically shifted from live steam to exhaust steam and vice versa, by changes in engine conditions but such systems have proved unsatisfactory under some conditions, particularly when the injector is shifted from exhaust steam to live steam operation. Injectors of the type herein considered are quite sensitive in operation and if the relative proportions of steam and water supplied to the injector are not correct, the latter will "break" and fail to operate until such time as correct proportions of steam and water are supplied. Such "breaking" of the injector occurs most frequently when the injector has been operating with an exhaust steam supply at relatively high pressure and a full water inlet opening, and is shifted to live steam operation by the closing of the engine throttle and failure of the exhaust steam supply. The cause of the injector "breaking" under these conditions is that the low pressure live steam supplied to take the place of the exhaust steam is not sufficient to

operate the injector with as large a water opening as was used with the exhaust steam at relatively high pressure, and before the injector can be made to operate with the low pressure live steam, the water inlet thereto must be adjusted by the operator so that only that amount of water which can be handled by the low pressure live steam is admitted to the injector. A further object of the invention therefore, consists in the provision of means by which the quantity of low pressure live steam admitted to the injector will be regulated in accordance with the amount of water delivered to the injector so that the low pressure live steam opening to the injector is always properly proportioned with respect to the water inlet opening to the injector.

The invention also comprises certain novel combinations of elements and arrangements of parts which will appear more fully from the ensuing description of the illustrative embodiments of the invention shown in the accompanying drawings forming a part hereof.

In the drawings Fig. 1 is a fragmentary elevation of a locomotive showing an injector control system embodying the invention; Fig. 2 is a partial longitudinal section taken through the injector; Fig. 3 is a fragmentary section taken on the line 3—3 of Fig. 2; Fig. 4 is a section similar to Fig. 2, showing a second arrangement; Fig. 5 is a section taken on the line 5—5 of Fig. 4; Fig. 6 shows plan and sectional views of one element of the apparatus; Fig. 7 is a section similar to Fig. 2 showing a third arrangement, and Fig. 8 is a plan view of a part of Fig. 7.

Referring now to the figures, the injector is indicated generally at 1. Exhaust steam is supplied from the engine of the locomotive to the injector by means of conduit 2, water through the supply pipe 3 and live steam through the supply conduit 4 leading from the turret 5. A shut-off valve 6 controlled from within the locomotive cab may be provided in the conduit 4, although this valve is not a necessary part of the apparatus as will appear from the ensuing description. The water supply to the injector is regulated by

the lever 7 located in the cab, this lever being connected with the injector by any suitable linkage such as is indicated generally at 8. The lever 7 also serves to control the admission of live steam, water and exhaust steam to the injector, the manner in which this control is accomplished being hereinafter fully described. Obviously the specific form of mechanical connection between the cab and the injector may be widely varied.

In Fig. 2 I have shown a portion of an injector of the general type disclosed in United States Patent #1,342,148 granted June 1, 1920, to J. Metcalfe et al., and to which live and exhaust steam are admitted to the injector in alternation through the medium of an automatic valve such as is disclosed in United States Patent #1,618,135 granted February 15, 1927, to Neal T. McKee. Reference may be had to these patents for a more detailed description of the injector which, for the purposes of the present invention, may be briefly described as follows: The injector comprises a main housing 9 forming a steam chamber 10 to which exhaust steam from the engine is admitted by way of the exhaust valve 11, the latter being normally closed by the pressure of spring 12 and opened by a fluid pressure actuated piston 13, the control of which will be hereinafter described. Steam from chamber 10 passes through a main low pressure steam nozzle 14 and combines in a water nozzle or cone 15 with water supplied to the latter through the water inlet passage 16. High pressure live steam hereinafter referred to as supplementary steam is injected into the main steam nozzle through the supplementary steam nozzle 17. The mixture of low and high pressure steam combines with the water in cone 15 and is delivered from the latter to the usual combining and delivery tubes which form no part of the present invention and are therefore omitted from the drawing.

The injector housing is formed with a high pressure steam inlet passage 18 to which the supply conduit 4 is connected. A second steam passage 19 is provided in the injector, the latter passage being placed into communication with passage 18 by the port 20. Port 20 is controlled by the automatic valve 21 hereinafter referred to as a starting valve which will be described in detail later. A portion of the high pressure live steam admitted to passage 19 passes through the branch passages 22 and 23 to the supplementary steam nozzle 17 and the remainder of the steam entering the passage 19 passes through the choke port 24 to the automatic valve 25 which controls the admission of exhaust steam and low pressure live steam (the latter being hereinafter referred to as auxiliary steam) in alternation to the low pressure steam chamber 10.

The automatic valve 25 comprises a housing 26 forming an open-ended cylinder 27 with valve seats at its opposite ends. The automatic valve member comprises a piston 28 loosely mounted in the cylinder 27 and a double seated valve head 29, one face of which is adapted to engage the seat at the lower end of cylinder 27. The other face of the valve head 29 is adapted to engage a seat surrounding port 30 formed in the injector housing, which port serves to provide communication between the steam chamber 31 and the main low pressure chamber 10. The automatic valve housing 26 is provided with a suitable cap 32 which serves as a guide for a check valve 33 adapted to engage the seat at the upper end of cylinder 27 and to form with the piston 28 a steam chamber 34. A steam chamber 35 is formed between the cap 32 and check valve 33, this chamber being connected by means of the conduit 36 with the live steam supply leading to the engine. A passage 37 connects the cylinder 27 with the cylinder in which the exhaust valve operating piston 13 is located.

The operation of the automatic valve 25 is as follows: If the engine is in operation and exhaust steam available for operating the injector, steam from the main line of the engine passing through conduit 36 forces the check valve 33 to its seat as shown in the drawing. Live steam entering the chamber 31 through choke 24 passes to cylinder 27 and leaking past piston 28 builds up a pressure in chamber 34. This pressure serves to force the automatic valve to the position shown in the drawing, thereby closing port 30 and cutting off the admission of live steam to chamber 10. Live steam from cylinder 27 passes through the passage 37 and acts on piston 13 to open the exhaust valve 11, thereby admitting exhaust steam to the chamber 10. If the engine throttle is closed, the failure of steam pressure in conduit 36 permits the check valve to rise and release the pressure in chamber 34, chambers 34 and 35 being vented through the conduit 36. The release of pressure above piston 28 causes the automatic valve to be shifted to its upper seat, this action opening port 30 to permit auxiliary steam to enter chamber 10, the reduction in pressure of this steam being accomplished by the throttling action of choke 24. The shifting of the automatic valve to its upper position also cuts off the steam supply to passage 37 and the exhaust valve is closed by spring 12, passage 37 being vented by leakage of the steam trapped therein past the piston 28.

The construction of the starting valve 21 is essentially the same as that of the automatic valve just described. Valve 21 comprises a piston 38 loosely mounted in the cylinder 39 and a double-seated valve head 40, the lower face of which is adapted to

engage a seat surrounding port 20. The upper face of the valve head 40 is adapted to engage a seat at the lower end of cylinder 39. A cap 41 secured to the valve housing serves to guide a check valve 42 and forms with the housing a steam chamber 43 above the valve. A chamber 44 is formed between the piston 38 and check valve 42 when the latter is seated.

The admission of water to the injector is controlled by a fluid pressure actuated water valve mechanism supplied with steam taken from passage 22 through the passage 45. The water valve and its controlling mechanism is of known construction and a typical example is shown in the McKee patent previously referred to. It is therefore not shown in detail in the present case but is indicated generally at 46 in Fig. 1.

Regulation of the amount of water supplied to the injector is effected by longitudinal movement of the steam nozzle 14 in the injector housing, and it will be obvious that such movement of the nozzle will effect the desired regulation by varying the cross sectional area of the annular passage 47 formed between the movable nozzle 14 and the stationary cone 15. Obviously the movement of nozzle 14 may be effected in a number of different ways. In the preferred form shown, the nozzle is moved by means of a vertical spindle 48 carrying at its upper end a lever 49 attached to the linkage 8 and at its lower end terminating in a bearing plate 50 having an eccentrically placed pin 51 which engages a suitable recess in the nozzle 14. The spindle 48 is provided with a suitable packing gland 52 where it passes through the injector housing. A passage 53 connects the steam passage 18 with the upper portion of a chamber 54 through which the spindle 48 passes, the bottom of said chamber forming an annular surface from which passage 55 leads to the chamber 43 of the starting valve and passage 56 leads to the low pressure steam chamber 10. The latter passage may lead to any passage or chamber which is at all times under reduced pressure. The spindle 48 is formed with flattened sides 57 where the spindle passes through the chamber 54 and carries the disk valve 58 (see Fig. 6) provided with the port 59 passing therethrough and with the arcuate recess 60 in its lower face.

The operation of this portion of the apparatus is as follows: Assuming the water regulating mechanism to be in the position shown in Fig. 2 with the nozzle 14 defining the minimum water inlet opening 47, the admission of steam to passage 18 will cause the starting valve 21 to seat over the port 20 and prevent steam reaching the injector. Valve 21 is forced to its lower seat over the port 20 by the action of steam passing through passage 53, port 59 and passage 55 to the

chamber 43 of the starting valve, thereby seating the check valve 42. Steam leaking past the piston 38 builds up pressure in chamber 44, and the unbalanced pressure on the valve 21 causes it to be forced to its lower seat. It will thus be seen that when the water regulating mechanism is in its "minimum" position the injector is automatically shut off by the operation of the starting valve 21. If now the water regulating mechanism be moved toward maximum position by rotation of the spindle 48, the disk valve 58 is moved so that the port 59 is out of registry with the passage 55 and the recess 60 is brought into registry therewith. This action results in the release of pressure in chamber 43 of the starting valve by way of passage 55, the recess 60 and passage 56 to a point of low pressure, and the release of pressure in chamber 43 acts in the same manner as heretofore described in connected with the automatic valve to cause the starting valve 21 to shift to its upper position, thereby opening the port 20 and allowing high pressure steam to enter the passage 19 from which steam enters the branch passages 22, 23 and 45 to supply the supplementary steam nozzle 17 and to actuate the mechanism for opening the water valve. Live steam from passage 19 also enters the steam chamber 31 surrounding the automatic valve and, depending upon engine conditions, serves either to open the exhaust valve 11 or to supply the low pressure steam chamber 10 with auxiliary live steam. It will be apparent that the form of the valve member 58 is such that continued movement of the water regulating mechanism toward maximum position will not affect the starting valve since the arcuate recess 60 will connect the vent passages 55 and 56 throughout substantially the entire range of the regulating mechanism. It is only when the mechanism is in its minimum position and the port 59 in registry with the passage 55 that the starting valve is shifted to its closed position.

From the foregoing it will be seen that the mechanism just described provides means whereby the entire control of the injector including the regulation of the amount of water supplied to it is brought under the control of a single manually operable mechanism.

In Fig. 4 I have shown a form of construction in which the operation of the injector and the control system is the same as the that described in Fig. 2, the corresponding elements of the two figures bearing the same reference numerals. In this form, however, the control mechanism affords an additional regulation of the auxiliary live steam supply so that the amount of the latter supplied to the injector is automatically regulated in accordance with the size of the water inlet opening. In this form the steam inlet passage 19 is enlarged where it passes around

the spindle 48, and the flattened sides 57 of the latter are extended to receive the arms of the valve member 61 adapted to close communication between passage 19 and the steam chamber 31 when the water regulating mechanism is in its minimum position. As will be seen most readily from Fig. 5, rotation of the spindle 48 will cause the valve member 61 to provide an opening of progressively greater area as the nozzle 14 is moved from minimum to maximum position. It is to be noted in this connection that where the regulation mechanism controls the steam opening leading to the automatic valve through the medium of the valve member 61 that the fixed choke 24 is omitted. In this form the opening provided past the valve member 61 serves as the choke for reducing the pressure of the steam passing to the automatic valve, and the principal advantage to be derived from this form of construction lies in the fact that this variable choke will supply the proper amount of auxiliary steam to insure operation of the injector regardless of the amount of water which is being fed to the injector.

Figs. 7 and 8 illustrate a mechanical form of starting valve which may be used either with or without the auxiliary steam regulating feature shown in Fig. 4. In the form shown in Fig. 7, the live steam supply passes from conduit 4 through inlet passage 18 and port 20, to the passage 19 from which it is supplied, to the auxiliary steam nozzle, the water valve operating mechanism, and by way of the automatic valve to the low pressure steam chamber in the same manner as heretofore described. In this construction, however, the port 20 is controlled by a mechanically actuated valve 62 provided with a stem 63 extending to the exterior of the injector through a suitable stuffing box 64. The projecting end of the stem 63 is provided with a slot 65 having a horizontal lower face 66 and a sloping upper face 67. A slide or wedge 68 having an offset portion 69 passing through the slot 65 is pivotally secured to a lever 70 attached to the spindle 48. As shown in the figure, the spindle 48 is in the position defining the minimum water opening in which position the position of the wedge 68 in the slot 65 is such that the valve 62 may be closed by steam pressure. As the spindle 48 is rotated toward maximum position, the wedge 68 is moved to the right to open valve 62 against steam pressure. Once the valve is opened, it is held in open position by the unbalanced steam pressure acting on the valve, and when the spindle 48 is moved in reverse direction to close the valve the lower face of the offset portion 69 of the wedge will act on the lower face of the slot 66 to force the valve toward its closed position against the unbalanced steam pressure acting on it. As the valve approaches the seat around port 20,

the throttling action serves to reduce the pressure in the passage 19 and this reduction in pressure reverses the unbalanced pressure on the valve so that final closure of the latter is accomplished by the pressure of steam in passage 18. As will be noted from the figure, when in closed position there is a small amount of clearance below the face of the wedge and the face 66 of the slot. This arrangement is desirable in order to secure the benefit of a resilient force for closing the valve, for a fixed mechanical connection were relied upon anywhere in the valve or seat it might result in lost motion which would prevent the valve from properly seating.

It will be obvious to those skilled in the art that numerous changes in the arrangement of the apparatus as shown in the illustrative embodiments may be made without departing from the invention and that some features of the invention may be utilized without making use of others. For example, if it is desired to make use of the automatically adjusted choke governing the amount of auxiliary steam supplied, in conjunction with a system using more than a single manually operable control, the starting valve and its controlling mechanism may be omitted and the shut-off valve 6 used in its stead to govern the live steam supply to the injector. The specific forms of apparatus herein shown are therefore not to be taken as limiting in sense but as illustrative only, and the invention is to be understood as limited only by the scope of the appended claims.

I claim:

1. In an exhaust steam injector, the combination with a plurality of conduits for supplying water, live steam and exhaust steam to the injector, and means for regulating the amount of water supplied to the injector, of means operatively associated with said regulating means for controlling the admission of live steam to the injector, and a single control means for manually operating said regulating means.

2. In an exhaust steam injector, the combination with valve controlled conduits for supplying water and exhaust steam to the injector, live steam actuating means for said valves, means for regulating the amount of water supplied to the injector, and a conduit for supplying live steam to the injector and to said actuating means, of means operatively associated with said regulating means for controlling the admission of live steam to the injector through said conduit, and a single control means for manually operating said regulating means.

3. In an exhaust steam injector of the type wherein the admission of water and exhaust steam is governed by fluid pressure controlled valves, the combination with a conduit for supplying live steam to operate the injector and control said valves, of a starting valve

controlling the flow of steam through said conduit, manually controlled means for regulating the amount of water supplied to the injector, and means actuated by said regulating means for controlling said starting valve.

4. In an exhaust steam injector, means for supplying live steam, exhaust steam and water to the injector, means for controlling the admission of both live and exhaust steam to the injector, means for regulating the admission of water to the injector, means for manually controlling said water regulating means, and means for governing said steam controlling means by movement of said water regulating means.

5. In an exhaust steam injector, means for supplying live steam, exhaust steam and water to the injector, a single valve means for controlling the admission of both live and exhaust steam to the injector, means for regulating the admission of water to the injector, means for manually controlling said water regulating means, and means for governing the position of said valve means by movement of said water regulating means.

6. In an exhaust steam injector of the type wherein the admission of water and exhaust steam is governed by fluid pressure controlled valves, the combination with a conduit for supplying live steam to operate the injector and control said valves, of manually controlled means movable between a minimum position and a maximum position for regulating the amount of water supplied to the injector, and means operatively associated with said regulating means for closing said live steam conduit when the regulating means is moved to minimum position.

7. In an exhaust steam injector of the type wherein the admission of water and exhaust steam is governed by fluid pressure controlled valves, the combination with a conduit for supplying live steam to operate the injector and control said valves, of manually controlled means movable between a minimum position and a maximum position for regulating the amount of water supplied to the injector, a starting valve located in said conduit, said valve being constructed and arranged to be moved to both open and closed positions by steam pressure from said conduit, and means actuated by said regulating means for controlling the steam pressure acting on said valve to close the latter when said regulating means is moved to minimum position.

8. In an exhaust steam injector of the type wherein the admission of water and exhaust steam is governed by fluid pressure controlled valves, the combination with a conduit for supplying live steam to operate the injector and control said valves, of manually controlled means movable between a minimum position and a maximum position for regulating the amount of water supplied to the

injector, a starting valve located in said conduit, said valve being constructed and arranged to be opened by steam pressure from said conduit acting on one side of the valve and to be closed by steam pressure from said conduit acting on the opposite side of the valve, passages for conducting steam from said conduit to said opposite side of the valve, and another valve operated by said regulating means to control said passages.

9. In an exhaust steam injector of the type wherein the admission of water and exhaust steam is governed by fluid pressure controlled valves, the combination with a conduit for supplying live steam to operate the injector and control said valves, of manually controlled means movable between a minimum position and a maximum position for regulating the amount of water supplied to the injector, a starting valve located in said conduit, said valve being constructed and arranged to be opened by steam pressure from said conduit acting on one side of the valve and to be closed by steam pressure from said conduit acting on the opposite side of the valve, passages for conducting steam from said conduit to said opposite side of the valve, and another valve controlling said passages and operated by said regulating means, said last named valve being arranged to open said passages when the regulating means is in minimum position and to close said passages when said regulating means is in any other position.

10. In an exhaust steam injector of the type wherein operating live steam is admitted through a single conduit, a fluid-pressure actuated starting valve located in said conduit and controlling steam flow therethrough, a pressure chamber controlling the position of said valve due to the presence or absence of pressure therein, and manually controlled means for governing the pressure in said chamber.

11. In an exhaust steam injector of the type wherein supplementary and auxiliary live steam is admitted through a single conduit, means controlled by steam from said conduit for admitting exhaust steam to the injector, a fluid-pressure actuated starting valve located in said conduit and controlling steam flow therethrough whereby the admission of all operating steam to the injector is governed, a pressure chamber controlling the position of said valve due to the presence or absence of pressure therein, and manually controlled means for governing the pressure in said chamber.

12. In an exhaust steam injector of the type wherein operating live steam is admitted through a single conduit, a starting valve controlling steam flow through said conduit and actuated by the pressure of steam from said conduit, means operated by the pressure of steam from said conduit for closing said

valve, and manually controlled means for applying pressure due to steam from said conduit to said first named means.

13. In an exhaust steam injector comprising a nozzle movable to regulate the amount of water supplied to the injector, the combination with a conduit for supplying live steam to operate the injector and a valve for controlling said conduit, of manually operated means for moving said nozzle between a minimum position and a maximum position, and means operatively connected with said nozzle-moving means for controlling said valve, said last named means being arranged to cause said valve to be closed when the nozzle moving means is in minimum position.

14. In an exhaust steam injector of the type wherein the admission of water and exhaust steam is governed by fluid pressure controlled valves, the combination with a conduit for supplying supplementary live steam and auxiliary live steam to the injector and live steam to control said valves, of manually controlled means movable between a minimum position and a maximum position for regulating the amount of water supplied to the injector, means associated with said regulating means for closing said live steam conduit when the regulating means is in minimum position, and other means associated with said regulating means for reducing the amount of auxiliary live steam supplied to the injector when the regulating means is moved toward minimum position.

15. In an exhaust steam injector to which water and auxiliary live steam are supplied, the combination with means movable between a minimum position and a maximum position for regulating the amount of water supplied to the injector, of a passage for admitting auxiliary live steam to the injector, and a valve controlling said passage, said valve being connected with said water controlling means and arranged to be progressively opened as said means is moved from minimum to maximum position.

16. In an exhaust steam injector to which supplementary live steam and water are admitted and to which exhaust steam and auxiliary live steam are admitted in alternation by an automatic valve, the combination with manually controlled means movable between a minimum position and a maximum position for regulating the amount of water supplied to the injector, of a passage for admitting auxiliary live steam to the automatic valve, and a valve for controlling said passage, said valve being actuated by said means to progressively open said passage as said means is moved from minimum to maximum position.

17. In an exhaust steam injector to which supplementary live steam and water are admitted and to which exhaust steam and auxiliary live steam are admitted in alternation by an automatic valve, the combination with

manually controlled means movable between a minimum position and a maximum position for regulating the amount of water supplied to the injector, of a passage for admitting auxiliary live steam to the automatic valve, and valve means located in said passage to form a variable choke port for auxiliary live steam admitted to the automatic valve, said valve means being actuated by said water regulating means and arranged to progressively enlarge said choke port as the regulating means is moved from minimum to maximum position.

JOSEPH F. GRIFFIN.

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