No. 641,832. Patented Jan. 23, 1900.

J. H. BULLARD.

AUTOMATIC BOILER FEEDING DEVICE.

(Application filed Feb. 3, 1899.)

(No Model.) 3 Sheets—Sheet 1.

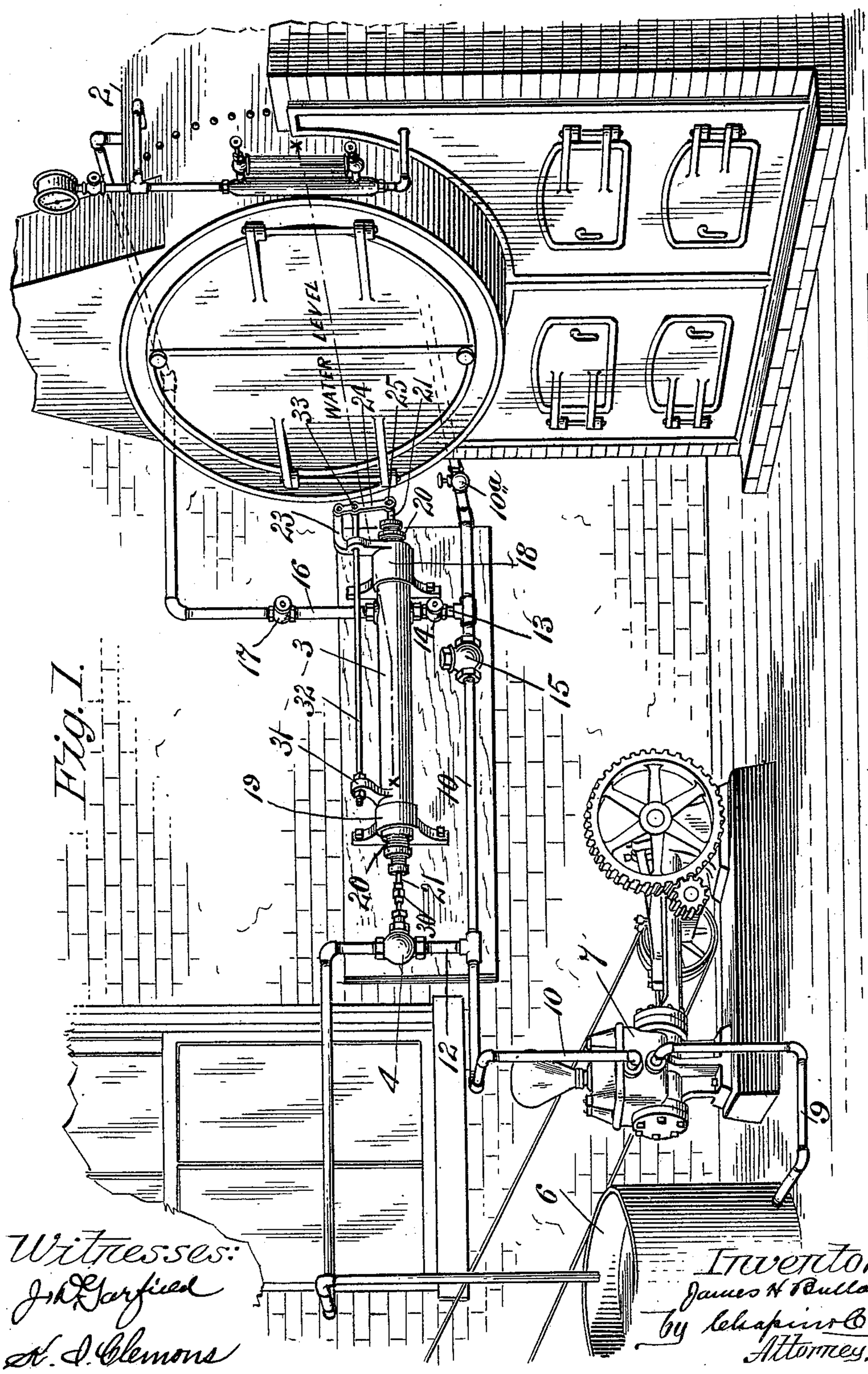

Fig. 1.

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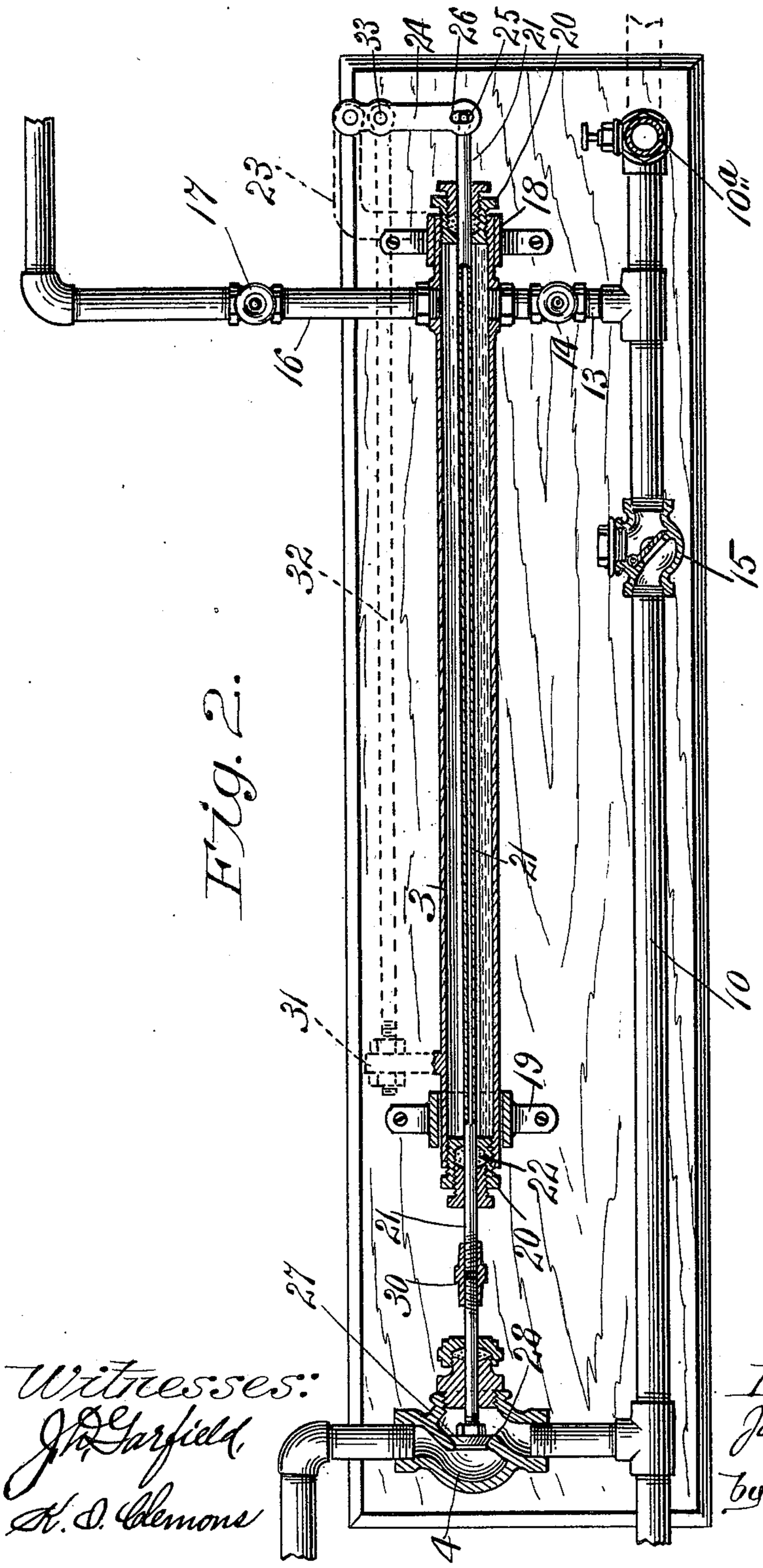

Fig. 2.

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Fig. 3.

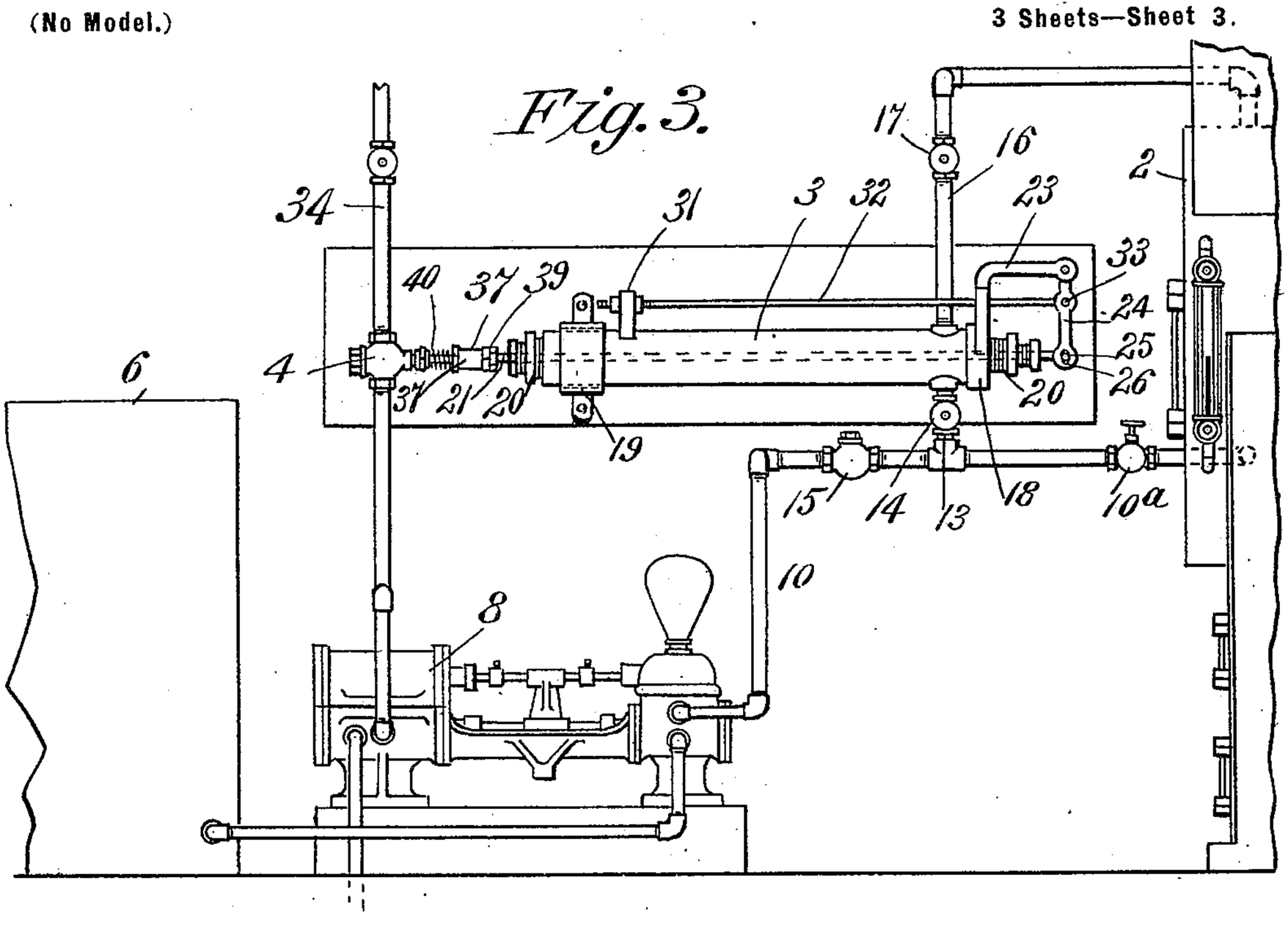


Fig. 4.

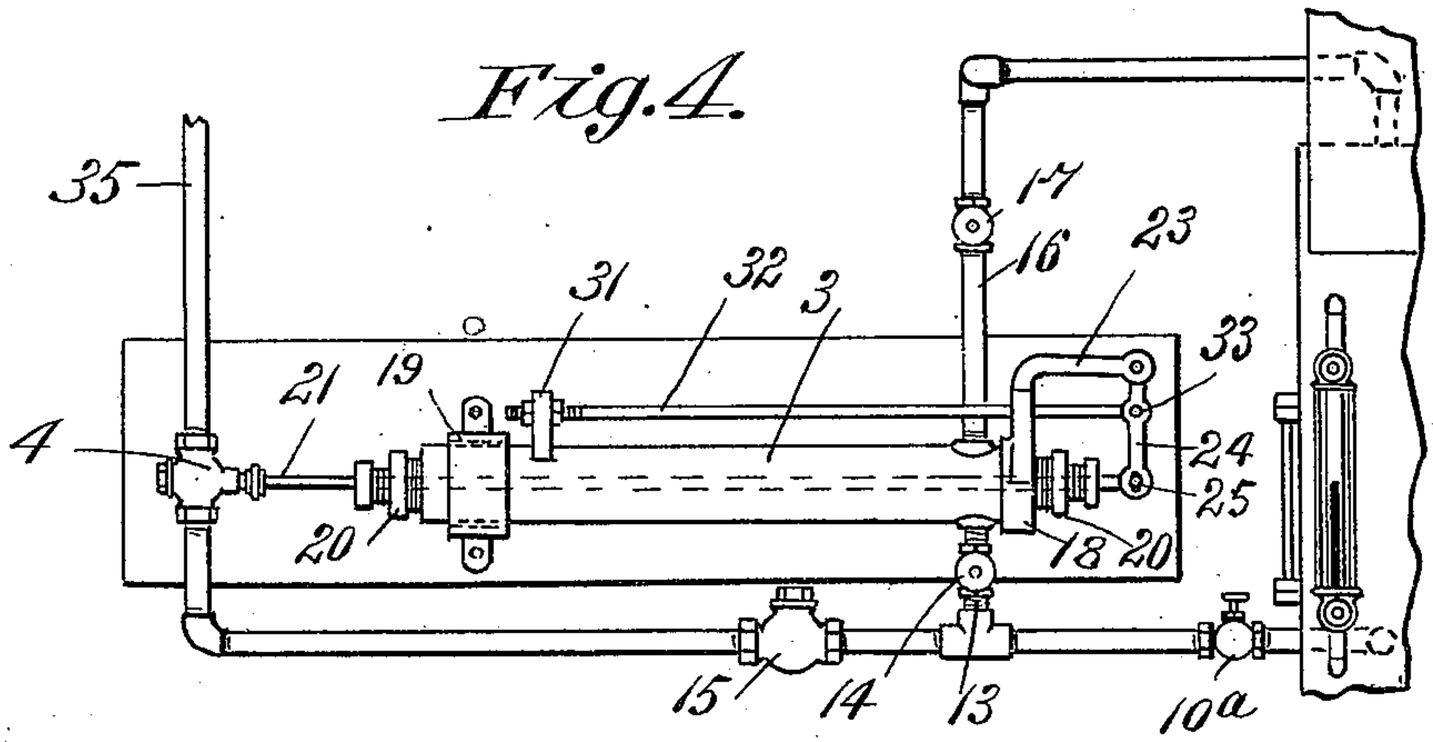
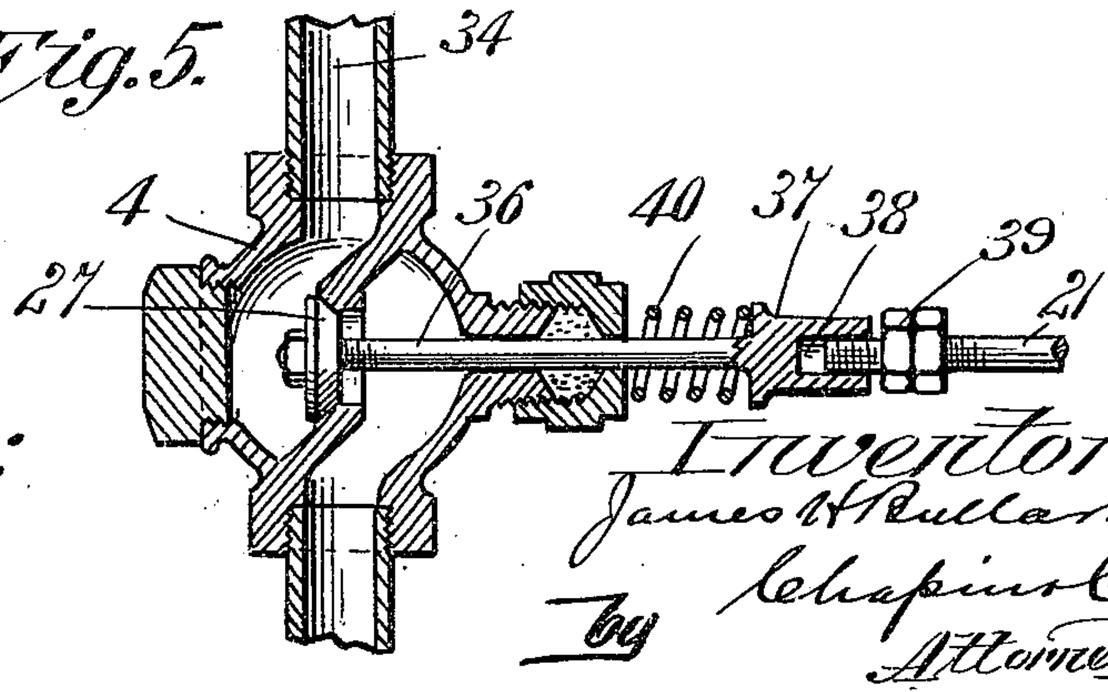


Fig. 5.



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UNITED STATES PATENT OFFICE.

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AUTOMATIC BOILER-FEEDING DEVICE.

SPECIFICATION forming part of Letters Patent No. 641,832, dated January 23, 1900.

Application filed February 3, 1899. Serial No. 704,393. (No model.)

To all whom it may concern:

Be it known that I, JAMES H. BULLARD, a citizen of the United States of America, residing at Springfield, in the county of Hampden and State of Massachusetts, have invented new and useful Improvements in Automatic Boiler-Feeding Devices, of which the following is a specification.

This invention relates to automatic boiler-feeding devices, and especially to that class operated by means outside of the boiler instead of by the usual float-operated devices, the object of the invention being to produce an automatic boiler-feeding mechanism positive in its action both in permitting water to be forced into the boiler and in excluding it therefrom and whose operative functions are induced by the contact therewith of either the water from the feed-pump or other source of supply or the steam from the boiler; and the invention consists of a chamber located substantially in the plane of the normal water-level of the boiler and which chamber is alternately occupied by the water from the pump or the steam from the boiler, according as the level of water rises and falls, whereby ingress to said chamber by the steam is either cut off or permitted. Within said chamber are located suitable valve-operating devices, caused to act by the variations of temperature between the water and steam to supply water to the boiler or to cut off the water being supplied thereto, all as fully described in the following specification and clearly pointed out in the claims.

In the drawings forming part of this specification, Figure 1 is a perspective view of the interior of a boiler-room, showing the application of this invention and accessory devices to a steam-boiler. Fig. 2 is an enlarged longitudinal section of the valve-operating mechanism for controlling the supply of feed-water entering the boiler. Figs. 3 and 4 illustrate slight modifications in the adaptation of the invention to different means of water-supply. Fig. 5 is an enlarged section of the valve controlling the feed-water supply and showing applied thereto a spring to assist in moving said valve in one direction.

Referring to the drawings, the boiler is indicated by 2 and may be of any desired type, and 3 (see Fig. 2) represents a chamber, within which are located the devices whereby by changes of temperature with said chamber a valve 4 is operated to open and close the passage in a pipe leading from a suitable feed-water tank 6 or other suitable source of supply to said boiler. To inject the feed-water into said boiler, a pump 7 is provided. Said pump may be a continuously-running belt-pump, such as is illustrated in Fig. 1, or a steam-actuated pump 8, (illustrated in Fig. 3,) or the water may be supplied to the boiler by gravity, the latter system being shown in Fig. 4, or by an injector.

The employment of a steam-actuated pump or an injector or the employment of gravity to supply water to the boiler necessitates only some slight changes in the pipe connections, which are illustrated in Figs. 3 and 4, which will be described farther on. These changes clearly lie within the scope of the invention, however, which relates particularly to devices for controlling automatically the supply of water to a steam-boiler or other pressure-generating device wherein pressure is the result of vaporization by heat by means lying entirely outside of said pressure-generating device actuated by the rise and fall of the water-level therein.

It is assumed herein, for the sake of convenience only, that water is always the liquid to be vaporized.

As stated above, the pump 7 (shown in Fig. 1) is a continuously-operating pump and is provided with an intake-pipe 9 and a discharge-pipe 10, the former running from said pump to a water-supply (represented by 6) and the discharge-pipe extending from said pump to the boiler in the usual manner. In said pipe 10 are two branches 12 and 13. The branch 12 leads back to the water-supply 6 and is located to permit water therefrom to be discharged back into said tank 6 when it is not permitted to enter the boiler. In said branch 12 is located the valve 4. The branch 13 connects said discharge-pipe 10 with said chamber 3 near one end of the latter, and in said branch is the valve 14. Between the said branches 12 and 13 is located a check-valve 15 in said pipe 10, as is usual in the water-supply pipes for steam-boilers when said water must be pumped in against the boiler-pressure. A valve 10^a is located in said

pipe 10 between the branch 13 and the boiler. A pipe 16 leads from said chamber 3 to the steam-space in the boiler, and a valve 17 is located in said pipe, which preferably enters said chamber near that end thereof with which the branch 13 is connected, but which may enter said chamber, if desired, at any other point. Said valves 10^a and 17 are provided merely for cutting off the boiler in case any repairs to the water regulating and pumping devices should be found necessary while pressure is on said boiler.

Fig. 2 shows, on an enlarged scale, the construction of the device by which the valve 4, which controls the water-supply of the boiler, is operated, and, referring to said figure, said chamber 3 is seen to consist of a metal tube, one end of which is rigidly held in a bracket 18 and the opposite end of which is loosely supported in a bracket 19 and has a sliding movement therein to allow for the lengthwise movements thereof under expansion and contraction. Each end of said chamber is closed by a suitable plug 20, through which the expansion-tube 21 passes. While said member 21 is represented as a tube, it may, if desired, be in the form of a bar or rod. This tube is made of copper or zinc or other metal having a high degree of expansibility. Suitable packing-glands 22 are provided for said tube where it passes through said plugs. On said bracket 18 or other suitable fixed support is secured an arm 23, from the end of which a link 24 is hung by one end and whose opposite end is connected to the end of the expansion-tube by a pin 25 in the latter extending through a vertical slot 26 in said link, thus permitting freedom of longitudinal movement to the tube and a swinging movement to the link as the lengthwise dimension of said tube changes under the expanding and contracting effects of changes of temperature. The end of said tube 21 opposite to that connected with the link 24 enters the valve 4, the same as would an ordinary valve-stem, and it has all of the functions of the latter, except that said tube moves in the body of said valve by expansion and contraction instead of being screwed in and out. The end of said tube within said valve 4 has secured to it a valve-disk 27 in any convenient way, (see Fig. 2,) and thus by the expansion and contraction of said tube said valve-disk may be moved away from or toward its seat 28, thus opening or closing the passage through the said branch 12 and forcing the water in the discharge-pipe 10 to pass through the check-valve 15 and into the boiler.

Of course when the valve 4 is open the water would naturally pass through it and back to the tank 6, as the check-valve 15 would be held closed by the boiler-pressure, which would much exceed that necessary to force the water back to the tank.

Preferably the expansion-tube 21 is composed of two pieces outside of one end of the chamber 3, and between it and the valve 4 the ends of said two pieces are united by a right and left hand screw-coupling 30, whereby fine adjustments of the valve-disk 27 and its seat may be made.

Referring again to Fig. 1 it will be seen that the chamber 3 is located so that the top thereof lies substantially in the plane of the normal water-level in the boiler, (indicated by the line $x\,x$.) The elongation of a piece of metal by expansion is relatively slight and bears a certain fixed relation to its length, and therefore to obtain a sufficient degree of opening of the valve 4 by the expansion of the tube 21 and to obviate the use of a very long tube or other expansible member the extent of the increase in endwise dimension is multiplied or compounded as follows: Near the free end of the chamber 3 there is secured thereon a post 31, to which is secured one end of a rod 32, the opposite end of which extends to the link 24 and is pivotally attached thereto at 33. By means of this construction the chamber 3 as it elongates by expansion carries with it the post 31, located near its free end, and this movement through the connecting-rod 32 causes the lower end of the link 24 to swing toward the fixed end of said chamber, the movement of the free end of the chamber being multiplied by the connection of said rod 32 near the pivotal point of said link. The link as it moves toward the end of said chamber in turn moves the tube 21 endwise, and as the latter elongates by expansion this expansive elongation is added to the mechanical movement imparted to it by the expansion of the chamber 3 through the medium of the rod 32 and said link 24. Thus the resultant movement of the valve-disk toward or away from its seat is equal to the total expansive elongation of the chamber 3, plus the expansion of the tube 21, plus the multiplication of the expansion of the said chamber as applied to said tube through the connection of the rod 32 with said link at a point near the pivotal point of the latter.

It is obvious that a still further multiplication of the elongation of the chamber 3 may be effected by increasing the length of the link 24 between the point 33 of connection therewith of the rod 32 and the point at which said link is connected with the end of the tube 21.

As shown in Fig. 2 of the drawings, the expansion of the tube 21 closes the valve 4 and, inversely, the contraction thereof opens said valve.

It is to be observed that the water from the pump 7 passing into the boiler will, as the water-level in the boiler rises, flow into the pipe 13 and thus flood the chamber 3, the pipe 16, connected with said chamber and entering the boiler above the water-level $x\,x$, equalizing the pressure in said chamber, and thus permitting the water therein and in the branch pipe 13 to have the same level as that in the boiler. From the above description it will be seen that the water from the boiler

cannot enter the chamber 3; but the latter will always be filled by water direct from the pump 7, for as water is pumped into said boiler it at the same time fills said chamber, and therefore the temperature of the water therein is substantially that of the feed-water and not that of the water in the boiler.

Some heat may be imparted to the water in the chamber from the boiler by means of some slight circulation in the discharge-pipe 10 between the check-valve and said boiler; but it is too unimportant to take into account. The frequent additions of a fresh-water supply from the pump entering said chamber maintains a practically uniform temperature therein. Thus water is forced simultaneously into said boiler and chamber, and as it flows into the latter it will cause it to contract, and when it reaches the level of the tube 21 that member in turn will also contract, and following in reverse the movements of those parts above described as to their expansive movements will draw the valve-disk on the end of the tube 21 away from its seat in the valve-body, and thus open the way for the water from the discharge-pipe 10 to pass back again into the tank 6, the pressure of steam in the boiler holding the check-valve to its seat with a greater force than is necessary to carry the water from the pump back to the tank 6.

From the above description it may be seen that the water-level in a boiler may be maintained at any desired point by the location of the chamber 3 at the level to be maintained.

As long as the relatively cold water is present in the chamber 3 in sufficient volume to prevent its expansion no more water can enter the boiler; but as soon as the water-level in the boiler, and consequently in the chamber 3, falls and steam begins to enter said chamber the expansion of the latter and the tube 21 causes the passage in the branch pipe 12 to be closed, and the pump 7 will then force water into the boiler until its rise in the said chamber drives out or condenses the steam therein, and reducing the temperature of said chamber and tube causes the contraction thereof and the shutting off of the water-supply to the boiler, as above described. Thus the level of water is constantly maintained within a narrow range of variation in an entirely automatic manner and without requiring any attention on the part of the person in charge.

The modifications in the above construction, heretofore alluded to and shown in Figs. 3 and 4 of the drawings, consist mainly in certain changes in pipe connections. Referring to Fig. 3, the arrangement therein shown illustrates the substitution for the continuously-running pump of a steam-actuated pump, and in this case the valve 4 instead of opening a passage for water not needed in the boiler, whereby it may be sent back from whence it came, is located in a steam-pipe 34, and the expansion and contraction of the chamber 3 and tube 21 act to open and close said valve to admit or cut off steam from the pump. With this arrangement the valve-disk is located on the opposite side of the partition in the valve-body from that it occupies in the valve shown in Figs. 1 and 2, for the expansion must open the steam-valve, where in Figs. 1 and 2 it is shown that expansion must close the water-valve. In Fig. 4 the arrangement of piping is shown which adapts this invention to be used where water can be delivered in service-pipes at a pressure exceeding that to be carried in the boiler and whereby no pump is needed. In this last-named arrangement the tube 21 is adapted to operate a valve in the service-pipe 35, which valve will, like that used in the construction shown in Fig. 3, open by the expansion of the tube 21 and, reversely, close by the contraction thereof.

Referring to Fig. 5, the construction therein illustrated consists in making that end of the tube 21 which enters the body of the valve 4 when the latter is located in a steam-pipe—for example, such as is shown in Fig. 3—of a separate piece. In such construction it may be desirable to allow the valve-disk to seat itself independently of the movement of the tube 21 as the latter contracts, and to that end, as stated, the said tube is made in two pieces, the short end 36 thereof being provided with an enlarged extremity 37, which is bored out at 38 to receive the end of the tube 21, which is screw-threaded and has the two nuts 39 thereon, one acting as a jam-nut for the other. These nuts are so located on the end of the tube that one of them will abut against the end of the enlarged part 37 before the end of the tube can come to a bearing against the bottom of the hole 38, bored therein, and thus these nuts may be used as means of adjustment between the tube 21 and the portion 36 thereof to determine at what point in the expansive movement of said tube the valve will begin to open; but as the contractile movement of the tube begins the portion 36 of the tube and the attached valve-disks will follow the movement of the tube, actuated by the spring 40, and the valve-disk will finally be held to its seat by said spring and by the pressure of steam (or water, if applied to the construction shown in Fig. 4.) After the valve 4 is closed by the seating of the valve-disk 27 the tube 21 may still further contract without setting up any strain on the parts of the expansion device.

In adjusting the expansion device for actual operation when the parts are arranged as in Fig. 2 the coupling 30 is manipulated to bring the valve-disk 27 to its seat, when the said tube is expanded to its fullest extent by the admission of steam into the chamber 3. In the construction shown in Figs. 3 and 4 the said adjustment is made when the tube 21 is contracted by the admission of water of

a relatively low temperature into said chamber 3

Having thus described my invention, what I claim, and desire to secure by Letters Patent of the United States, is—

1. In an automatic boiler-feeding device, the combination with a boiler and a water-supply pipe therefor, of a valve in said pipe, and a thermally-actuated device for automatically operating said valve, which device consists of a tubular chamber of expansible metal rigidly held by one end thereof, an expansible metal rod or tube extending through said chamber, and movable mechanically lengthwise therein, a swinging abutment for one end of said rod or tube, and a rigid connection extending from the free end of said chamber to said swinging abutment, and connected therewith, whereby expansive movements of said chamber may impart mechanical movement to said rod or tube, in addition to its expansive movement, substantially as described.

2. The combination in a thermally-actuated valve-operating mechanism, of a tubular member immovably fixed by one end thereof, a second member within said first-named member, a connection pivoted to the fixed end of the latter and one end of the second member, and a rigid connection between the free end of said first-named member to said pivoted connection whereby a mechanical movement will be imparted to said second member by expansive movements of the first member in the direction of movement of the latter, in addition to any expansive movement of the second member, substantially as described.

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