H. E. CADE & D. R. KNAPP.

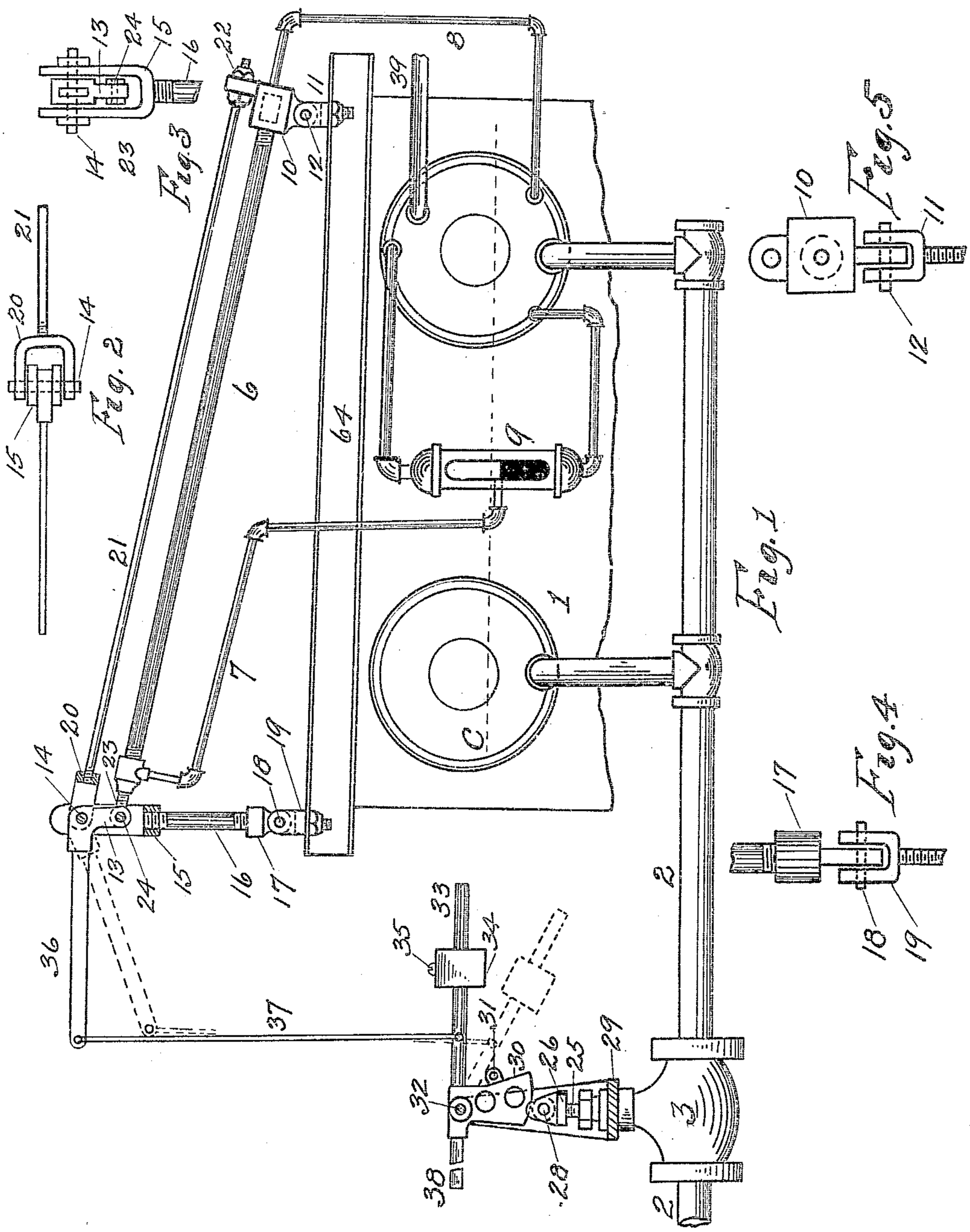
BOILER FEED REGULATOR.

APPLICATION FILED AUG. 19, 1908.

953,734.

Patented Apr. 5, 1910.

3 SHEETS—SHEET 1.



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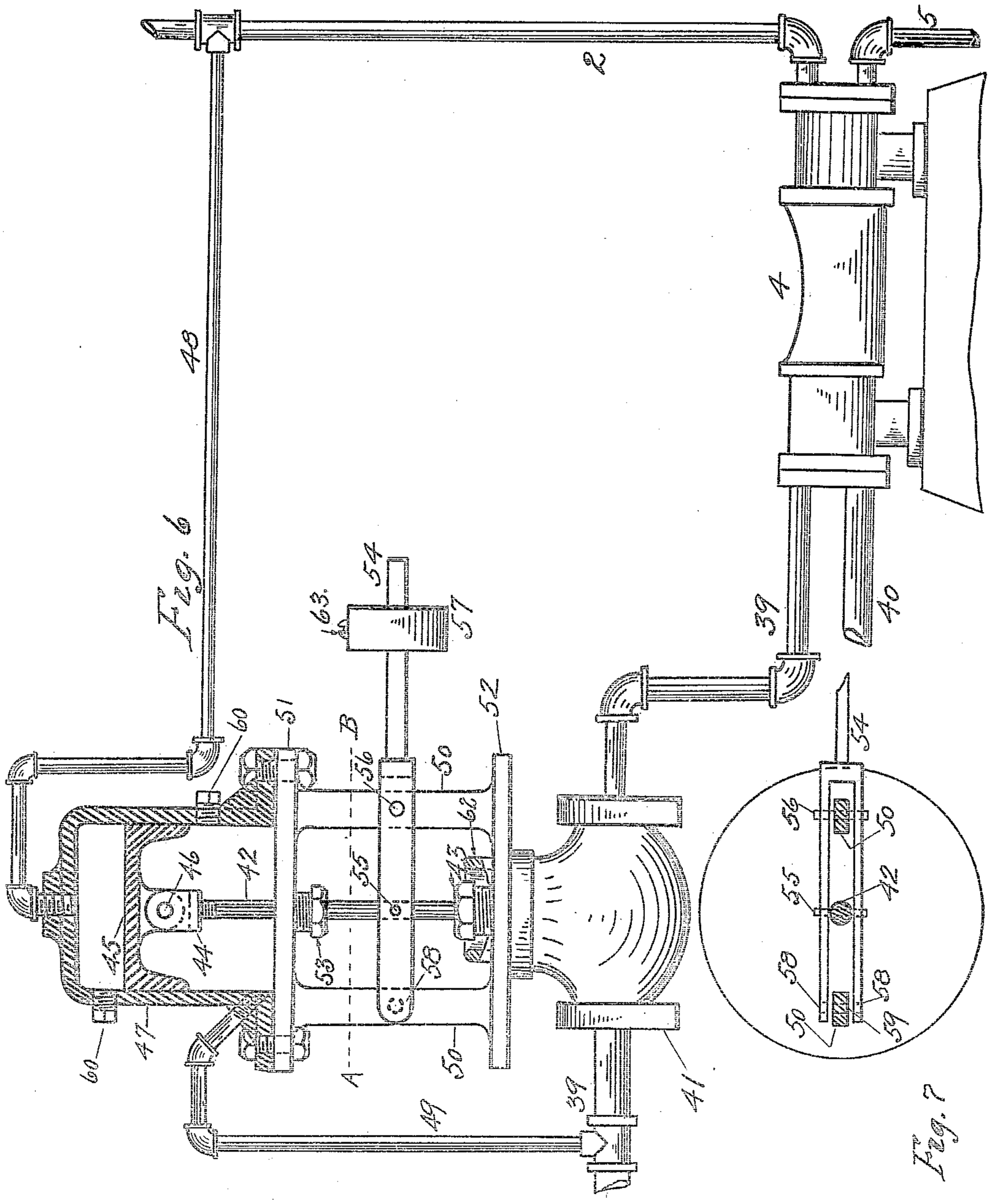

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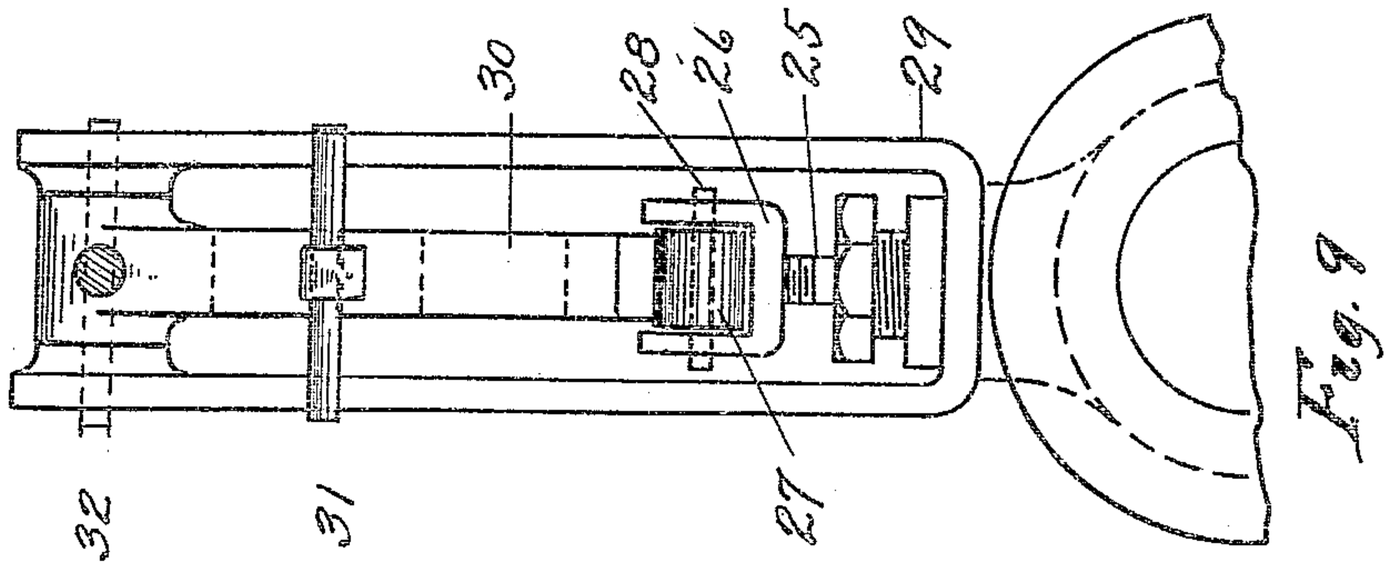

Fig. 9

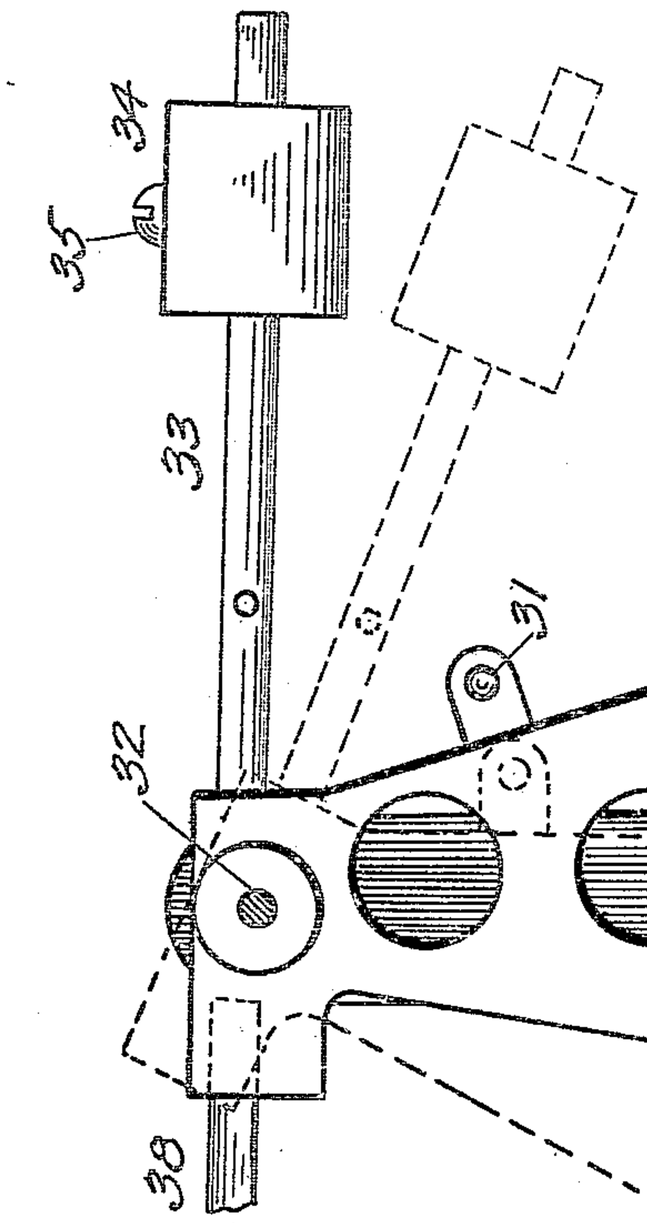

Fig. 8

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UNITED STATES PATENT OFFICE.

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BOILER-FEED REGULATOR.

953,734. Specification of Letters Patent. Patented Apr. 5, 1910.

Application filed August 19, 1908. Serial No. 449,334.

To all whom it may concern:

Be it known that we, HOWARD E. CADE and DAVID R. KNAPP, citizens of the United States, residing, respectively, at Pencoyd, in the county of Montgomery, and at Philadelphia, in the county of Philadelphia, both in the State of Pennsylvania, have invented certain new and useful Improvements in Boiler-Feed Regulators, whereof the following is a specification, reference being had to the accompanying drawings, and forming part of the specification.

Our invention relates to that class of devices wherein an expansion tube is connected to a steam boiler at the mean water level and is so arranged that when the water in the steam boiler is at its normal height, the expansion tube is closed to the steam space of the boiler by the water in the boiler acting as a seal to the steam to the expansion tube and vice versa, when the water in the boiler is below normal, due to the evaporation of the water, the expansion tube is connected to the steam space in the boiler and the expansion and contraction of said tube due to the difference in temperature when opened and closed to the boiler steam being utilized to control a valve in the feed water line to said boiler, the actuation of said valve in turn controls hydraulic means wherein the steam supply to a steam pump supplying water under pressure to said boiler may be regulated with precision.

It is the object our invention, first, to provide a simple and efficient means for automatically regulating the flow of water to a boiler, provided with an expansion tube, as aforesaid, and in case a boiler feed pump is required to furnish feed water under pressure to said boiler, hydraulic means in cooperative relation with said tube whereby the operation of the boiler feed pump may be adjustably predetermined with precision, second, to provide a means whereby the boiler steam may be admitted to said tube on low mean water level and cut off to said tube on high mean water level, third, to provide an arrangement of mechanism controlling the valve in said feed water line whereby the tendency of abnormal hydraulic pressure to open same will be reduced to a minimum and thereby prevent water being admitted to the boiler at an undesirable time, fourth, to provide mechanism supporting said tube so that when under expansion, all tendency of said tube to buckle may be eliminated, fifth, to provide mechanism supporting said tube so that no bending strains will be exerted on same upon installation, and sixth, to provide means whereby the condensation of steam in said tube may be drained back to the boiler.

With these objects in view our invention consists in certain novel features of construction, arrangement of parts as will be hereinafter fully described and pointed out in the claims, reference being had to the accompanying drawings in which,

Figure 1 is a front elevation of a boiler, showing a convenient embodiment of our invention applied thereto, Figs. 2 and 3 are, respective, plan and elevation views showing more clearly the arrangement of parts connected to the free end of the expansion tube. Figs. 4 and 5 are elevation views of the supporting mechanism for said tube, Fig. 6 is a vertical section of an automatically-operated governor controlling a balanced valve in the steam line to the aforesaid boiler feed pump, Fig. 7 is a section on A—B showing the arrangement of the yoke in relation to the supporting standards, Fig. 8 is a side elevation view showing the relative position of the valve operating mechanism upon the expansion and contraction of said tube and Fig. 9 is an end elevation view of Fig. 8.

Similar figures refer to similar parts throughout the several views.

In said figures, 1 designates a boiler provided with a feed water pump 4 which supplies water under pressure to said boiler through pipe 2, and 5 designates the supply pipe for said pump.

6 designates a tube made from some metal having a high coefficient of expansion, such as copper, and is connected at one end by the pipe 7 to the mean water level of the boiler and at the other end by the pipe 8 to the water in said boiler. Pipe 8 serves as a drain for any condensation of steam that takes place in said tube 6. The pipes 7 and 8 are small in comparison with the expansion tube 6 and are put in place after said tube has been connected and adjusted throughout. The maximum travel of the expansion tube is a small fraction of an inch and the lengths of pipes 7 and 8 and the number of bends required to make the said connections enables these pipes to have suf-

ficient flexibility to allow the expansion tube to expand and contract and perform its function.

The mean water level of the boiler is indicated in Fig. 1 by the dotted line C and the pipe 7 is connected thereto at the water gage 9, at a point determined by the mean water level on same. When the water is at a low level as indicated by the gage, steam is admitted to the tube 6 and vice versa, when the water rises above said mean water level the said tube is deprived of steam, due to the water acting as a seal to pipe 7.

It is obvious that the tube being subjected to a wide range of temperature will expand and contract accordingly.

64 designates a channel or beam as usually found at the top and at the front of the boiler and on which is mounted the expansion tube 6. The lower extremity of said tube is connected to the terminal member 10 which is pivotally connected to the support 11 by the pin 12. The support 11 is secured to the beam 64 by bolted engagement.

15 designates a yoke upon which a bell crank lever is mounted. The bell crank lever is pivotally connected to the yoke 15 by the pin 14 and is free to oscillate thereon. The upper and free extremity of the tube 6 is pivotally connected to the short arm 13 of the bell crank, through the connecting member 23, by the pin 24.

16 designates a standard connected at one end to said yoke by threaded engagement and at the other end to the member 17 by similar method. The member 17 is pivotally connected by the pin 18 to the support 19 which is secured to the beam 64 by bolted engagement.

20 designates a yoke adapted to embrace yoke 15 and is secured thereto by the pin 14. Secured to the yoke 20, by threaded engagement, is the adjusting rod 21 which passes through the aperture in the member 10. Said rod is threaded and provided with a nut 22 on either side the part 10. It is obvious that by shifting said nuts longitudinally with respect to said rod, a certain degree of oscillation of the bell crank can be effected which permits of a michrometer adjustment of the relation of the parts.

3 designates a check valve in the feed water line and 25 designates the stem of said valve to which is attached, by threaded engagement, the yoked support 26 which carries the roller bearing 27 free to revolve on the pin 28.

29 designates a yoke secured to said check valve and in alinement with the valve stem 25.

30 designates a cam pivoted to the yoke 29 by the pin 32 and is free to oscillate thereon. The periphery of said cam is adapted to engage with the roller 27 by line contact. This line contact being so near in alinement with the stem of said valve and the cam pivot, that the leverage exerted on said cam by any force acting on the stem 25 of the valve 3 and the tendency of said cam to oscillate due to the force acting on said stem will be zero. The roller 27 is kept in alinement with the cam 30 by means of the yoke 26 partially embracing said cam and which also acts as a guide therefor. 31 designates a pin carried on said cam and serves as a stop to limit the degree of oscillation of the cam by its engaging with the yoke 29.

33 designates a lever arm attached to the cam 30 and carries the adjustable weight 34 which is secured to said lever arm 33 by the set screw 35. This weight acting through its leverage is sufficient to cause the cam to oscillate and close the valve 3 against normal feed water pressure. The long arm 36 of the bell crank lever connects with the lever arm 33 by the connecting rod 37. This connection between lever arm 36 and lever arm 33 can be made a chain or other flexible connection as its function being only to lift said lever arm 33 and open said valve as the weight 35 acting thereon is sufficient to cause the lever arm to lower against normal feed water pressure and close said valve as aforesaid stated. 38 designates a lever arm attached to said cam 30 and disposed opposite to lever arm 33. By transferring the weight 34 from the lever arm 33 to lever arm 38 an opposite movement of the valve is effected by a downward movement of the weight. This may be desired in case it becomes necessary to invert the valve mechanism due to structural conditions near the feed line.

39 designates a steam line to the steam end of the pump 4 and 40 designates the exhaust therefor. 41 designates a balanced valve controlling the steam supply to said pump. 42 designates the stem of said valve which passes through the stuffing box 43 and terminates in the yoke 44 which is pivotally connected to the governor piston 45 by the pin 46.

47 designates a governor cylinder in which is adapted to reciprocate the piston 45. Above said piston 45 the cylinder 47 is connected by a pipe 48 to the feed water pipe 2 and below said piston said cylinder is connected by the pipe 49 with the steam supply pipe 39. The standards 50 are provided with flanges 51 and 52. Flange 51 is connected to the governor cylinder by bolted engagement and is provided with a stuffing box 53 through which the stem 42 of said valve 41 passes. Flange 52 is rigidly connected to the valve 41.

60 designates plugs screwed into apertures in the upper and lower parts of the cylinder 47. Upon removing these plugs any

refuse that may have collected in the cylinder may be readily blown out through these apertures.

54 designates a lever of the first order, one end being provided with a yoke embracing the standards 50. The lever 54 is mounted to oscillate upon the fulcrum 56 on said standard and is pivotally connected by the pin 55 to the stem 42 of the balanced valve 41.

57 designates an adjustable weight on the lever arm 54 and is fixed in any desirable position by the set screw 63.

It is obvious that the feed water pressure must be greater than the steam pressure in order for the feed water to enter the boiler. The pressure on the top of the piston is therefore greater than that on the bottom and said weight is therefore so adjusted as to just overbalance the pressure on the top of said piston coacting with the steam pressure on the under side of said piston and therefore serves to open said valve 41 whenever the piston 45 is relieved from the excess of pressure above it in the cylinder 47. Provisions are made by the aperture 58 in the lever 54 and the aperture 59 in the standard 50 to fulcrum the lever at this place and thereby convert said lever into a lever of the second order so as to cause a reverse motion of the valve stem 42 by a downward movement of said lever.

Having thus described the various parts throughout the several views and upon their being proportioned and connected throughout, all of which will be readily understood by those skilled in the art to which this invention relates, its mode of operation will be substantially as follows:—The position of the mechanism as shown in the accompanying drawings is such as they occupy when the expansion tube has expanded due to the low water level as shown and water is being admitted to the boiler through the check valve 3 supplied under pressure from the pump 4. The water in the boiler will thus continue to rise until normal water level is reached when the tube 6 will be deprived of steam due to the water in the gage acting as a seal to the pipe 7 that supplies steam to said tube. Said tube 6 being deprived of steam will get cold and contract and the following movements of the mechanism will take place. The tube 6 being pivotally connected to the short arm of the bell crank lever and the fulcrum of said lever being in a fixed position, the contraction of said tube will cause the bell crank lever to oscillate on its fulcrum 14 in such a direction as to lower the long arm of said bell crank lever and thus deprive the lever arm 33 of its supporting force. The pressure acting under the valve 3 has caused the valve to lift to such a height as determined by the engagement of the cam 30 with the roller 27. It is obvious that so long as pressure is acting on the under side of said valve the roller 27 will be kept in engagement with the cam 30 and the amount of opening of the valve will therefore be determined by the relative position of the cam in relation to said roller. As aforesaid the weight 34 acting through its leverage is sufficient to cause the cam to depress the roller and thereby close the valve and as the contraction of said expansion tube has deprived, as aforesaid, the lever 33 of its supporting force, the weight will descend forcing the cam to move in such a direction as to depress the roller and thereby close the valve 3, shutting off the feed water to said boiler. The cam is free to oscillate until it has firmly seated the valve on its seat which will restrict any further movement of the cam. The said tube being now deprived of steam and upon becoming cold the steam therein condenses causing a slight reduction in pressure in said tube which is accompanied by a slight surging of water from the boiler. This water together with the water of condensation is drained back to the boiler.

The maximum oscillation of the cam is determined by the pin 31 which is adapted to engage with the yoke 29 and on this position the cam will have depressed the valve the maximum distance. It is obvious that with the proper adjustment of the position of the cam in relation to the said roller on the stem of said valve, that any wear on the valve or the parts connected thereto will be readily taken up by the increased degree of movement of the cam and will so continue until the maximum degree of oscillation shall have taken place which is determined by the pin 31 engaging with the yoke 29 as aforesaid. The balanced valve 41 being still on the opened position allows the pump to continue to act.

It is obvious that the valve 3 being closed and there being no outlet for the feed water, the hydraulic pressure in the feed line 2 will rise. The top of the cylinder 47 being thus connected to the feed water line 2 by the pipe 48, the top of the piston acting therein will be subjected to and under the influence of this increased pressure. The lever arm, as aforesaid, is so adjusted that its force coacting with the steam pressure on the under side of the piston, supplied by the pipe 49, will just raise the balanced valve 41 against normal feed water pressure acting on the top of said piston. The continued action of the pump will cause the hydraulic pressure to increase on the top of the piston and will continue so until it is of sufficient amount to overpower the effect of the lever arm and the steam pressure as aforesaid and cause the valve to lower and close the steam supply to the pump, and the pump being thus deprived of steam will

cease to operate. The conditions are now as follows: The water in the boiler is at normal level, the valve 3 has closed the feed water to the boiler and the pump has ceased operating. There is however sufficient pressure in the feed line 2 to admit water to the boiler in case the valve 3 opens. The water in the boiler will evaporate and thus lower the level of the same. When the water shall have evaporated below the normal level as indicated, steam will be admitted to the expansion tube 6 which will cause it to expand and thereby raise the long arm of the lever which in turn will raise the lever arm 33 through the connecting rod 37. The raising of the lever arm 33 will release the pressure of the cam on the roller 27 and the water pressure acting under the valve will lift the same and allow water to be admitted to the boiler under pressure that was determined when the valve 41 closed the steam supply to the pump. The feed water line 2 being thus relieved of the excess of pressure will also relieve the excess of pressure acting on the top of the piston 45. This reduction of pressure will therefore allow the weight 57 coacting with the steam pressure on the under side of said piston to open said valve and allow a steam supply to said pump. The pump being thus subjected to steam pressure will start to act and furnish feed water to the boiler under the desired pressure. The water will continue to rise in the boiler under this condition until the expansion tube is closed to the steam supply when a cycle of operation will take place as aforesaid and thus accomplish the aforesaid first, second and sixth objects of our said invention.

After the valve 3 has been closed against the boiler feed line it is obvious that the hydraulic pressure in said feed water line will rise due to the continued action of the pump. The balance weight 34, as aforesaid is just sufficient to close the check valve 3 under normal feed water pressure and it is therefore obvious that abnormal feed water pressure will open the valve against the weight 34 and allow water to be admitted to the boiler at an undesirable time unless the mechanism controlling said valve is so arranged so as to prohibit the same. The contact between the roller and cam being of line contact it is obvious that the leverage acting on the cam by the upward pressure of the stem 25, due to abnormal hydraulic pressure, will be reduced to a minimum. Any increased hydraulic pressure acting on the valve 3 will be so near in a straight line against the pivot 32 and this force being with so small a leverage will be unable to move said cam from its position. The cam being in a fixed position maintains the valve on its closed position, thus preventing water from being admitted to the boiler, due to the abnormal hydraulic pressure on the feed line, after the contraction of said expansion tube has closed said valve and thus accomplishing the heretofore third mentioned object of our said invention.

The expansion tube 6 being pivotally connected to the bell crank lever arm 13 by the connecting member 23, it is obvious the altitude of the free end of the tube changes as the bell crank lever oscillates through its degree of travel. This change of the altitude of the free end of the tube will change the angle formed by said tube and the beam 64 acting as a base. It is obvious that if the parts 10 and 11 were in a fixed position relative to the tube and the base 64 an undue bending strain would be exerted on the tube as the altitude of the free end of said tube varied. The parts 10 and 11 being pivoted by the pin 12 will readily yield to any angular change of the tube with the base 12, caused by the oscillation of said bell crank lever and therefore no undue bending strain will be exerted on said tube in its act of expanding or contracting and thus accomplish the aforesaid fourth mentioned object of our said invention.

64 being a beam or channel located above the boiler is usually of rough surface due to dirt and paint thereon and it is obvious that if the angle formed by said base and said expansion tube is fixed and cannot be varied, considerable trouble will then be experienced in making the connection of the free end of the tube to the short arm 13 of the bell crank lever. If these connections do not coincide upon the tightening down of the supports an undue strain will be exerted on the tube which will cause its liability to buckle on expansion or contraction. As aforesaid the expansion tube 6 being pivoted to the support 11, will allow a limited change in the angle formed by the base 12 and said tube which will relieve any tendency of the tube 6 to strain upon the tightening down of the supporting members and thus accomplish the aforesaid fifth mentioned object of our said invention.

We are aware that expansion tubes have been employed in connection with devices for controlling the flow of feed water to a boiler but know of none similar to that which is herewith shown and described.

We do not wish to limit ourselves to the exact construction of the apparatus as shown as it is obvious that slight departures can be made therefrom without departing from the spirit and intent of our said invention.

Having thus described the nature and objects of our said invention, what we claim as new and desire to secure by Letters Patent; is,

1. In a boiler feed regulator, in combination with the feed line, and a valve therein provided with a stem, a yoke adjustably connected to said stem, a roller pivoted between

the arms of said yoke, a second yoke supported from the feed line, a cam pivoted between the arms of said second yoke and having its free end guided between the arms of said first yoke to engage said roller of the first yoke, a pin carried by said cam to engage the second yoke and thereby act as a stop for limiting the movement of the cam, a lever connected to said cam, an adjustable weight on one end of said lever, and means to operate said lever by the boiler water level.

2. In a boiler feed regulator, the combination with an expansion tube connected to the boiler below and at the normal water level therein and a feed line with a valve therein provided with a stem, of a roller rotatably connected to said stem, a cam, means for pivotally supporting said cam at its upper end from the feed line, said cam being adapted to have its lower end engage with said roller, a counter weighted arm connected to said cam and extending outwardly from one side of the cam above the lower end of the cam, and a connection between said expansion tube and said cam.

3. In a boiler feed regulator, the combination with an expansion tube connected to the boiler below and at the normal water level therein and a feed line with a valve therein provided with a stem, of a yoke extending upwardly from the feed line, a cam pivoted at its top end between the arms of the yoke and being adapted for engagement with the stem to operate the same, means carried by the cam arranged on one side thereof and extending outwardly therefrom to engage with the yoke to restrict the swinging movement of the cam, and a connection between said expansion tube and said cam.

4. In a boiler feed regulator, the combination with an expansion tube connected to the boiler below and at the normal water level therein, and a feed line with a valve therein provided with a stem, of a yoke carried by and supported from the feed line and extending upwardly to be disposed on opposite sides of the valve stem, a cam pivoted between the arms of the yoke at the upper end of the same, and being disposed between the sides of the yoke, a second yoke carried by the valve stem and disposed between the arms of the first named yoke, a roller journaled between the arms of the second yoke and adapted to be engaged by said cam, and a connection between said expansion tube and said cam.

5. In a boiler feed regulator, in combination with the feed line, and a valve therein provided with a stem, a cam pivotally supported so as to directly overlie said valve stem, and adjustable means carried by the stem to engage said cam, said means being formed to receive the cam so as to guide the latter and being held against rotation by engagement with the opposite side faces of the cam, and means to operate the cam by the level of the water in the boiler.

6. In a boiler feed regulator, in combination with a feed line, and a valve therein provided with a stem, a cam, means for pivotally supporting said cam, said cam being adapted for engagement with the stem to operate same, means carried by the cam arranged on one side thereof to engage with said supporting means to restrict the swinging movement of the cam, and means to operate said cam by the level of the water in the boiler.

7. In a boiler feed regulator, in combination with a feed line and a valve therein provided with a stem, a yoke, a cam pivoted to the yoke and extending downwardly in the space between the arms of the yoke, one side of the cam extending outwardly from the adjacent side of the yoke, and a pin carried by said outwardly projecting side of the cam and extending outwardly from one of the sides of the latter to engage the adjacent side of the yoke to restrict the swinging movement of the cam.

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