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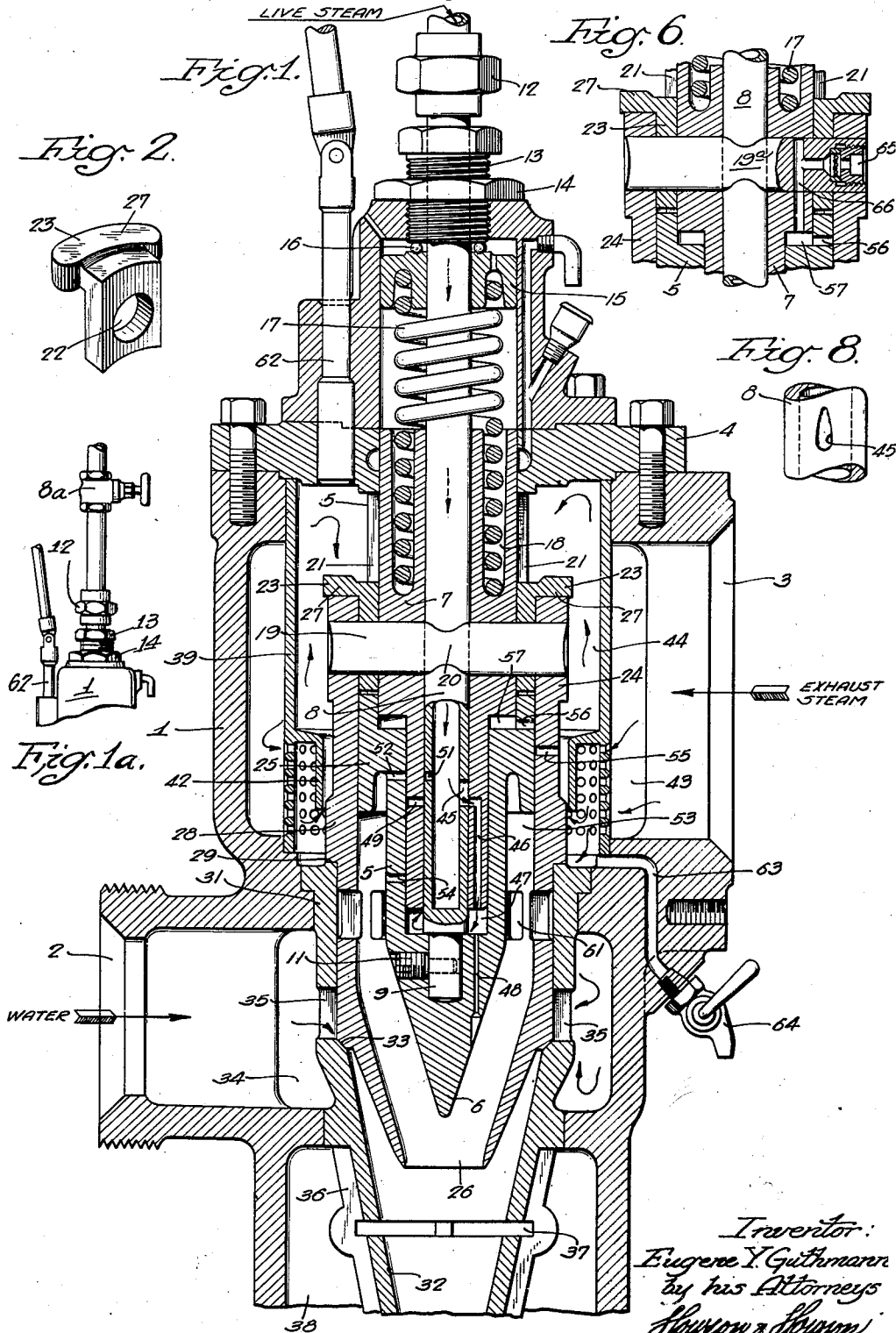
E. Y. GUTHMANN

2,211,058

FLUID CONTROL DEVICE

Filed April 3, 1936

3 Sheets-Sheet 1



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Aug. 13, 1940.

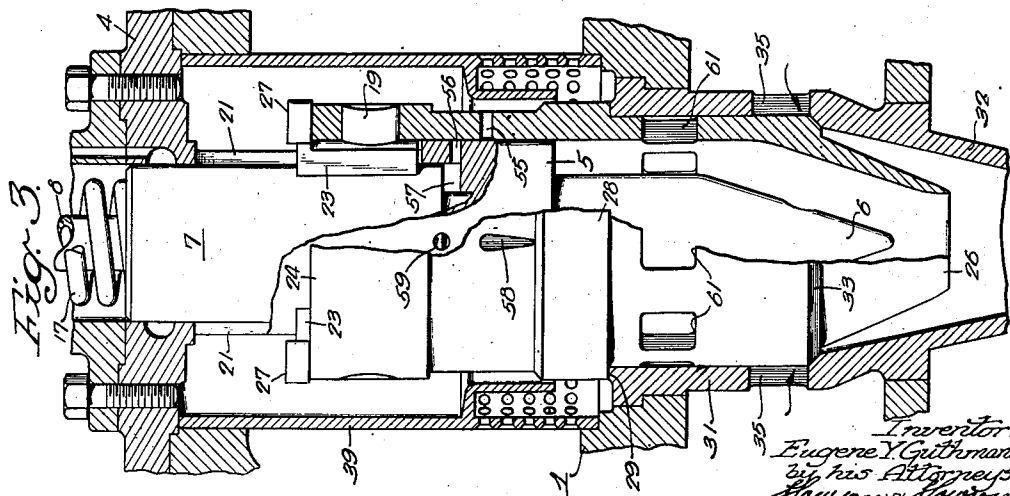
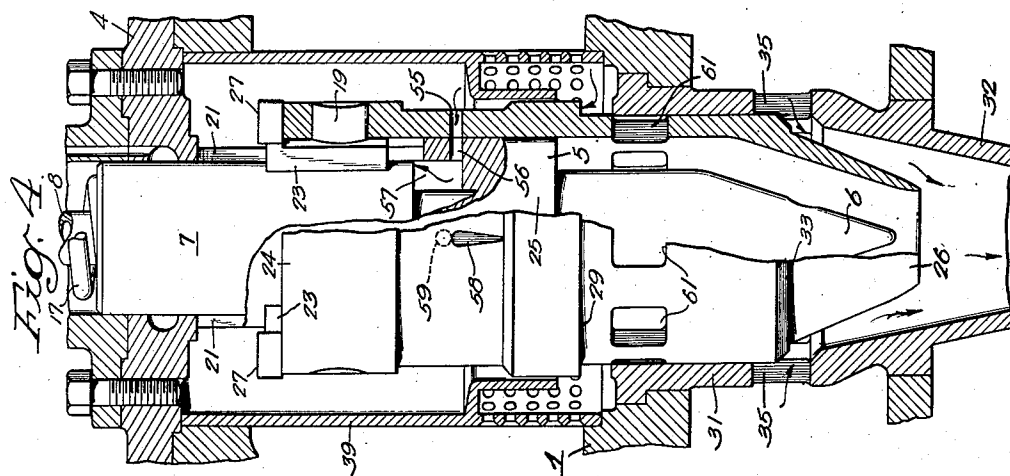
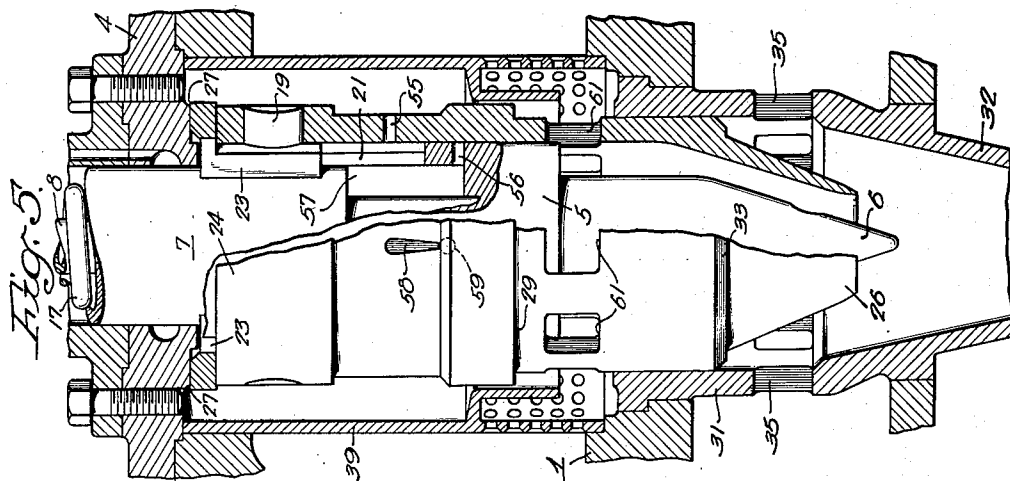
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FLUID CONTROL DEVICE

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3 Sheets-Sheet 2



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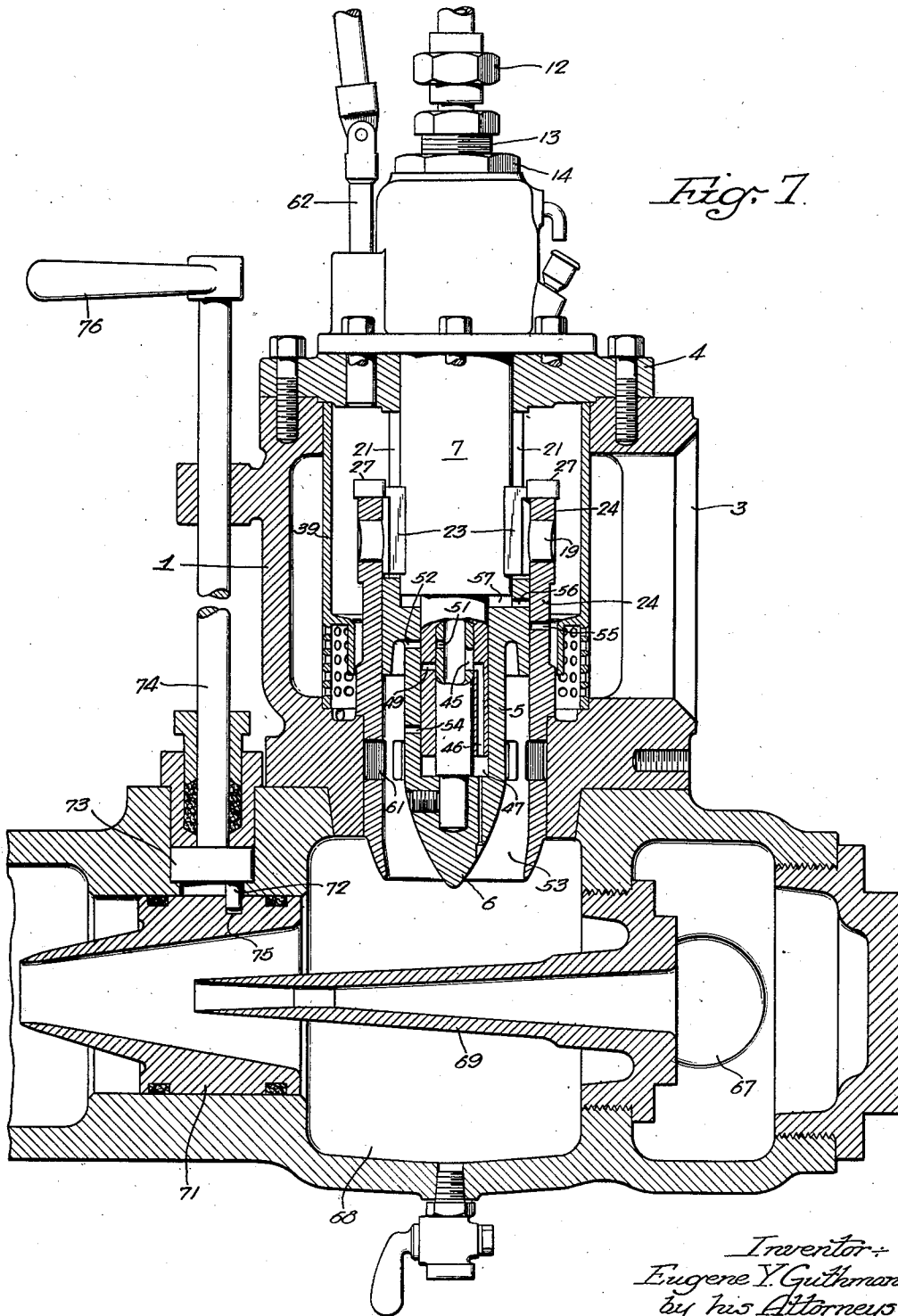
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FLUID CONTROL DEVICE

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3 Sheets-Sheet 3



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2,211,058

FLUID CONTROL DEVICE

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Application April 3, 1936, Serial No. 72,635

22 Claims. (Cl. 277-20)

An object of the present invention is to provide a novel device for delivering fluids to a given point from a plurality of sources at least one of which is of fluctuating character, said device being adapted by automatic selective operation to deliver fluid from the last-named source at such times as the supply from that source is adequate to meet the requirements, and to deliver fluid from the other source when the supply from the fluctuating source is inadequate.

More specifically, an object is to provide a device of the stated character operative to deliver steam as described above from live and exhaust steam sources.

Another object of the invention is to provide an improved device for combining fluids, such for example as water and steam, in automatically regulated and controlled amounts.

Still another object of the invention is to provide a novel and improved form of water heater utilizing steam as the heating medium.

In a specific application of the invention, a further object is to provide an improved feed water heater for boilers, and more particularly for the boilers of locomotive engines, utilizing steam as a heating medium.

Still further, an object of the invention is to provide an improved feed water heater operatively connected both to the sources of live and exhaust steam and automatically operative to utilize the steam from the exhaust source to the exclusion of live steam at such times as the exhaust steam is available in sufficient quantities to meet the heating requirements.

Still another object of the invention is to provide a feed water heater of the stated character that shall be characterized by relative simplicity of mechanical structure and assembly, compactness of form and high functional efficiency.

A still further object of the invention is to provide a feed water heater providing for automatic simultaneous control of the liquid and steam supply, with the resultant multiple advantages hereinafter specifically set forth.

The invention further resides in certain advantageous mechanical and structural features and details hereinafter set forth.

In the attached drawings, wherein for the purpose of disclosing the principles involved I have illustrated a feed water heater made in accordance with the invention;

Figure 1 is a vertical sectional view of the device;

Fig. 1a is a fragmentary view showing an element of the manual control means;

Fig. 2 is a detached view in perspective of one of the elements of the mechanism;

Figs. 3, 4 and 5 are, respectively, vertical sectional views illustrating the device in various positions of automatic adjustment;

Fig. 6 is a fragmentary sectional view illustrating a modification within the scope of the invention;

Fig. 7 is a vertical sectional view of a feed water heater of a different type from that disclosed in the preceding figures but incorporating the principles of the invention, and

Fig. 8 is a fragmentary view showing a detail of construction.

With reference to Figure 1 of the drawings, the feed water heater therein illustrated comprises a casing 1 having admission or supply ports 2 and 3 adapted for connection to sources of water and exhaust steam respectively. The casing comprises a flanged head 4 having a depending cylindrical extension or bushing 5 which projects downwardly into the interior of the casing and which terminates at its lower end in a tapered extremity 6. The bushing 5 is hollow and receives for sliding adjustment in its cylindrical bore a sleeve 7, said sleeve embracing a cylindrical duct 8. The lower solid extremity 9 of the duct 8 is secured in the tapered end 6 of the bushing 5 by means of a set screw 11, and the upper end of the duct projects through the head 4 of the casing and is provided with a union 12 by means of which the duct may be connected with a source of live steam. Admission of steam to the duct 8 from the live-steam source is controlled by a manual valve 8a. The upper end of the duct 8 where it passes through the head 4 is embraced by a bushing 13, said bushing being threaded into the head and being secured in predetermined adjusted position by means of a lock nut 14. The inner end of the bushing 13 forms an abutment for an upper spring seat 15, and anti-friction bearings 16 are interposed between the seat 15 and the opposed end of the sleeve. The seat 15 receives one end of a coiled spring 17, which embraces the duct 8 and which seats at its lower end upon the sleeve 7, said sleeve being provided at its upper end with an extended recess 18 for reception of the spring. The spring 17 urges the sleeve 7 downwardly into the normal position in which it is shown in Figs. 1 and 6, and the pressure of the spring against the sleeve may be regulated in obvious manner through the medium of the bushing 13. The sleeve 7 carries a transverse pin 19, the mid portion 20 of which is provided with an

opening through which extends the duct 8. The outer ends of the pin 19 project through slotted openings 21, 21 in opposite sides of the bushing 5, through apertures 22 in anvil elements 23, see also Fig. 2, which are fitted slidably in the slotted openings 21 of the bushing 5, and terminate in an outer sleeve 24 which closely embraces the enlarged mid portion 25 of the bushing 5 and which has at its lower end a tapered extremity 26 which surrounds the tapered extremity 6 of the said bushing. The anvils 23, as shown in Fig. 2, are shaped to conform to the cylindrical surfaces of the sleeves 7 and 24, between which they are closely confined with their flanged head portions 27 in engagement with the upper end surface of the sleeve 24. The pin 19 unites the inner and outer sleeves 7 and 24 and the anvils 23 into a unitary structure adapted for sliding adjustment within the casing.

Intermediate its ends the sleeve 24 is provided with a section 28 of increased diameter forming a shoulder 29 which seats upon the upper end of a combining tube 31, this tube being suitably mounted within the casing and extending downwardly through the area of the water-supply port 2 to terminate at its lower end in a tapered extremity 32 which forms a port for delivery of the combined water and steam from the casing as hereinafter set forth. The shoulder 29 by seating upon the combining tube 31 limits the downward movement under the action of the spring 17 of the sleeve 24, and hence of the sleeve 7 to which it is attached as previously described through the medium of the pin 19. The lower end of the sleeve 24 fits neatly within the upper end of the combining tube 31 and has formed thereon a shoulder 33, which preferably, in the depressed position of the sleeve 24, seats upon a reverse shoulder formed in the tube 31, as illustrated in Fig. 1. The water supply port 2 of the casing communicates with a chamber 34, the inner wall of which is formed by the tube 31, and the said tube is provided around its circumference with a series of ports 35 which communicate with the chamber 34 and which are normally closed by the lower end of the sleeve 24, as illustrated, the ports 35 thus constituting the effective valve-controlled water supply ports. The tapered extremity 32 of the combining tube is provided externally with longitudinal ribs 36, and between these ribs with ports 37 which, conventionally, provide for overflow of water from the tube to the overflow or suction chamber 38.

Suitably mounted in the interior of the casing within the area of the exhaust-steam supply port 3 is a sleeve 39, the lower end of which is perforated, as indicated at 41, and this sleeve also is provided with an inwardly offset depending flange 42, which may be similarly perforated if desired and which lies in proximity to the outer surface of the sleeve 24. The port 3 communicates with a chamber 43 which embraces the sleeve 39, and this chamber is in communication with the annular chamber 44 in the interior of the sleeve 39 through the apertures in the lower end of the said sleeve and the space between the flange 42 and the sleeve 24.

The tube 8 is provided with a port 45 which normally registers with the upper end of a port 46 in the sleeve 7 which extends from the inner face of this sleeve downwardly therethrough to the lower end. The ports 45 and 46 thus establish communication between the interior of the tube 8 and the chamber 47 formed between the lower end of the sleeve 7 and the lower end of

the interior bore of the bushing 5. From this chamber 47 a port 48 of restricted cross sectional area extends through the lower tapered end 6 of the bushing 5 to the outer surface thereof. The sleeve 7 is also provided with a port 49, which when the said sleeve is elevated, as hereafter described, to a predetermined extent is adapted to register with and establish connection between a port 51 in the wall of the tube 8 and a port 52 in the bushing 5, the port 51, supplemented by the port 52, constituting the effective live-steam admission or supply port for the device. The port 52 is formed directly below the enlarged midportion 25 of the said bushing and communicates with the chamber 53 formed between the lower end of the bushing 5 and the outer sleeve 24. Registration of the port 49 with the live-steam supply ports 51 and 52 thus establishes a direct connection between this chamber 53 and the source of live steam. It will be noted that the port 49 and the upper end of the port 46 are in substantial alignment, and that the upper end of the port 45 corresponds substantially to the lower side of the port 51. The bushing 5 also contains a fourth port, 54, which when the sleeve 7 has been elevated to a predetermined extent establishes direct communication between the chamber 47 and the chamber 53.

The outer sleeve member 24 has in the wall thereof a port 55 which is normally closed at the inside by the enlarged portion 25 of the bushing 5. This port 55, when the sleeve 24 has been elevated to an extent bringing the port 49 opposite the ports 51 and 52, registers with a port 56 in the bushing 5, which port communicates with the chamber 57 formed between the sleeve 7 and the upper side of the enlarged portion 25 of the bushing 5. The port 55 communicates at its outer end with the chamber 44, which as previously set forth is in communication with the apertures in the lower portion of the sleeve 39 and with the chamber 43 which communicates with the exhaust-steam supply port 3. The sleeve 24 also contains a pear-shaped port 58, see Figures 3, 4 and 5, arranged to register in predetermined positions of the sleeve 24 with a port 59 in the bushing 5 communicating at its inner end with the chamber 57.

Also provided in the sleeve 24 is a circumferential series of ports 61 which when the sleeve 24 occupies a normal depressed position as shown in Figs. 1 and 3 are closed at the outer side by the combining tube 31. When the sleeve 24 is elevated to a predetermined extent, these ports 61 establish communication between the exhaust-steam supply port 3 and the chamber 53.

Insofar as described, the operation of the device is as follows: With the parts in the position shown in Figs. 1 and 3, it will be noted that the ports 35 and 61 being closed, both water and exhaust steam are excluded from the combining tube 31. Also exhaust steam if present in the chambers 43 and 44 is excluded from the chamber 57. The spring 17 tends to hold the movable parts in the depressed or advanced positions, and the exhaust steam not only has no tendency to elevate these parts against the pressure of the spring 17, but actually exerts a pressure at the upper surfaces of the anvils 23 and the sleeve 24 tending to hold the moving parts in the depressed position. If, now, live steam is admitted to the duct 8, this steam passing to the chamber 47 through the ports 45 and 46 will exert pressure against the lower end of the sleeve 7 tending to elevate or retract this sleeve and with it 75

the outer sleeve 24 from the normal or fully advanced positions. This elevation of the parts has two effects; first, it opens the ports 35 and establishes communication between the source of water through the port 2 and the interior of the combining tube 31, and, second, it eventually brings the port 49 into registration with the ports 51 and 52 so that live steam will pass from the tube 8 into the chamber 53 and downwardly through the tapered lower end 26 of the sleeve 24 into the combining tube 31. The effect of this steam discharging into the combining tube 31 is to heat the water entering the tube 31 through the ports 35. It will be noted that the arrangement provides by selection of the number, location and size of the ports involved in the operation described above a thorough regulation of the flow of live steam and water to the combining tube, and this factor, coupled with the simultaneous and unified control of the water and steam inflow, provides for delivery of these elements to the combining tube in accurately controlled ratio to afford the most efficient, economical and stable operation. With a device of this character, it is unnecessary to have any means for independent control of the water from the source.

Attention is directed to the live steam lift chamber 47 and the manner in which steam is admitted thereto. The drain port 48 is smaller than the supply port 46, this permitting a gradual increase of pressure in the chamber avoiding too sudden lift of the moving parts. The length of the lift is determined by the length of the port 45 in the direction of movement, and is definitely limited by the pressure-equalizing port 54, which as previously described is opened when the sleeve 7 has reached a predetermined elevation corresponding substantially to the length of the port 45. The port 54 functions to permit an escape of excess pressure in the chamber 47 and precludes upward or retraction movement of the sleeve 7 under the action of the live steam beyond the limits of the port 45. Preferably this latter port is restricted towards its upper end after the manner illustrated in Fig. 8, so that as the sleeve 7 rises, the effective area of the port is gradually decreased. This gradual reduction in area of the supply port and the fact that the drain port 48 is eventually supplemented by the equalizing port 54 makes possible the maintenance in the chamber 47 of an effective pressure substantially equal to the weight of the moving parts and the counter pressure imposed by the spring 17, so that a definite line or lift level may be established.

The initial lift thus effected by the live steam brings the ports 61 to a position of partial retraction at the top of the combining tube 31, wherein an additional lift will effect the opening of these ports to establish connection between the exhaust-steam supply port 3 and the chamber 53, the valve being still sufficiently advanced in this position of initial lift to maintain the ports 61 closed. Also the initial lift as previously set forth brings the port 55 into registration with the port 56, and thereby admits exhaust steam, if present in the chamber 44, to the secondary lift chamber 57. If exhaust steam is present in sufficient quantity to further lift or retract the sleeves 7 and 24 against the pressure of the spring 17 and the counter exhaust steam pressure upon the moving parts, there results an immediate closing of the live steam ports 45 and 51 and an opening of the ports 61 ad-

mitting the exhaust steam to the chamber 53. The device is so designed that when the supply of exhaust steam is such that the steam from this source is capable of assuming the water heating function, the live steam from the other source is automatically cut off, thereby conserving the live steam for other useful work and utilizing the waste exhaust steam for the water heating operation.

It will be noted by reference to Fig. 4, which shows the moving parts in the "initial lift position" effected by the live steam as previously described, that the ports 58 and 59 have been brought to a position in which they are about to register. This registration, occurring when the exhaust steam further elevates the moving parts, supplies exhaust steam to the chamber 57 continuously to the point of maximum lift, as shown in Fig. 5. When the ports 55 clear the upper end of the enlarged portion 25 of the extension 5, this port also admits exhaust steam to the chamber 57. Preferably the port 58 is of inverted pear-shape, as shown in Figs. 3, 4 and 5, so that there is a gradual reduction in the supply of exhaust steam to the chamber 57 toward the upper end of the stroke, thereby throttling the admission of the exhaust steam to the chamber and precluding undue shock at the upper end of the stroke. In this secondary lifting or retraction of the moving parts by the exhaust steam, the ports 61 are opened to admit exhaust steam to the chamber 53, from whence it passes through the tapered lower end 26 of the sleeve 24 into the tube 31 for combining with the water admitted to this tube through the ports 35. In this secondary lift also, there is a simultaneous and automatic regulation of the flow of the water and exhaust steam as in the previously described primary lift employing live steam with the same attendant advantages.

It will be noted further by reference to Fig. 5 that the regulation of the exhaust steam ports during the secondary lift is effected in part by the overlapping of these ports with the enlarged portion 25 of the bushing 5. The extent to which in the extreme elevated position of the moving parts the ports 61 are closed may differ from that shown in Fig. 5, it being possible by increasing or decreasing the travel in the upward retractive direction of the moving parts to vary the ultimate areas of the ports 61 exposed for steam admission or to completely close them. It is apparent that with this arrangement of ports it is possible to obtain a well controlled and regulated flow of water and exhaust steam to the combining tube calculated to afford the most efficient results.

If at any time the supply of exhaust steam fails or is reduced to a point where it is inadequate for the water-heating function, the device will automatically adjust itself for continued operation from the live steam source. Thus when the parts by reason of the failure of the exhaust steam advance under the action of the spring 17 toward the normal depressed position, the ports 61 are cut off and the port 49 simultaneously returned to registration with the live-steam supply ports 51 and 52, admitting live steam to the chamber 53. The operation of the device may be discontinued entirely either by shutting off the supply of live steam to the duct 8 in the event that the device is operating on live steam alone; or in the event that the device is operating on exhaust steam by momentarily interrupting the supply of exhaust steam and subsequently cut-

ting off the supply of live steam to the duct 8, the parts being then returned to their normal or inoperative positions as shown in Figs. 1 and 3.

Means is also provided for manually returning the moving parts to the normal inoperative or fully advanced position in the event that it is undesirable or inconvenient to momentarily check the supply of exhaust steam. This means comprises a plunger rod 62 slidably mounted in the head 4 and normally occupying a retracted position as shown in Fig. 1. The plunger is arranged so that when depressed it engages the top of one of the anvils 23, so that by the application of an adequate force, the entire moving-part assembly may be forced down against the pressure of the exhaust steam into the inoperative position. When under these conditions the supply of live steam to the tube 8 is discontinued, the exhaust steam is ineffective to again elevate or retract the parts, so that they remain in the inoperative position. In this respect, attention is directed to the shoulder 29 of the outer sleeve 24 which normally seats as described upon the upper end of the combining tube 31. When so seated, the effective pressure area of the moving-part assembly exposed to exhaust steam is that provided by the top surface of the outer sleeve 24 and the anvils 23, the steam pressure upon this area tending to retain the parts in the normal inoperative position. If this area is larger than the lift area of the moving-part assembly exposed in the chamber 57, the exhaust steam, even though admitted to the latter chamber, will not be effective to elevate the parts from their normal or inoperative position. The excess area subjected to counter pressure preventing the lift by exhaust steam under these conditions is neutralized by the pressure of the live steam in the initial starting chamber 47. When the sleeve 24 is elevated or retracted from the normal position, however, the shoulder 29 forms a lift area exposed to the exhaust steam, which also neutralizes a portion of the counter pressure area at the top of the sleeve. In every instance the total of the effective lift areas exposed to the exhaust steam pressure when the moving-part assembly has been initially elevated must be in excess of the effective counter pressure areas exposed under these conditions to exhaust steam. While in embodiments of my invention such as shown in Fig. 1 the operation does not necessarily depend upon the function of the shoulder 29 as a supplementary lift area, this function of the shoulder may be utilized to advantage in other embodiments of the invention, one of which will be hereinafter described.

Attention is directed to the central tapered element 6 at the lower end of the bushing 5. It will be noted that as the sleeve 24 is elevated the space between this sleeve and the part 6 becomes progressively more restricted, such restriction having a throttling effect upon the steam, and particularly the exhaust steam, passing from the source to the combining tube. The shape and dimensions of this tapered part, therefore, constitutes one of the factors of control and regulation of the operating pressures, and may vary in accordance with the specific requirements. Attention is also directed to the channel or port 63 and the cock 64 associated therewith which provides a means for bleeding the condensate from the exhaust steam chambers.

From the foregoing description the application of the device as a feed water heater in connection with an injector for locomotive and other

engines will be apparent. The heated water is delivered from the combining tube to the forcing tubes of the injector in well known manner, the latter tubes being operated in the conventional manner from the live steam source. When used for this purpose, the device will operate automatically for all conditions under which an additional supply of water to the boiler may be required. If, for example, the locomotive is standing so that only live steam is available for the water-heating function, the device is capable of operating efficiently with steam drawn from that one available source. If the locomotive is moving and working steam, the device once started by application thereto of the live steam will automatically change over to the exhaust steam, which is available under these conditions. The device is automatically operative to deliver steam under conditions wherein the supply of exhaust steam is erratic, such for example as when the locomotive is intermittently stopped and started, or when in motion, the steam intermittently is being worked or not worked. This latter condition may prevail for example when the locomotive is drifting. Under these conditions the device will automatically change over from live steam to exhaust steam operation when steam from the latter source is available and will return itself to the live steam position during those periods when the exhaust steam is not available. Under any of these conditions, the device may readily be thrown into or out of operation by the operator as demanded by the water requirements. This extremely flexible range of automatic operation, which is a characteristic peculiar to my device, is made possible in large part by provision of the means for simultaneous control of water and steam operated by and subject to the pressure control of the steam from the exhaust source.

It is evident that the greater the pressure of the exhaust steam, the heavier will be the drain on the water in the boiler. Under these conditions of available exhaust steam at high pressures, the automatic regulation of the ports as described above will afford an increased supply of water through the injector to the boiler, and thereby compensates for the excessive drain. It will be apparent also that while the heater is operating solely with live steam, opening of the water supply ports 35 is considerably reduced, say to the minimum capacity of the injector but sufficient to supply the required amount of water to the boiler under these conditions. As the exhaust steam becomes available, the device automatically adjusts itself to the increased drain upon the boiler, and under extreme conditions of drain will deliver water to the full capacity of the injector. This action materially helps the operator in maintaining a satisfactory water level in the boiler. Simultaneous control of the water and steam also contributes materially to the economical operation and stability of the injector as previously set forth.

It will be noted further that during those periods of relatively great exhaust steam pressure when the supply is in excess of that required for heating the inflowing water, there is provision for automatic throttling of the exhaust steam supply to the combining tube. Such a condition might prevail for example when the wheels of the locomotive slip on the rails under difficult haul conditions. The excessive exhaust steam pressure then elevates the sleeve 24 to a point where the normal areas of the ports 61 are reduced

by ring 25 of the bushing 5 and creates a further throttling effect between the lower end of the sleeve and the extremity 6 of the bushing. At the same time the water ports 35 are given their maximum opening. This automatic regulation maintains a proper relation between the water and steam supplies and insures a continued efficient operation under the extreme conditions.

Particular attention is directed to the fact that the moving parts of the device are limited in effect to a single member or unit consisting of the sleeves 7 and 24, the pin 19 and the anvils 23, and that the movement of this assembly or unit is in a straight line corresponding to the longitudinal axis of the device. As a result, the device is extremely compact and symmetrical and free from structural complications. In this arrangement, the ring 25 of the bushing 5 constitutes an important element. It forms a sealing partition between the live and exhaust steam sources in that it separates the secondary or exhaust steam lift chamber 57 from the live steam passing from the primary lift chamber 47 through the ports 51, 49 and 52 into the chamber 53. It constitutes in effect a solid abutment from the under side of which the live steam is directed downwardly toward the combining tube and against the upper side of which the exhaust steam may react in the secondary lift operation.

In Fig. 6 of the drawings, I have illustrated a modified means for admitting the exhaust steam to the chamber 57. In this instance the port 55 is eliminated and is replaced by a port 65 in one end of the pin 19a. This port communicates with a channel 66 extending through the pin and through the adjoining portion of the sleeve 7. It is apparent that with this arrangement exhaust steam when available is continuously supplied to the chamber 57. Under this condition, it is essential that the counter pressure surface at the upper end of the sleeve 24 shall be of greater area than the lift pressure of the sleeve 7 exposed to the exhaust steam within the chamber 57. In this modification, the function of the shoulder 29 of the sleeve 24 as a supplementary lift area is to be noted. This area must be sufficient in extent that when added to the lift area of the sleeve 7 exposed in the chamber 57 it will increase the total effective lift area to an amount exceeding the counter pressure area at the top of the sleeve 24. It has been previously pointed out that when the moving parts occupy their normal inoperative positions, wherein the shoulder 29 seats upon the tube 31, that this area is not available for lift purposes. Under these conditions, therefore, the preponderance of the counter pressure area through which the exhaust steam tends to hold the moving parts in the inoperative position will be effective for that purpose. When, however, the moving parts are elevated initially by the live steam as described, the shoulder 29 immediately becomes effective as a lift area and combines with the lift area exposed in the chamber 57 to elevate the movable parts in opposition to the counter pressure of the exhaust steam.

In Fig. 7, I have illustrated the application of my invention to another well known type of injector. The control and regulating mechanism in this case is essentially the same as that described above, and the corresponding parts are accordingly identified by the same reference numerals. In this case, however, the outer sleeve 24 is disassociated from the water source. The steam chamber 53 communicates in this case with

a chamber 68 which embraces the Venturi tube 69 extending from the live steam inlet port 67. The chamber 68 communicates with the inner relatively large end of a tube 71 into which the discharge end of the tube 69 extends. The tube 71 in this case is mounted in the casing for axial adjustment, and this adjustment is effected through the medium of a pin 72 secured in eccentric position on the cylindrical head 73 of a shaft 74. The pin as illustrated projects into a slotted recess 75 in the outer surface of the tube 71. By rotating the shaft 74 by means of its handle 76, the position of the tube 71 with respect to the tube 69 may be varied. The water in this case is introduced into the chamber 77 and is combined with the steam entering the chamber 68 as described in subsequent tubes (not shown). It will be apparent that the principle of operation in this instance and insofar as concerns the apparatus forming the subject of my invention is the same as that described above in connection with the embodiment illustrated in Figs. 1 to 5, inclusive.

In addition to the functional advantages set forth above, a device made in accordance with my invention is characterized by its relative simplicity of construction and assembly and its relative dependability resulting from the superior design which provides in effect a single moving part at all times under full control and never subject to violent shocks or jars under normal operating conditions. Other advantages reside in the compact form of the device, the accessibility of the parts for inspection, and the relatively low expense of manufacture. Specifically, it constitutes a material improvement over the prior devices used for and in connection with exhaust steam injectors to supply a continuous flow of steam alternating between two sources, not only as a matter of function but also because with its relatively few parts it is capable of accomplishing results not heretofore obtainable from the relatively complex assemblies employed in the art prior to my invention.

In the illustrated embodiments provided for the purpose of illustrating the principle of the invention, there has been no attempt to adhere strictly to an exact relative dimensioning of the various parts and functional areas. The relative dimensions and distribution of the parts, for example, and of the pressure areas and ports may vary widely without departure from the invention.

I claim:

1. In a device of the character described, the combination with a casing having admission and delivery ports and adapted through said admission port for connection with a source of fluid pressure, a valve member movably mounted in said casing and operative in an advanced position to prevent flow between said ports, means adapted for actuation by static fluid pressure from said source for shifting the valve into a retracted position permitting flow between the ports, said means being inoperative when the valve is in the said advanced position, and means for initially withdrawing the valve from the advanced position so as to render said shifting means operative.

2. In a device of the character described, the combination with a casing having admission and delivery ports and adapted through said admission port for connection with a source of fluid pressure, a valve member movably mounted in said casing and operative in a normal seated

position to prevent flow between said ports, said valve having a lift area against which fluid pressure from said source may react to lift the valve into a position permitting flow between the ports, a portion at least of said lift area being unexposed to said pressure when the valve is seated, means for normally holding the valve to its seat, said holding means being effective against the lifting pressures exerted through the exposed portion of the said lift area, and being ineffective against the lifting pressures exerted through the entire lift area, and means for initially lifting the valve to render the entire lift area effective to shift the valve in opposition to said holding means.

3. In a device of the character described, the combination with a casing having admission and delivery ports and adapted through said admission port for connection with a source of fluid pressure, a valve member movably mounted in said casing and operative in a normal position to prevent flow between said ports, said valve being constructed to provide a lift area against which the static fluid pressure from said source may react to lift the valve into a position permitting flow between the ports, and having a lesser counter lift area exposed to said pressure and tending to seat the valve, a portion at least of said lift area being unexposed to the pressure when the valve is in the said normal position whereby the counter pressure is effective to hold the valve closed, and means for initially lifting the valve to expose the entire lift area to said pressure.

4. In a device of the character described, the combination with a casing having admission and delivery ports and adapted through said admission port for connection with a source of fluid pressure, a valve member movably mounted in said casing and operative in advanced positions to prevent flow between said ports, means forming a chamber between the valve and a relatively fixed part of the casing within which chamber said fluid pressure is operative to shift the valve into a position permitting flow between said ports, said valve being operative in an extreme advanced position to exclude the fluid pressure from said chamber and in a position of lesser advancement to establish communication between said chamber and the said pressure source, and means independent of the pressure from said source for retracting the valve to the said position of lesser advancement whereby the fluid pressure may operate in said chamber to retract the valve to the position permitting flow between said admission and delivery ports.

5. In a device of the character described, the combination with a casing providing a chamber and having a plurality of ports for admission to said chamber of fluids from different sources, of a valve structure movably mounted in said casing and constituting a common control means for said ports affording a joint regulation of the flows to the chamber from said sources, means for normally retaining the valve in port-closing position, means actuated by fluid pressure from one of said sources for lifting the valve into a position to open the ports connected with that source, and means actuated by fluid pressure from another of said sources for further lifting the valve to a second position opening the port connected with the last-named source.

6. In a device of the character described, the combination with a casing providing a chamber and having a plurality of ports for admission to

said chamber of fluids from different sources, of a valve structure movably mounted in said casing and constituting a common control means for said ports affording a joint regulation of the flows to the chamber from said sources, means for normally retaining the valve in port-closing position, means actuated by fluid pressure from one of said sources for lifting the valve to open the ports, and means operative when the valve is lifted beyond a predetermined point to progressively throttle the flow to said chamber of fluid from the last-named source.

7. In a device for delivering fluids selectively from a plurality of different sources of supply, the combination with a casing having separate supply chambers respectively connected with said sources, of a delivery chamber adapted to receive the fluid from the chambers first named, a movable member adjustably mounted in said casing and having a plurality of ports adapted to establish communication respectively between the supply chambers and said delivery chamber, said ports being closed in a normal position of said member and being relatively positioned so that they are opened successively and individually by a progressive movement of said member from the normal position, means actuated by fluid pressure from one of said sources for initiating said movement of the member to open the port connecting that source with the delivery chamber, and means actuated by fluid pressure from another source and rendered operative by said initial movement of the member for continuing the movement of said member to an extent opening the port connecting the delivery chamber with said last-named source.

8. In a device for delivering fluids selectively from a plurality of different sources of supply, the combination with a casing, of a valve member mounted in said casing, a delivery chamber, and ports controlled by said valve and adapted to connect said sources respectively with the delivery chamber, means actuated by fluid pressure from one of said sources to move the valve to an extent connecting that source with the delivery chamber, and means actuated by fluid pressure from another of said sources and rendered operative by the said initial movement of the valve for further moving the valve to an extent disconnecting the first-named source from the delivery chamber and opening the port connecting the second source with the said delivery chamber, said device being operative to deliver fluid from said second source to the delivery chamber and for excluding fluid from the first-named source when the pressure from the second source reaches a predetermined minimum.

9. In a device of the character described, the combination with a casing providing a combining chamber and having a port for connecting said chamber with a primary source of fluid supply, said casing having also ports for connecting said chamber with a plurality of secondary sources of fluid respectively, and means comprising a single valve unit mounted in the casing for controlling said ports and for selectively connecting said secondary sources with the combining chamber.

10. In a device of the character described, the combination with a casing providing a combining chamber and having a port for connecting said chamber with a primary source of fluid supply, said casing having also ports for connecting said chamber with a plurality of secondary sources of fluid respectively, and a single valve unit controlling said ports and adapted by progressive

movement from a normal port-closing position to open the first-named port and to consecutively and exclusively establish connection between the secondary sources and said chamber, means for initiating said movement of the valve and for advancing the valve by fluid pressure from one of said secondary sources to an extent connecting that source with the chamber, and means for further advancing the valve by fluid pressure from another of said secondary sources to an extent connecting the latter source with said chamber and disconnecting the secondary source first named.

11. In a device of the character described, the combination with a casing having in the interior thereof a longitudinally extending bushing, of a valve unit comprising inner and outer sleeves slidably engaging the inner and outer surfaces of said bushing respectively, said bushing having a section of relatively great diameter forming a sliding bearing for the said outer sleeve, and means controlled by said valve for admitting fluid from a plurality of sources selectively to the interior of the outer sleeve at one side of said section of increased diameter, said means comprising a port affording access to the other side of said section of increased diameter of fluid from one of said sources only whereby the fluid pressure from the latter source may predeterminedly actuate said valve.

12. In a device of the character described, the combination with a casing having in the interior thereof a longitudinally extending bushing, of a valve unit comprising inner and outer sleeves slidably engaging the inner and outer surfaces of said bushing respectively, said bushing having a section of relatively great diameter forming a sliding bearing for the said outer sleeve, and means controlled by said valve for admitting fluid from a plurality of sources selectively to the interior of the outer sleeve at one side of said section of increased diameter, said means comprising a port affording access to the other side of said section of increased diameter of fluid from one of said sources only, and means whereby the fluid pressure from the latter source may actuate the valve to admit the said fluid to the interior of the outer sleeve.

13. In a device of the character described, the combination with a casing, of a valve member movably mounted in said casing, said casing having a plurality of ports arranged to be closed by the valve when the latter occupies a normal position in the casing and to be successively and individually opened by progressive movement of the valve in one direction from said normal position, said ports being adapted for connection respectively to different sources of fluid pressure, means adapted for actuation by fluid pressure from the source connected to the first of said ports for moving the valve into position to open said first port, and means adapted for actuation by fluid pressure from the source connected to the second of said ports for advancing the valve into the further position to open the said second port.

14. In a device of the character described, the combination with a casing, of a valve member movably mounted in said casing, said casing having a plurality of ports arranged to be closed by the valve when the latter occupies a normal position in the casing and to be successively and individually opened by progressive movement of the valve in one direction from said normal position, the first of the ports to be opened in said progressive movement of the valve being adapted

for connection to a primary source of relatively high fluid pressure, and the second of said ports to a secondary source of relatively low pressure, means adapted for actuation by pressure from the primary source for moving the valve into position to open the first port but inoperative to move the valve beyond that position, and means adapted for actuation by pressure from the secondary source in excess of a predetermined minimum for advancing the valve into position to open said second port.

15. In a device of the character described, the combination with a casing, of a valve member movably mounted in said casing, said casing having a plurality of ports arranged to be closed by the valve when the latter occupies a normal position in the casing and to be successively and individually opened by progressive movement of the valve in one direction from said normal position, the first of the ports to be opened in said progressive movement of the valve being adapted for connection to a primary source of relatively high fluid pressure, and the second of said ports to a secondary source of relatively low pressure, means adapted for actuation by pressure from the primary source for moving the valve into position to open the first port but inoperative to move the valve beyond that position, and means adapted for actuation by pressure from the secondary source in excess of a predetermined minimum for advancing the valve into position to open said second port, said last-named means being inoperative to move the valve when the latter is in the said normal position.

16. In a device of the character described, the combination with a casing, of a valve member movably mounted in said casing, said casing having a plurality of ports arranged to be closed by the valve when the latter occupies a normal position in the casing and to be successively and individually opened by progressive movement of the valve in one direction from said normal position, the first and second of said ports being adapted respectively for connection with primary and secondary sources of fluid pressure, means for moving the valve from said normal position into position to open said first port, and means adapted for actuation by pressure from said secondary source for advancing the valve into position to open said second port.

17. In a device of the character described, the combination with a casing, of a valve member movably mounted in said casing, said casing having a plurality of ports arranged to be closed by the valve when the latter occupies a normal position in the casing and to be successively and individually opened by progressive movement of the valve in one direction from said normal position, the first and second of said ports being adapted respectively for connection with primary and secondary sources of fluid pressure, means for moving the valve from said normal position into position to open said first port, and means adapted for actuation by pressure from said secondary source for advancing the valve into position to open said second port, said means being inoperative to move the valve when the latter is in the said normal position.

18. In a device of the character described, the combination with a casing, of a valve member movably mounted in said casing, said casing having a plurality of ports arranged to be closed by the valve when the latter occupies a normal position in the casing and to be successively and individually opened by progressive movement of the

valve in one direction from said normal position, the first and second of said ports being adapted respectively for connection with primary and secondary sources of fluid pressure, means for moving the valve from said normal position into position to open said first port, and means adapted for actuation by pressure from said secondary source for advancing the valve into position to open said second port, said means being operative under a predetermined pressure from said secondary source to advance the valve into a position of maximum port opening, and under a greater pressure to advance the valve further into a position of partial port obstruction.

19. In a device of the character described, the combination with a casing, of a valve member movably mounted in said casing, said casing having a plurality of ports arranged to be closed by the valve when the latter occupies a normal position in the casing and to be successively and individually opened by progressive movement of the valve in one direction from said normal position, the first and second of said ports being adapted respectively for connection with primary and secondary sources of fluid pressure, means for moving the valve from said normal position into position to open said first port, and means adapted for actuation by pressure from said secondary source for advancing the valve into position to open said second port, and loading means exerting a pressure on the valve tending to maintain the latter in said normal position.

20. In a device of the character described, the combination with a casing, of a valve member movably mounted in said casing, said casing having a plurality of ports arranged to be closed by the valve when the latter occupies a normal position in the casing and to be successively and individually opened by progressive movement of the valve in one direction from said normal position, the first and second of said ports being adapted respectively for connection with primary and secondary sources of fluid pressure, means for moving the valve from said normal

position into position to open said first port, and means adapted for actuation by pressure from said secondary source for advancing the valve into position to open said second port, said casing having a third port adapted for connection to an independent fluid-pressure source and arranged to be closed by said valve when the latter occupies said normal position and to be opened when the valve moves from the normal position into the position opening said first port.

21. In a steam injector, the combination with a casing having a port adapted for connection to a source of live steam, and a second port adapted for connection with a source of exhaust steam, a valve element mounted in the casing and controlling both of said ports, said valve being normally operative to close the ports, manually-controlled means for actuating the valve to open the live steam port, and means adapted for actuation by pressure from the exhaust steam source for operating said valve to open said exhaust steam port and to simultaneously close the live steam port, said latter means being normally inoperative and being rendered operative by the said actuation of the valve required to open the live steam port.

22. In a device of the character described, the combination with a casing having admission and delivery ports and adapted through said admission port for connection with a source of fluid pressure, a valve member movably mounted in said casing and operative in both fully advanced and partially retracted positions to prevent flow between the ports, means adapted for actuation by fluid pressure from said source for retracting the valve to an extent permitting flow between the ports, said means being operative when the valve is in the said partially retracted position and being inoperative when the valve is in the fully advanced position, and means for initially moving the valve from the said fully advanced position into the said position of partial retraction.

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