Nov. 26, 1946. W. L. HUNTER 2,411,728

FEED WATER REGULATING APPARATUS FOR BOILERS

Filed Aug. 29, 1944 2 Sheets-Sheet 1

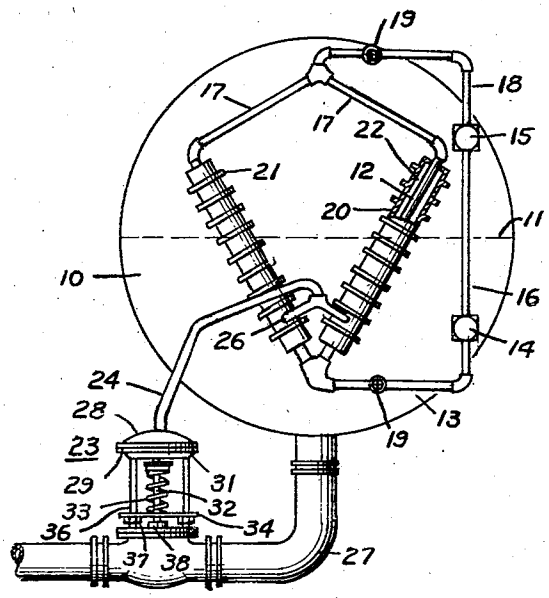


Fig. 1

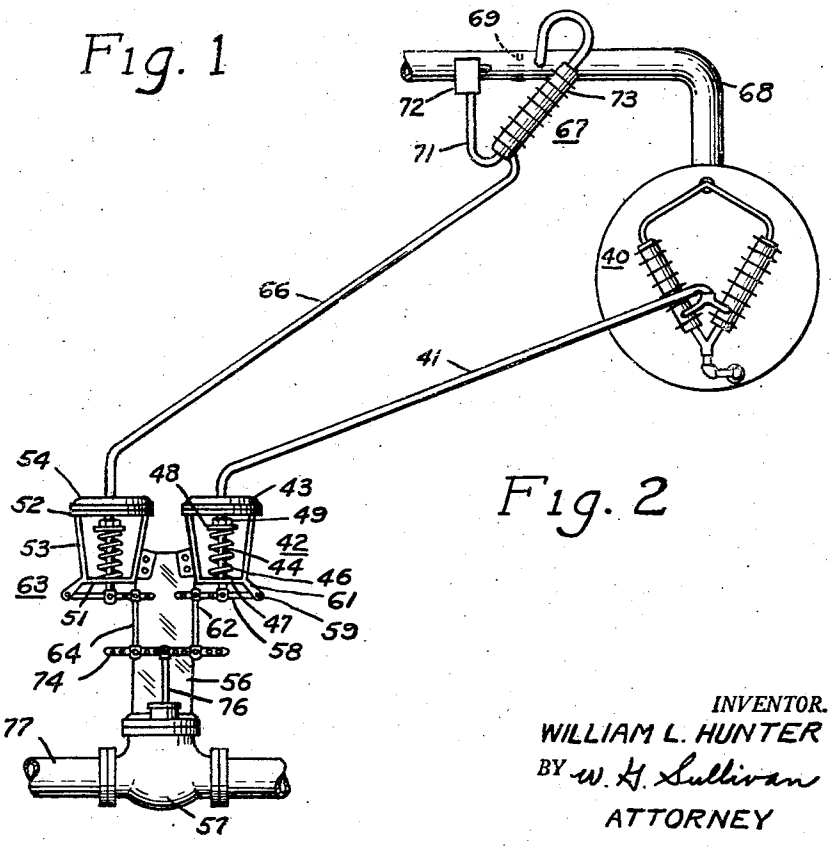


Fig. 2

INVENTOR.
WILLIAM L. HUNTER
BY W. H. Sullivan
ATTORNEY

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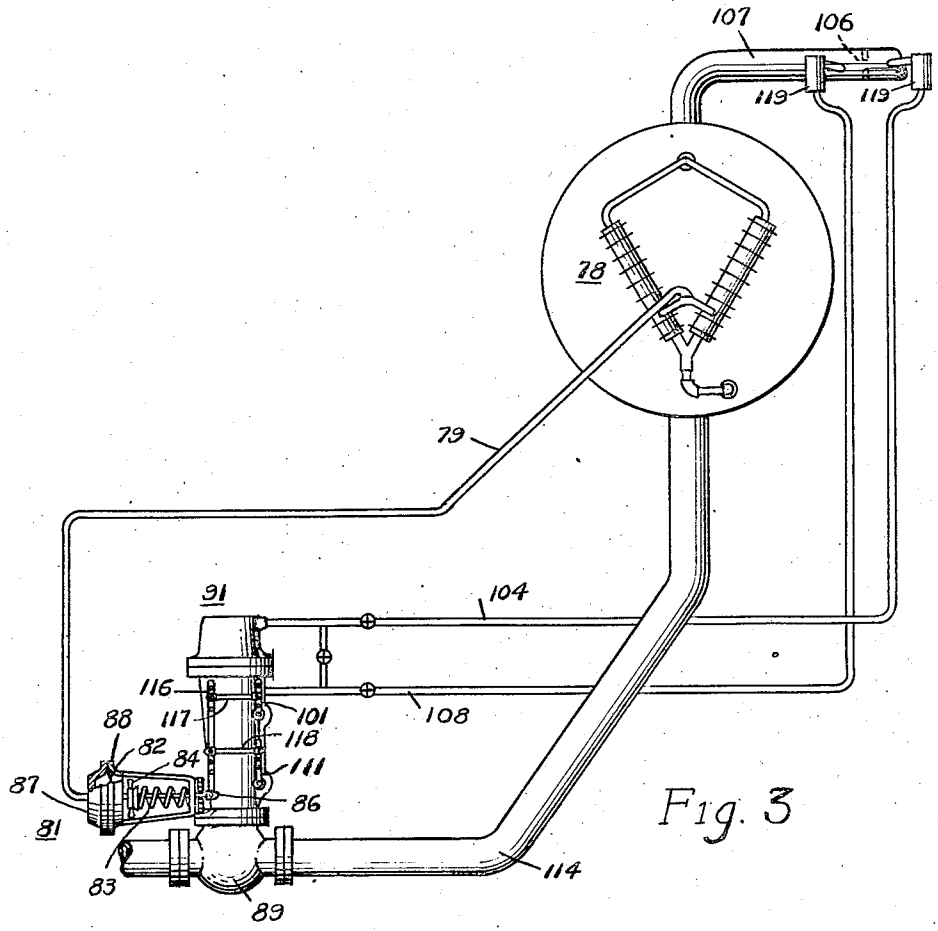


Fig. 3

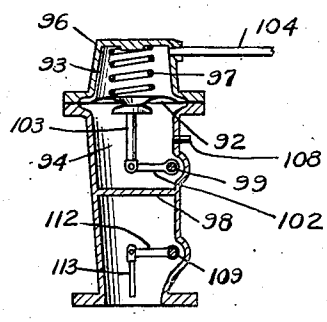


Fig. 4

INVENTOR.
WILLIAM L. HUNTER
BY W. H. Sullivan
ATTORNEY

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FEED WATER REGULATING APPARATUS FOR BOILERS

William L. Hunter, Erie, Pa., assignor to Northern Equipment Company, Erie, Pa., a corporation of Pennsylvania

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9 Claims. (Cl. 122—451.2)

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This invention relates to feed water regulating apparatus for boilers, and more particularly to apparatus of this type which has distinct advantages when employed on marine boilers although not limited to such use.

The present application is a continuation in part of the subject matter of United States Letters Patent 2,365,081, issued to me December 12, 1944.

As is well understood, it is desirable to automatically regulate the feed water supply to boilers and maintain the boiler water level within pre-determined limits. This has commonly been effected in stationary boilers by having a tube or the like in communication with the steam and water space of the boiler whereby the water level in the tube will correspond to the water level in the boiler and regulate the feed water valve in accordance with tube water level. However, such apparatus is not satisfactory for marine boilers since the tube water level is materially disturbed by the roll of the ship resulting in rapid and highly undesirable fluctuations in the amount of feed water being fed to the boiler.

I am aware that it has previously been proposed to compensate for ship roll by employing two tubes or the like fixed to each side of the boiler and laterally outward thereof whereby as the boiler is tilted due to ship roll a drop in water level in one tube will be accompanied by a corresponding rise in the other tube. Both tubes are adapted to influence the feed water supply so that a compensating effect is achieved with a relatively small angular ship roll. However, since each tube is necessarily disposed a substantial distance from the vertical center line of the boiler considerable fluctuation in tube water level results and with considerable angular roll the tubes may be emptied or completely filled. Practical considerations limit the height or extent of the tubes and it is apparent that if the water level extended beyond the tube limits that the control of the feed water will be erratic.

It is a primary object of my invention to provide improved feed water regulating apparatus for boilers.

Another object of my invention is to provide feed water regulating apparatus for boilers and which is particularly adapted to marine boilers whereby an accurate control of the feed water will be maintained responsive to the steam demands despite considerable angular roll of the ship.

Another object of my invention is to provide feed water regulating apparatus of the above

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type wherein the feed water valve is actuated responsive to boiler water level variations or is actuated both in response to water level variations and steam flow variations in the system.

Another object of my invention is to provide improved feed water regulating apparatus for boilers which can be easily installed on a conventional boiler and which is readily adjustable.

Other objects of the invention will be increasingly apparent from a consideration of the following description and drawings.

According to the invention, a generally V shaped tube is mounted externally of the drum head of a boiler with the apex of the tube being disposed substantially in alignment with the vertical center line of the drum head and the tube arms extending at substantially equal angles at each side of the center line. The apex of the tube and the arm ends are connected to the water and steam spaces of the boiler whereby in a stationary boiler the water level in the tube arms will correspond to boiler water level. Each tube arm is encased by a tube sealed at the top and bottom with the arm forming chambers surrounding the arms within which a volatile fluid is disposed. A connection extends from the encasing tubes to a fluid pressure motor actuating the feed water valve. The fluid will volatilize in accordance with the relative amount of steam and water in the tube arms or boiler water level and correspondingly operate the fluid pressure motor and feed water valve.

When the above described apparatus is employed on a marine boiler the water level in one arm will drop and will rise in the other arm as the boiler is tilted but the composite level will not materially change or effect the position of the feed water valve. Due to the normal water level in each arm being only a short distance laterally from the vertical center line of the drum head the water level only fluctuates through relatively small distances despite considerable angular roll of the ship and well within the tube limits so that an accurate control of the feed water is maintained.

In a modified form of the apparatus a second fluid pressure motor is provided which is responsive to steam flow variations in the system and the feed water valve is controlled under the joint influence of boiler water level variations and steam flow variations.

In the following description and drawings:

Fig. 1 is an end elevational view of a boiler drum and my improved regulating apparatus

wherein a single pressure motor controls actuation of the feed water valve.

Fig. 2 is an end elevational view, largely diagrammatic, of a modification of my invention wherein two pressure motors jointly control operation of the feed water valve.

Fig. 3 is a view generally similar to Fig. 2 showing a further modification of my invention, and

Fig. 4 is a vertical section through the upstanding pressure motor of Fig. 3.

Referring now to the drawings, and particularly Fig. 1, I have indicated at 10 one end portion or drum head of a conventional boiler. The normal boiler water level is indicated by the line 11. A generally V shaped tube 12 is disposed with its apex substantially in longitudinal alignment with the vertical center line of the drum head and its arms extending at substantially equal angles on each side of the vertical center line. A pipe 13 connects the tube apex with a three way fitting 14, the fitting communicating with the water space of the boiler through a pipe (not shown) and with a similar upper fitting 15 through a level indicator tube 16. The arm ends are connected by pipes 17 and 18 with the fitting 15 which communicates with steam space of the boiler through a pipe (not shown). It will now be understood that the tube 12 is in communication at the apex and arm ends with the water and steam spaces of the boiler. Valves 19 control the flow of steam and water to the tube and in a stationary boiler the water level in each arm of the tube will be the same and correspond to boiler water level.

Each arm of tube 12 is surrounded by a spaced generator tube 20 preferably provided with fins 21, the tubes being sealed at the top and bottom with the arms thereby providing an encasing chamber 22 for each arm. Disposed within the chambers 22 is a suitable volatile fluid which being in heat exchange relation with each tube arm will volatilize and create pressure in accordance with the relative amount of steam and water in each arm. The fluid pressure is transmitted to a fluid pressure motor generally indicated at 23 through a pipe 24 communicating with each chamber 22 through a Y connection 26 at the lower end of the chambers. The fluid pressure motor actuates a valve controlling flow of feed water through a supply line 27 for the boiler. The particular type of fluid pressure responsive valve employed constitutes no essential part of my invention but it may comprise a fluid pressure chamber formed by a dome shaped member 28 and a diaphragm 29 sealed between peripheral flanges provided on member 28 and a lower member 31. The diaphragm is connected to a valve stem 32 which operates the valve piston (not shown). The diaphragm has its underside exposed to atmosphere and is balanced by a compression spring 33 adapted to be adjusted by a plate 34 movable along guide rods 36 by manipulation of nuts 37. The valve stem is encircled by a stuffing box 38 which prevents water in the supply line from acting on the underside of the diaphragm.

It will now be understood that pressure exerted on the liquid in generator tubes 20 will be transmitted to the diaphragm whereby the valve will be operated in correspondence with fluid pressure. Under normal operating conditions or when the boiler is stationary the liquid level in the arms of tube 12 will be substantially the same and correspond with boiler water level and as the level falls a greater amount of steam will be contained in the tube arms resulting in an increase

in generator fluid pressure and causing the valve to open more. In a similar manner the valve will be moved towards closing position as the boiler water level rises.

When the boiler is tilted due to ship roll the water level in one arm of tube 12 will be lowered causing an increase in fluid pressure in its associated generator tube 20 and the water level in the other arm will rise causing a decrease in fluid pressure in its associated tube and the net result is no appreciable change in fluid pressure or no appreciable change in valve position. It will be noted that at normal water level as indicated by line 11 the level in each tube arm is only a relatively small distance laterally from the vertical center line of the drum head and that the arms will not be completely filled or emptied despite considerable angular roll of the ship thereby maintaining an accurate control of the feed water valve.

Although the apparatus may be supported in any convenient manner I preferably support it from the boiler by the pipes extending from fittings 14 and 15 resulting in a simple installation on a conventional boiler. Also, the position of the valve piston for a given fluid pressure may be easily altered by adjusting nuts 33.

Referring now to Fig. 2, I have shown a modification of my invention wherein two generator type units are employed.

A pair of fluid pressure motors jointly operate the feed water valve and each motor is independently operated by one of the generator units. The V shaped generator unit 40 is similar to that described in connection with Fig. 1 and varying fluid pressure is transmitted through a line 41 to a fluid pressure motor 42 in accordance with boiler water level variations. Motor 42 may comprise a pressure chamber 43 including a diaphragm forming the base of the chamber and having its underside exposed to atmosphere. The diaphragm is connected to a rod 44 and is adjustably loaded by a spring 46 encircling the rod having its lowermost convolution abutting the base of a frame member 47 and its upper convolution abutting a plate 48 movable along the rod by nut 49 threaded to the rod.

Frame member 47 preferably is formed with a circular base 51, perforated to have rod 44 projected therethrough, and an annular top flange 52 inter-connected by oppositely disposed arms 53. The diaphragm is sealed between flange 52 and the flange of a dome-shaped member 54. The pressure motor is supported by a plate 56 extending from the housing of the feed water valve 57. Rod 44 is pivotally connected to a lever 58 which in turn is pivoted as indicated at 59 to an arm 61 extending from frame member 47. Lever 58 operates an arm 62 which is adjustably pivoted thereto.

A second fluid pressure motor 63 is supported by plate 56 and is similar in construction to motor 42 but disposed opposite hand. Linkage similar to that provided for motor 42 operatively connects arm 64 with motor 63. A line 66 extends from the chamber of motor 63 to a manometer unit generally indicated at 67 and controlling fluid pressure in line 66 responsive to steam flow variations in the system.

The steam line 68 is provided with an orifice 69 and a generally U shaped tube 71 including a reservoir 72 is connected to the steam line across the orifice. It is understood that the orifice is merely illustrative of any means causing pressure differential during flow in the steam line.

A tube 73 encases a portion of tube 71 and is sealed thereto whereby a volatile liquid in tube 73 will create fluid pressure therein in accordance with the relative amount of steam and water in the portion of tube 71 in heat exchange relation with the fluid in tube 73. At no flow the water level in both legs of U tube 71 is the same and corresponds to the elevation of the reservoir overflow line. As steam flows through the orifice a pressure differential is created in the right hand or upstream leg of U tube 71 and steam entering this leg causes evaporation of a portion of the fluid in tube 73 resulting in increased pressure transmitted to the diaphragm of motor 63.

Reservoir 72 acts primarily as a capacity tank whereby at maximum load the liquid level in the right leg of tube 71 approaches the bottom of the leg and if the load is suddenly reduced the reservoir has sufficient capacity to fill the right leg of the manometer with but small loss of level in the left leg. If the capacity tank were not provided or the system had a uniform cross-sectional area upon a sudden decrease in load the liquid level would even up in each leg but liquid would not fill the right leg and bring the regulator to the no load position.

Arms 62 and 64 are adjustably and pivotally connected to a lever 74 which in turn is pivotally connected to the valve stem 76. Movement of the valve stem in a generally vertical direction will increase or decrease the flow of feed water to the boiler through the feed water line 77. The operation of the apparatus illustrated in Fig. 2 will now be described. Upon a decrease in boiler water level the motor 42 through the link means described will force valve stem 76 downwardly to cause the feed water valve to open more. In a similar manner motor 63 will be operated upon an increase in steam flow to move the valve in opening direction. Thus, the boiler water level and steam flow control systems for the feed water valve act independently and each produces the proper working pressure without reacting in any way upon the other.

Referring now to Fig. 3, I have shown an arrangement similar to that illustrated in Fig. 2 in that two fluid pressure motors operate the feed water valve through link means but pressure differential in the steam line is transmitted directly to a motor.

Generator 78 transmits pressure through line 79 to fluid pressure motor 81 in accordance with boiler water level variations as described in connection with Fig. 2. This pressure acts on a diaphragm 82, loaded by a spring 83 bearing against and adjustable by a nut 84 threaded to rod 86 which has a headed end engaging the diaphragm. The diaphragm is sealed between a dome-shaped member 87 and an annular flange of a member 88 having oppositely spaced arms inter-connecting the flange and a base through which the rod 86 is projected. For illustration, the member 87 and the flange of member 88 have been shown in section. The motor is supported in any suitable manner as by being bolted to a plate extending from the feed water valve housing 89.

A second fluid pressure motor generally indicated at 91 is supported by the valve housing 89. As best illustrated in Fig. 4, the motor casing is divided by a diaphragm 92 into an upper sealed chamber 93 and a lower sealed chamber 94. The upper chamber is formed by a dome-shaped member 96 against which one end convolution of a compression spring 97 balancing the diaphragm abuts. The base of the lower chamber is indicated at 98. Rotatably mounted in the lower chamber is a shaft 99 which has the near end extended through the chamber wall and fixed to an arm 101 disposed externally of the casing (Fig. 3). Also fixed to shaft 99 and disposed within the lower chamber is an arm 102 having its other end pivotally connected to a headed stem 103 engaging the under side of the diaphragm. The upper chamber 93 communicates by a pipe 104 with the downstream or low pressure side of an orifice 106 in the steam line 107. The lower chamber 94 communicates with the upstream or high pressure side of the orifice through a pipe 108. The shaft 99 is suitably sealed with the casing wall.

A second shaft 109 is rotatably mounted in the lower part the motor casing with its near end extended through the casing wall and fixed to an arm 111 disposed externally of the casing. An arm 112 within the casing is fixed to shaft 109 and is pivotally fixed to the stem 113 of the valve whereby as the shaft is rotated the valve piston will be raised or lowered to control the flow of feed water to the boiler through the supply line 114.

Rod 86 of motor 81 is pivotally connected to a lever 116 which in turn is connected to arm 101 by a link 117 and to arm 111 by a link 118. The links are pivotally connected to the lever and arms by pins and are adjustable by disposing the pins in different holes spaced along the lever and arms.

The operation of the apparatus will be described. As the boiler water level drops increased pressure in line 79 acting on diaphragm 82 forces rod 86 to the right thereby forcing lever 116 in a counterclockwise direction about the pivoted connection with link 117. Lever 116 through link 118 will rotate arm 111 and shaft 109 in a counterclock-wise direction. The rotation of shaft 109 will rock arm 112 and lift the valve stem 113 to cause the feed water valve to open more. Upon a rise in boiler water level the action will be reversed.

Upon an increase in steam flow through line 107, the pressure on the underside of diaphragm 92 is relatively increased and stem 103 moves upwardly with shaft 109 and arm 102 rotating clockwise. Link 117 moves lever 116 clock-wise about the pivoted connection with rod 86 and link 118 rotates arm 111 and shaft 109 clock-wise. Shaft 109 will lift arm 112 and valve stem 113 upwardly to increase the flow of feed water. Upon a decrease of steam flow through line 107 the action will be reversed.

It will be noted that a reservoir 119 is inserted in both lines 108 and 107 serving as capacity tanks whereby the liquid level variation in each line due to movement of diaphragm 92 under pressure change caused by sudden load variation in the steam line is relatively small.

Thus, in both the arrangement of Figs. 2 and 3, the feed water valve is jointly controlled by two fluid pressure motors, and one motor is independently responsive to steam flow variations and the other is independently responsive to boiler water level variations.

It will be noted that the apex of the V tube lies substantially in a vertical plane through the longitudinal center line of the boiler drum with the tube arms extending at substantially equal angles at each side of the plane. Further the V tube is of a size to lie entirely within an area defined by the drum circumference. Also, the V tube is preferably mounted so that the arms ex-

tend substantially equal distances above and below the normal water level in the boiler.

Although I have shown and described preferred embodiments of my invention I contemplate that numerous and extensive departures may be made therefrom without departing from the spirit of my invention and the scope of the appended claims.

The invention is hereby claimed as follows:

1. Feed water regulating apparatus for boilers comprising a boiler drum, a generally V-shaped tube having its apex disposed substantially in longitudinal alignment with the vertical center line of the drum head and its arms inclined at substantially equal angles thereto, connections extending from the tube apex and arm ends to the steam and water spaces of the boiler whereby the water level in each arm will be the same with the boiler in normal position, a feed water valve, a fluid pressure motor for operating the valve, and a closed fluid pressure system communicating with the motor including a volatile liquid in heat exchange relation with each arm whereby the fluid pressure will be determined by the composite water level in both arms and will be relatively unaffected by tilting of the boiler.

2. Feed water regulating apparatus for boilers comprising a boiler drum, a generally V shaped tube having its apex disposed substantially in longitudinal alignment with the vertical center line of the drum head and its arms extending at substantially equal angles thereto, connections extending from the tube apex and arm ends to the steam and water spaces of the boiler whereby the water level in each arm will be the same with the boiler in normal position, a feed water valve, a fluid pressure motor for operating the valve, a fluid pressure generator comprising a pair of tubes each sealed with an arm of the V tube and forming chambers containing a volatile fluid, and communicating means extending from the chambers to the motor.

3. The regulating apparatus as described in claim 1 and wherein the tube arms are disposed to extend substantially equally above and below the normal boiler water level, and the arms are inclined at an angle to have the normal water level therein a relatively small distance laterally of the tube apex whereby the water level will remain within the limits of each arm despite considerable angular movement of the boiler.

4. Feed water regulating apparatus for boilers comprising a boiler drum, a generally V shaped tube mounted on a drum head of the boiler with its apex disposed substantially in a vertical longitudinal plane through the center of the drum head and its arms extending at substantially equal angles on each side of said plane, connections extending from the tube apex and arm ends to the steam and water spaces of the boiler whereby the water level in each arm will be the same with the boiler in normal position, a generally V shaped generator unit comprising closed chambers encasing each arm and a volatile liquid in the chambers adapted to volatilize and create pressure in accordance with the relative amount of steam and water in each arm, a feed water valve, a fluid pressure motor for operating the valve, and communicating means extending from the chambers to the motor.

5. The combination with a boiler drum, a steam line extending from the boiler drum, a feed water supply line, and a feed water valve in the supply line, of feed water regulating apparatus comprising a generally V shaped tube having its apex disposed substantially at the vertical center line of the drum and its arms extending at substantially equal angles thereto, said tube being connected to the water and steam spaces of the drum at the apex and arm ends whereby boiler water level will be communicated to the tube arms, a feed water valve, a fluid pressure motor, a closed fluid pressure system including a volatile liquid in heat exchange relation with the tube arms and communicating with the motor whereby the motor will be operated in accordance with the composite water level in both arms, a second fluid pressure motor adapted to be independently operated in response to steam flow variations, and link means operatively connecting both motors and the feed water valve.

6. The regulating apparatus as described in claim 5 and wherein the link means comprises a pair of arms each pivotally mounted on a different motor and operable by its associated motor, a pair of links each pivotally connected to a different arm, a lever pivotally connected to both said links, and the lever being pivotally connected to the stem of the feed water valve whereby the lever may pivot about either link connection to operate the valve.

7. The regulating apparatus as described in claim 5 and wherein the steam line is provided with means creating pressure differential during flow, a connection across said means comprising a generally U form tube and a reservoir, a generator tube forming a chamber encasing the upstream leg of the U tube and containing a volatile liquid adapted to create varying pressure in accordance with the relative amount of steam and water in said upstream leg, and communicating means extending from said generator tube to one of the pressure motors.

8. The regulating apparatus as described in claim 5 and wherein the second fluid pressure motor comprises a pair of sealed chambers divided by a diaphragm, means in the steam line creating pressure differential during flow, a conduit connecting one of said chambers with the steam line upstream of said means, a second conduit connecting the other chamber with the steam line downstream of said means, and the diaphragm being operatively connected to the link means.

9. Feed water regulating apparatus for boilers comprising a boiler drum, a pair of upwardly extending arms mounted on one drum head of the boiler and lying within a periphery defined by the drum head, the upper ends of the arms being substantially equally spaced at opposite sides of a vertical plane bi-secting the drum and connected to the steam space of the boiler, the lower ends of the arms being substantially equally spaced at opposite sides of said vertical plane bisecting the drum and connected to the water space of the boiler, a feed water valve, a fluid pressure motor for operating the valve, a closed fluid pressure system communicating with the motor including a volatile liquid in heat exchange relation with each arm whereby the fluid pressure will be determined by the composite water level in both arms and will be relatively unaffected by tilting of the boiler, a second fluid pressure motor adapted to be independently operated in response to steam flow variations, and link means operatively connecting both motors and the feed water valve.

WILLIAM L. HUNTER.