(No Model.) 3 Sheets—Sheet 1.

R. BERG.

DIFFERENTIAL FEED WATER REGULATOR.

No. 582,498. Patented May 11, 1897.

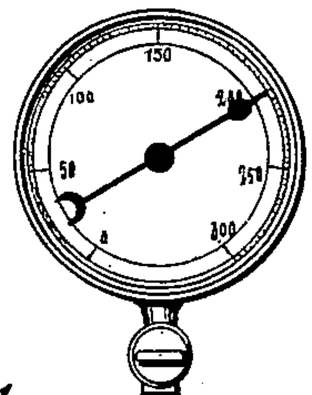
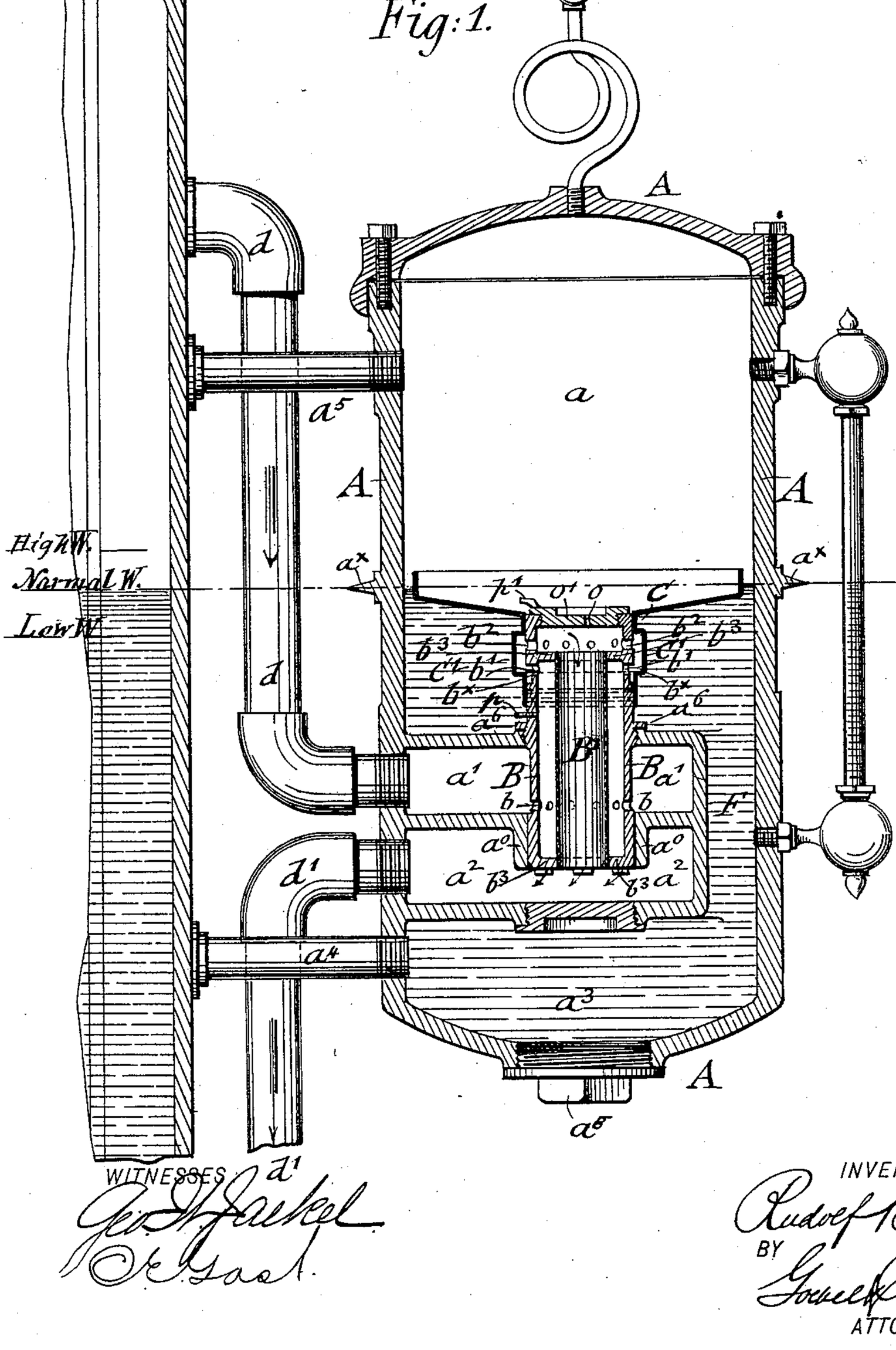


Fig: 1.



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(No Model.) 3 Sheets—Sheet 2.

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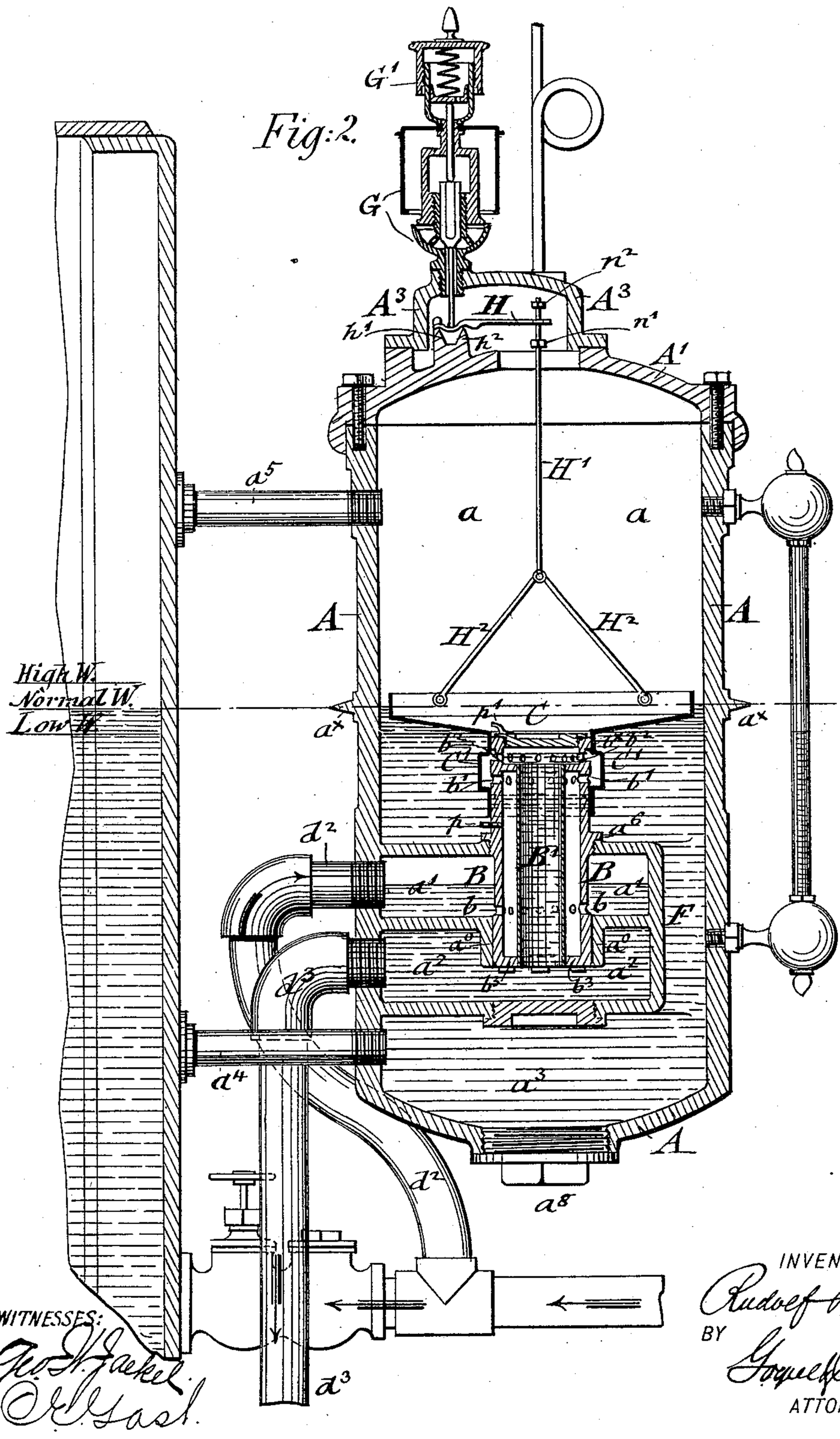
DIFFERENTIAL FEED WATER REGULATOR.

No. 582,498. Patented May 11, 1897.

Fig: 2.



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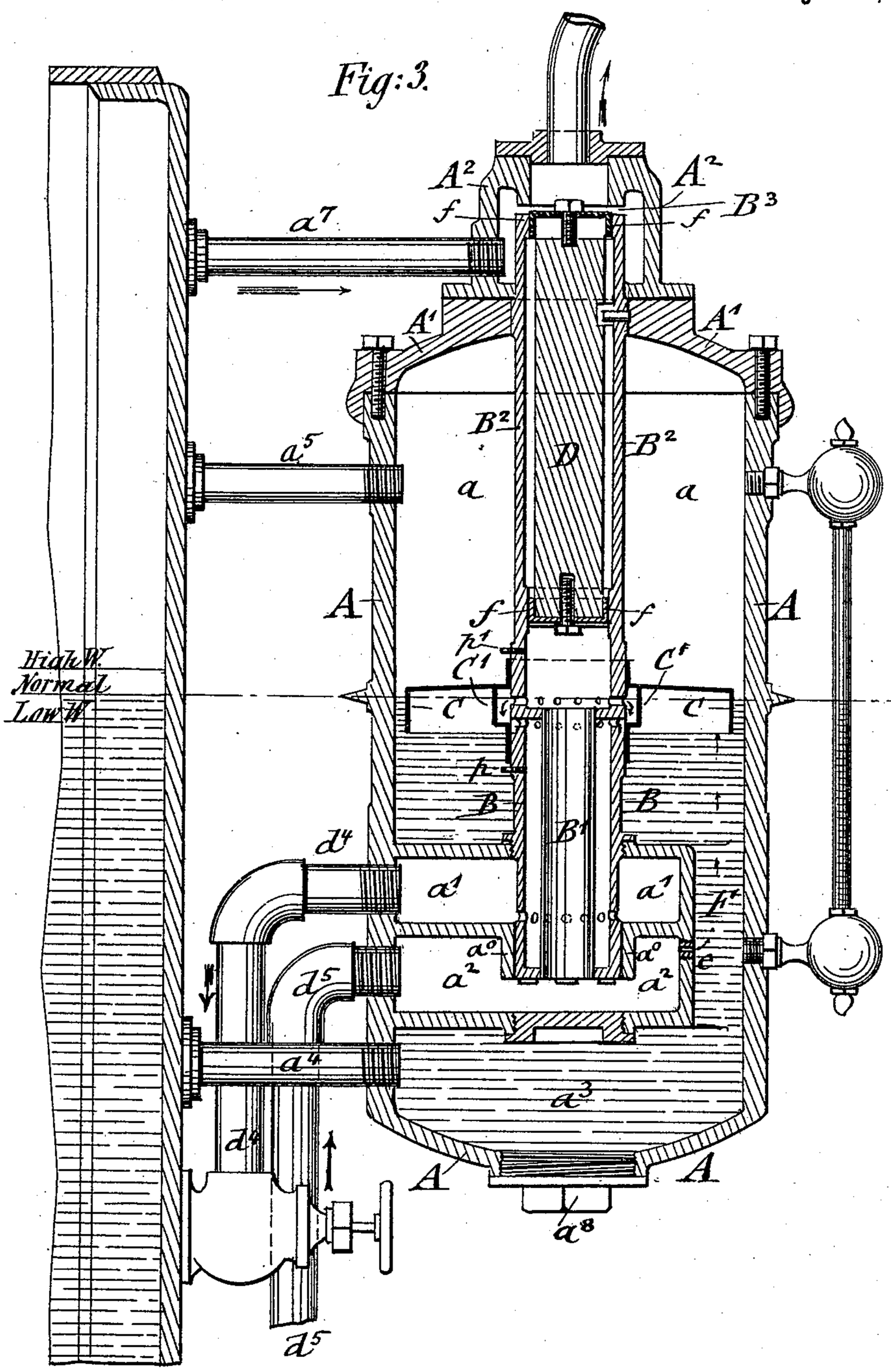
(No Model.) 3 Sheets—Sheet 3.

R. BERG.

DIFFERENTIAL FEED WATER REGULATOR.

No. 582,498. Patented May 11, 1897.

Fig: 3.



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DIFFERENTIAL FEED-WATER REGULATOR.

SPECIFICATION forming part of Letters Patent No. 582,498, dated May 11, 1897.

Application filed November 21, 1896. Serial No. 612,916. (No model.)

To all whom it may concern:

Be it known that I, RUDOLF BERG, a citizen of the Empire of Germany, residing in Pittsburg, in the county of Allegheny, in the State of Pennsylvania, have invented certain new and useful Improvements in Differential Feed-Water Regulators, of which the following is a specification.

My invention relates to an improved differential feed-water regulator for automatically controlling the supply of water to steam-boilers.

My improved differential feed-water regulator is intended to be used for regulating the supply of feed-water to a steam-boiler as well as to a battery of boilers in proportion to the quantity of steam used, said feed-water regulator being adapted for independent feed-pumps, dependent feed-pumps, injectors, and for regulating the steam-supply to the feed-pump, with or without a high and low water alarm, as desired, so that the action of the feed-pump is retarded or accelerated according to the water-level in the boiler and thereby a uniform water-level obtained.

The invention consists of a feed-water regulator for steam-boilers which comprises an exterior shell or casing provided with interior chambers, said casing being connected with the water and steam spaces of the boiler and said chambers with the steam-space of the boiler and the feed-pump, or with the suction and discharge end of a dependent or an independent pump, or with an injector, or with the water-space of the boiler and the steam-pump, as the case may be. In the casing is arrranged a valve-cylinder having three groups of ports, the lower one being located in the upper chamber and the two upper ones in the casing, the upper group of ports being inclosed by a sliding float-valve having an enlarged portion that opens or closes the middle groups of ports by which the communication of the casing through the valve-cylinder and the chambers with the feed-pump and the steam-boiler is established. At the interior of the valve-cylinder is arranged a stationary tube that is attached to annular inwardly-projecting ribs, one being located between the two upper groups of ports and the other at the lower end of the valve-cylinder, so as to establish connection of the lower chamber with the upper group of ports. The valve-cylinder is provided at its upper end with a valve-seat for the float-valve, said valve-seat being provided with capillary grooves for preventing the ingress of the water in the casing to the exterior of the float-valve.

The invention consists, further, of certain details of construction, which will be fully described hereinafter and finally pointed out in the claims.

In the accompanying drawings, Figures 1, 2, and 3 represent vertical central sections of my improved differential feed-water regulator for steam-boilers, showing the same respectively connected for supplying the steam-boiler from an independent feed-pump, from a dependent feed-pump, or from an independent feed-pump in which the steam supplied to said pump is controlled by my improved regulator.

Similar letters of reference indicate the same parts.

My improved differential feed-water regulator for steam-boilers consists of three main parts: first, a shell or casing for the feed-water provided with interior chambers; second, a valve-cylinder supported by said interior chambers; third, a float-valve arranged at the upper end of the valve-cylinder.

The shell or casing A is divided into four chambers, namely, a main chamber a, interior chambers a' and a^2, which are located in the lower part of the casing A, and between which and the wall of the casing A a channel F is formed, by which the main chamber a is connected with the bottom or sediment chamber a^3. The interior chambers a' a^2 can also be arranged in the upper part of the casing A, in which case the relative position of the valve-cylinder and float-valve are not changed, but only reversed relatively to the casing A and the interior chambers a' a^2. The bottom or sediment chamber a^3 is connected by a pipe a^4 with the water-space of the steam-boiler and the main chamber a by a pipe a^5 with the steam-space of the boiler. As the difference between high and low water in a boiler is comparatively small, the motion of the water from the steam-boiler to the bottom chamber a^3 and back into the boiler is comparatively slow and steady, so that the sediments contained in the feed-water can be

readily collected in the bottom chamber a^3. A screw-plug a^8 is arranged in the bottom of the casing A for removing the sediments collected in the bottom chamber a^3 from time to time. As the walls of the main chamber a are cooled off by the influence of the air, a small quantity of steam is continuously condensed on the inner edges of the main chamber a, the water of condensation being supplied to the water in the main chamber a, so that the water in the same is kept pure, it forming the upper layer, so to say, of the water in casing A, which mingles only slowly with the water-supply from the boiler, as the same has to rise through the bottom chamber a^3 and channel F into the main chamber a. As the motion of this water is very slow and the water of condensation is lighter than the water from the boiler, it is obvious that the float-valve moves up and down in a body of water condensed from the steam. The casing A is provided with the usual accessories, such as a water-gage, pressure-gage, &c. On the exterior of the casing A is arranged a tapering projection or lip $a^\times$, which is arranged on a level with the mean water-level of the steam-boiler.

The valve-cylinder B is supported stationary in the horizontal top and bottom walls of the interior chamber a', it being screwed into the top wall of the chamber a' and guided in a sleeve a^0 of the bottom wall. The valve-cylinder B is provided with lugs at its lower end for applying a key for screwing in the valve-cylinder until arrested by a stop-collar a^6 above the threaded portion of the valve-cylinder. The valve-cylinder B has three groups of ports b, b', and b^2, of which the two groups b' b^2 are arranged near the upper end of the valve-cylinder, while the lower group b is arranged in the chamber a'.

The valve-cylinder B is provided with inwardly-projecting annular ribs b^3, one being located between the upper groups of ports, while the lower one is located at the lower end of the same. To these annular ribs is tightly fitted a connecting-tube B', which forms at the interior of the valve-cylinder two spaces, an interior cylindrical space and an annular space around the same. The middle and lower groups b' b of ports communicate with this annular space, while the upper group of ports communicates with the interior cylindrical space of the tube B'. The intermediate group b' of ports is located in a groove or depression $b^\times$, which is somewhat larger than the diameter of the ports, so that this group is opened or closed by the float-valve C. The groove or depression $b^\times$ has for its object the removal of any pressure on the float-valve, so as to produce the easy motion of the same. The valve-seat is provided below the groove or depression $b^\times$, in which the middle group of ports are arranged, with a number of capillary grooves, by which the lower end of the float-valve C is fitted tightly to the valve-seat and the friction of the float-valve with the surface of the same reduced. The capillary grooves prevent at the same time the lodging of impurities on the exterior surface of the valve-cylinder. The edges of these grooves, as well as the edges of the float-valve, are ground off at a sharp angle, so that the entering of impurities is prevented, as the sharp edges keep the valve-seat constantly clear of sediments. The valve-cylinder B is further provided with two stops p p', one at the lower end of the valve-seat and the other at the upper end of the valve-cylinder, by which stops the vertical motion of the float-valve is limited. The float-valve C is composed of an open cup-shaped body, which is made either in one piece with the lower annular portion or screwed into the same. The cup of the float is either open at the upper end, as shown in Figs. 1 and 2, or inverted and open at the lower part, as shown in Fig. 3. The cup can be made of light metal, such as aluminium, while the annular lower portion is made of bronze or other suitable metal. The lower portion of the float-valve C is guided on the valve-seat of the valve-cylinder B and provided with an annular enlargement C', which is located on the valve-seat and which forms an annular channel around the upper groups of ports. The float-valve C moves up and down with the water-level in the main-chamber a, the friction between it and the valve-seat being reduced to a minimum. The lower edge of the enlargement of the float-valve C closes the middle group of ports by the upward motion of the float and opens the same by its downward motion, the upper group of ports being always in the channel formed by the annular enlarged portion of the float-valve during the highest as well as during the lowest position of the same.

Fig. 1 shows my improved boiler feed-water regulator arranged in such a manner that the steam for the steam-boiler acts directly on the feed-pump. For this purpose the interior chamber a' is connected by a pipe d with the steam-space of the boiler and the interior chamber a^2 by a pipe d' with the steam-cylinder of the feed-pump. The steam passes from the boiler through the pipe d into the chamber a', then through the lower group of ports b and the middle and upper groups of ports b' b^2, the interior tube B', and from the same through the lower chamber a^2 and pipe d' to the steam-cylinder of the feed-pump. As soon as the water-level in the steam-boiler rises the water in the main chamber a rises likewise and lifts the float-valve, so that the middle group of ports is gradually closed and thereby the motion of the feed-pump retarded, as less steam is supplied to the same. When the water-level in the boiler falls, the water in the main chamber a falls likewise and the float-valve moves by its own weight in downward direction, so that the middle group of ports is gradually opened and thereby a greater quantity of steam supplied to the feed-

pump and the motion of the same accelerated, so that in this manner the number of strokes of the feed-pump are regulated by the supply of steam to the same.

As some of the water of condensation is deposited on the surface of the cup of the float-valve, this water is conducted off through a small hole *o*, arranged in a screw-plug *o'* at the top of the float-valve, from which it passes through the interior tube of the valve-cylinder into the lower chamber a^2.

Fig. 2 represents the feed-water regulator connected in such a manner that it regulates directly the supply of feed-water to the steam-boiler. In this case the upper group of ports is located in the groove or depression $b^\times$ and opened or closed by the float-valve, while in the regulator shown in Fig. 1 the middle group of ports is opened by said valve. In this case the chamber a' is connected by a pipe d^2 with the discharge-pipe of the feed-pump and the chamber a^2 by a pipe d^3 with the suction-pipe of the feed-pump. At high-water level the float-valve produces the communication between the discharge and suction pipes of the feed-pump by the opening of the upper group of ports, so that no feed-water is supplied to the boiler, but the same moved in a cycle in the pipe connections. When the water-level in the steam-boiler falls, the float-valve is lowered, so that the upper group of ports is gradually closed. The course of the feed-water is thereby gradually retarded, a part passing into the steam-boiler, while the balance circulates in the pipe connections. When the float-valve assumes its lowermost position, the upper group of ports is entirely closed, the circulation of water in the pipe connections is discontinued, and all the water supplied to the steam-boiler. This form of regulator is applicable to pumps which are actuated by the steam-engine and which have the same number of strokes as the engine, so that the same amount of feed-water will be supplied to the steam-boiler, while the steam-supply to the engine, due to the variable expansion, is different according to the load on the same. This regulator is also adapted for feeding injectors up to a certain point and can be used for independent feed-pumps, though for economical reasons it is not so well adapted for the latter.

Notwithstanding that the float-valve is fitted tightly to the valve-seat, a certain quantity of the water of condensation passes between the float-valve and the valve-seat into the chamber a^2 for the reason that there is considerable difference of pressure between the main chamber *a* and the lower chamber a^2.

Fig. 3 shows the feed-water regulator which regulates the supply of feed-water from an independent feed-pump to the steam-boiler. In this case the chamber a' is connected by a pipe d^4 with the water-space of the boiler, while the discharge-pipe of the feed-pump is connected with the bottom chamber a^2 by a pipe d^5. In the chamber a^2 is arranged a small perforated brass plug *e*, which serves for the purpose of conducting the air that is liberated by the heating of the feed-water in the feed-water heater interposed between the feed-pump and the steam-boiler. This air rises in bubbles through the perforated plug *e* and is collected by the chamber formed in the inverted float C, so that the air-space in the same is constantly supplied with air and the float supported by the body of air in the same. With the rise of the water in the steam-boiler the float-valve is moved in upward direction, so that the middle group of ports is gradually closed and the pressure in the discharge-pipe of the feed-pump gradually increased and the motion of the feed-pump retarded. The steam-cylinder of the feed-pump has to be provided with a pressure-regulator for producing the economical working of the pump, which regulator produces by the water-pressure the closing or opening of the steam-valve according as the pressure in the discharge-pipe is increased or decreased. When the water-level in the steam-boiler falls, the float-valve is lowered by its own weight and the middle group of ports is gradually opened and the pressure in the discharge-pipe of the feed-pump is decreased, so that the motion of the pump is accelerated and thereby the steam-boiler supplied with a correspondingly greater quantity of water according to the quantity of steam drawn off from the same.

Instead of providing the steam-cylinder of the feed-pump with a pressure-regulator the feed-water regulator is preferably provided with a piston-valve at its upper end, by which the supply of steam to the feed-pump is regulated. This modification is shown in Fig. 3, in which the valve-cylinder is extended through the float-valve C and the cover of the casing A. In this extension B^2 of the valve-cylinder B is arranged a solid cylindrical piston D, of cast-iron, the ends of which are provided with brass or other caps F, which move along interior seats of the cylindrical extension B^2 of the valve-cylinder. To the cover A' of the casing A is applied a cylindrical cap A^2, which is connected by a pipe a^7 with the steam-space of the boiler and which forms a steam-port B^3 with the extension B^2 of the valve-cylinder. By the increase of pressure in the chamber a^2 the piston-valve D is raised and the steam-port B^3 gradually closed. When the pressure in the chamber a^2 is diminished, the piston-valve is lowered by its own weight and the steam-port B^3 gradually opened. In this manner the supply of steam to the feed-pump is regulated by the rising and lowering of the piston-valve, so that the feed-pump feeds the water to the steam-boiler in proportion to the quantity of steam supplied to the steam engine or engines.

In some cases it is necessary that the feed-water regulator be provided with a high and low water alarm. This arrangement is shown at the upper part of Fig. 2, and consists of a whistle G, provided with a spring-chamber

G′ at its upper end and with a lever H, located in a chamber A^3, attached to the cover of the casing A. The tension of the spring located in the spring-chamber G′ is adjusted so as to exert a counter-pressure on the valve of the whistle G. The tension of the spring corresponds to the maximum steam-pressure in the steam-boiler, so that only a small pressure of steam is necessary for opening the valve of the whistle. The lever H rests on two knife-edges h' h^2, and is provided with a depression between said knife-edges, in which the lower end of the valve-spindle rests. Through a hole in the opposite end of the lever H passes the lever-rod H′, which is provided at its upper end with adjustable screw-nuts n' n^2, respectively above and below the end of the lever H. The lower end of the lever-rod H′ is connected with the float by suitable pivot-links H^2. When the float-valve is moved in upward direction and gradually approaches its highest position, the screw-nut n' presses on the lever H and raises thereby the valve-spindle, which opens the valve, so that the whistle is sounded by the supply of steam to the same. When the float-valve is moved in downward direction and arrives at its lowermost position, the screw-nut n^2 acts on the outer end of the lever H and produces thereby also the lifting of the valve-spindle and the sounding of the whistle, so that thereby an alarm is given for high or low water.

The advantages of my improved differential feed-water regulator are:

First. The regulator is very sensitive and keeps up the normal water-level in the boiler whether the feed-water is supplied by pumps or injectors. It can be used for feeding single steam-boilers or a battery or batteries of steam-boilers, in which latter case the feed-water regulator is connected by means of corresponding pipe connections with the different boilers. It can also be applied to locomotive and steamboat boilers.

Second. The wear of my improved feed-water regulator is almost minimal, for the reason that the motion of the float-valve is vertical, the limits of motion are reduced to the utmost, and the up-and-down motion of the float-valve, corresponding to the rise and fall of the water, is comparatively slow. When the regulator is combined with an alarm, the latter is useful for the reason that when the feed-pump has been disconnected for the purpose of cleaning the valve, filling the stuffing-boxes, &c., and the engineer should overlook to reconnect the feed-pump with the boiler the latter would soon assume its lower water-level, in which case the alarm would immediately call the engineer.

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

1. The combination, with a casing connected with the steam and water spaces of a steam-boiler, and chambers arranged within the casing, of a valve-cylinder supported by the upper chamber, a stationary tube at the interior of the valve-cylinder, a group of ports at the lower end of the valve-cylinder and two groups of ports at the upper part of the same, a float-valve extending over the upper groups of ports, and pipes connecting the interior chambers with the feed-pump and boiler, substantially as set forth.

2. The combination, with a casing connected with the steam and water spaces of a steam-boiler, and chambers arranged within the casing, of a valve-cylinder supported by the upper chamber, a stationary tube within the valve-cylinder, a group of ports located at the lower end of the valve-cylinder and communicating with the upper chamber, two groups of ports at the upper end of the valve-cylinder, the middle group being located in a groove or depression of the valve-seat, a float-valve provided with a lower part fitted to the valve-seat of the valve-cylinder and provided with a tubular enlargement extending over the two upper groups of ports, and pipe connections between the casing, chambers and feed-pump, substantially as set forth.

3. The combination, with a casing connected with the steam and water spaces of a steam-boiler, and chambers arranged within the casing, of a valve-cylinder supported by the upper chamber, a stationary tube in said valve-cylinder attached to inwardly-projecting ribs of the same, a lower group of ports at the lower part of the valve-cylinder within the upper chamber, two groups of ports at the upper part of the valve-cylinder, one of them being located in a groove or depression, capillary grooves below the lower group of ports, a float-valve provided with a lower portion fitted to the valve-seat on the valve-cylinder and with an annular enlargement extending over the two upper groups of ports, and pipes connecting the chambers with the feed-pump and the boiler, substantially as set forth.

4. The combination, with a casing connected with the steam and water spaces of a steam-boiler, and chambers arranged within said casing, said casing having an upper condensing-chamber and a bottom or sediment chamber connected by a channel between the chambers and the wall of the casing, a valve-cylinder open at the lower end and closed at the upper end, supported by the upper valve-chamber, a stationary tube attached to inwardly-projecting ribs of the valve-cylinder, a group of ports at the lower part of the valve-cylinder within the upper chamber, two groups of ports at the upper end of the valve-cylinder, a float-valve provided with a lower portion fitted to the valve-seat of the valve-cylinder and with an annular enlargement extending over the upper groups of ports, stops for arresting the motion of the float-valve in either direction, and pipes connecting the chambers with the feed-pump and the water-space of the boiler, substantially as set forth.

5. The combination, with a casing connected with the steam and water spaces of a steam-boiler, and chambers arranged within the casing, of a valve-cylinder supported by the upper chamber and extended through the top of the casing, a stationary tube supported on inwardly-projecting annular ribs of the valve-cylinder, a group of ports in the lower part of the valve-cylinder and communicating with the upper chamber, two groups of ports located at the upper part of the valve-cylinder respectively above and below the annular rib to which the interior tube is attached, a float-valve, the lower part of which is fitted to the upper end of the valve-cylinder and provided with an annular enlargement extending over the upper groups of ports, a piston-valve located in an extension of the valve-cylinder, a cap extending over the upper end of the piston-valve and forming a steam-port therewith, pipes connecting said cap with the steam-spaces of the boiler and feed-pump, and pipes connecting the interior chambers of the casing with the feed-pump and the water-space of the boiler, substantially as set forth.

6. The combination, with a casing connected with the steam and water spaces of a steam-boiler, and chambers arranged within said casing, the lower chamber being provided with a perforated plug for the escape of air liberated from the feed-water, a valve-cylinder supported by the upper chamber, a stationary tube supported by annular ribs at the interior of the valve-cylinder, a group of ports in the lower part of the valve-cylinder, two groups of ports in the upper part of the same, one group communicating with the annular space between the valve-cylinder and the interior tube and the other group with the space within the tube, a float-valve composed of an inverted-cup portion and a contracted portion fitted over the valve-seat on the valve-cylinder, the contracted portion being provided with an annular enlargement extending over the upper groups of ports, and pipes connecting the interior chambers with the feed-pump and the boiler, substantially as set forth.

In testimony that I claim the foregoing as my invention I have signed my name in presence of two subscribing witnesses.

RUDOLF BERG.

Witnesses:
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AD BOTTENFELDT.