(No Model.) 3 Sheets—Sheet 1.

L. JOHNSTONE.

AUTOMATIC FEEDING DEVICE.

No. 507,910. Patented Oct. 31, 1893.

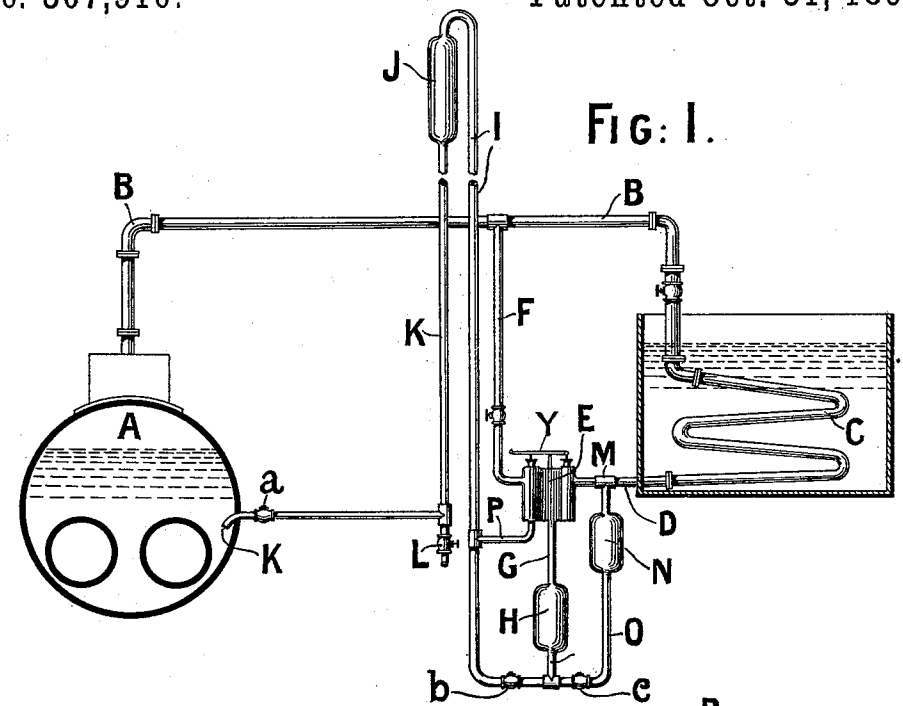


FIG: 1.

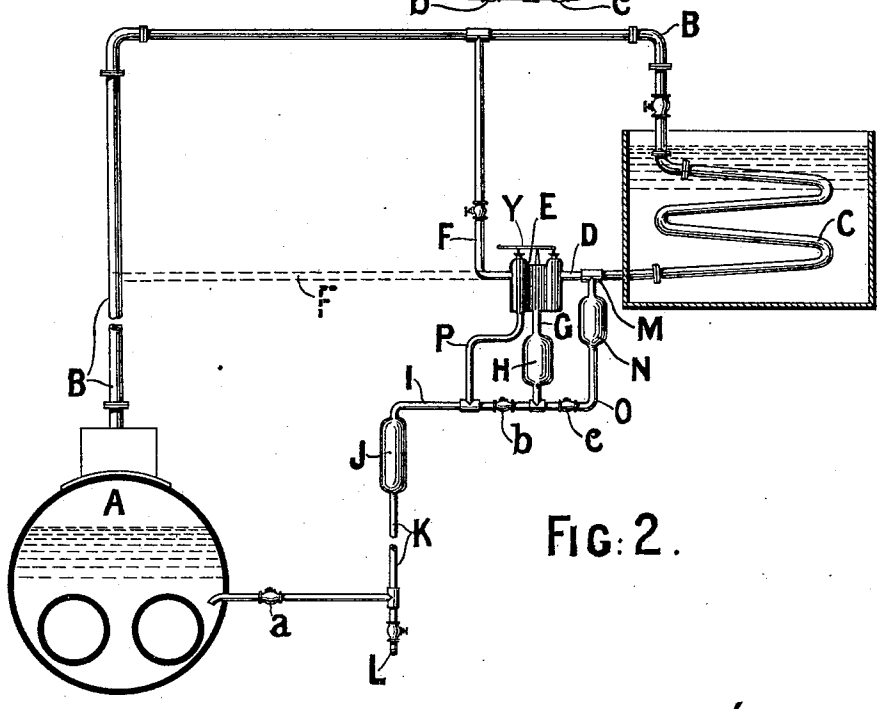


FIG: 2.

WITNESSES.

John C. Coulson.

Percy A. Bowen.

INVENTOR.

Lewis Johnstone

by Whitman & Wilkinson,

Attys.

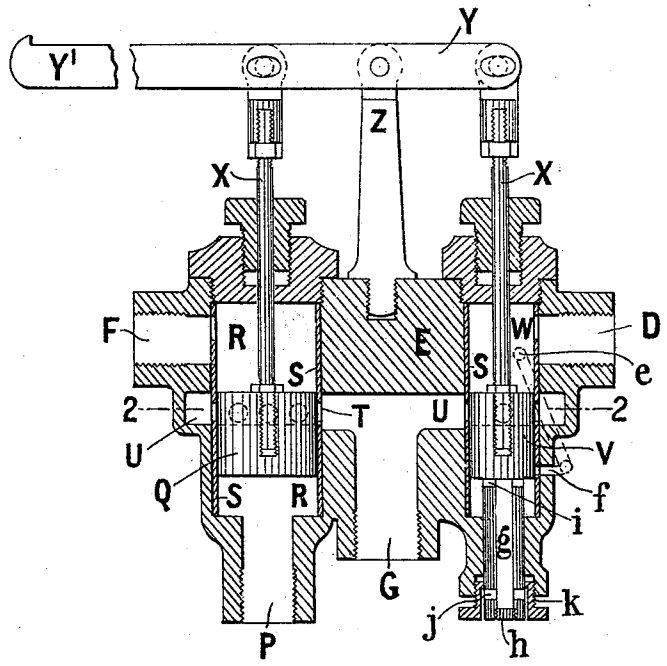
(No Model.) 3 Sheets—Sheet 2.

L. JOHNSTONE.

AUTOMATIC FEEDING DEVICE.

No. 507,910. Patented Oct. 31, 1893.

FIG. 3.



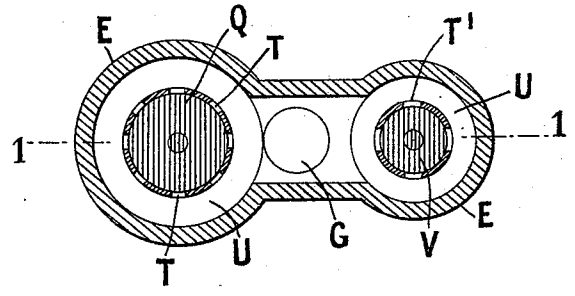


FIG. 4.

WITNESSES.
John A. Wilson
Percy C. Bowen.

INVENTOR.
Lewis Johnstone.
by Whitman & Wilkinson,
Attys.

(No Model.) 3 Sheets—Sheet 3.

L. JOHNSTONE.

AUTOMATIC FEEDING DEVICE.

No. 507,910. Patented Oct. 31, 1893.

FIG: 5.

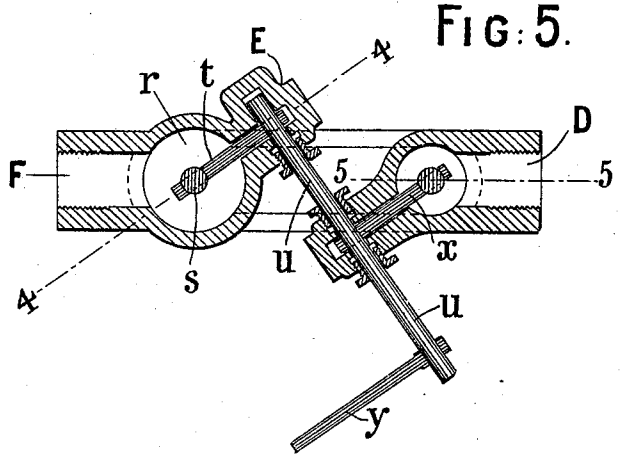


FIG: 6.

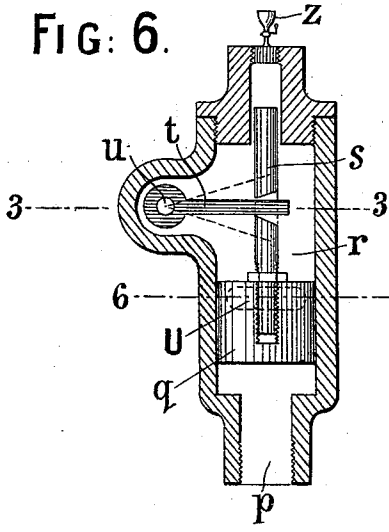
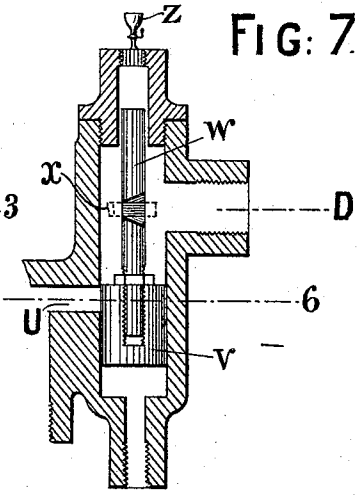


FIG: 7.



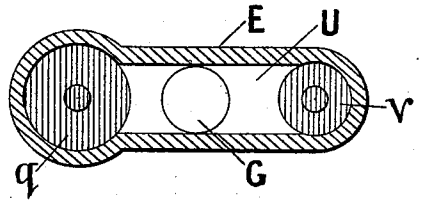


FIG: 8.

WITNESSES.

John L. Wilson

Percy C. Bowen

INVENTOR.

Lewis Johnstone,

by Whitman & Wilkinson

Attys.

UNITED STATES PATENT OFFICE.

LEWIS JOHNSTONE, OF EDINBURGH, SCOTLAND.

AUTOMATIC FEEDING DEVICE.

SPECIFICATION forming part of Letters Patent No. 507,910, dated October 31, 1893.

Application filed May 22, 1893. Serial No. 475,029. (No model.) Patented in England August 20, 1892, No. 15,062.

To all whom it may concern:

Be it known that I, LEWIS JOHNSTONE, engineer and analytical chemist, a subject of the Queen of Great Britain, residing at 10 St. Andrew's Square, Edinburgh, Scotland, have invented an Improved Automatic Feeding Device, (for which I have obtained Letters Patent in Great Britain, No. 15,062, dated August 20, 1892,) of which the following is a specification.

My invention relates to an improved apparatus for returning into the boiler the water of condensation from coils, steam jackets, heating pipes, steam drying cylinders, &c., or for forcing ordinary feed water into the boiler, or other similar purposes. And in order that my present invention may be easily understood and readily carried into practice I will proceed to describe same with reference to the drawings hereunto annexed.

Figure 1 is a general view of an apparatus for returning water of condensation into the steam generator from a point below the water level in such steam boiler. Fig. 2 is a similar view of my apparatus for effecting the same purpose from a point above the water level in the generator. Fig. 3 is a vertical (longitudinal) sectional view on line 1—1 Fig. 4 of the special valve apparatus and its connections according to my present invention. Fig. 4 is a sectional plan on line 2—2 Fig. 3. Figs. 5, 6, 7, and 8 illustrate a slightly modified construction of the special valve—as hereinafter explained.

Similar letters of reference indicate corresponding parts throughout.

A is the steam boiler or steam generator of any usual or suitable construction.

B is the main steam pipe—leading to any steam motor, steam jacket coil or drying chamber, or other steam actuated or steam heated device or the like all of which for the sake of brevity I shall hereinafter refer to as the "coil."

C is the "coil" illustrated by way of example.

D is the outlet from the coil—leading into E.

E is the casing containing the special valve apparatus—shown in detail in Figs. 3 and 4 and in Figs. 5 to 7.

F is the branch steam pipe—leading from the main steam supply pipe B into the casing E.

G is the outlet pipe from the valve casing E—leading to the reservoir H.

H is the "lower" reservoir (as I term it) in which the water of condensation is accumulated ready to be forced into the reservoir J.

I is a pipe leading from H to J.

J is the "upper" reservoir (as I term it) from whence the water passes into the generator A.

K is a pipe leading from J into the lower part (*i. e.* below the water level) of generator A.

L is a blow off cock in pipe K.

M is a T-piece or branch pipe leading from D to a third reservoir N.

N is a reservoir where the water of condensation accumulates from the "coil" C.

O is a pipe connecting the lower part of reservoir N with the lower part of the reservoir H.

P is a branch pipe leading from the pipe I to the under side of the steam piston valve Q in the casing E.

Referring now to the equilibrium or balance valve apparatus shown in Figs. 3 and 4:—Q is a large piston valve acting as a tightly fitting piston or plunger in the cylinder or chamber R which latter may advantageously be formed with a bush or lining S as shown. T T are apertures in the cylinder R controlled by the valve Q and leading from the cylinder R to the outlet G through the steam passage way U. U is a steam passage way leading from the pipe F cylinder R and apertures T to the outlet pipe G and also to the inlet apertures T′ round the second valve cylinder W. V is a second and smaller piston valve. W is the cylinder of the second valve V also advantageously lined similar to R and also having apertures T′ (or other communication) with the passage way U. X is the piston rod on the piston Q, and X′ the piston rod on the piston V, both pivoted to the pivoted lever Y. Z is a fixed support carrying the pivoted lever Y which latter therefore has its fulcrum on Z. *a* is a back pressure valve to prevent any return of water from the boiler A into the pipe K. *b* is a back pressure valve in the pipe I to prevent pressure from the pipes K and I and chamber J,

passing back in the chamber H. *c* is a back pressure valve to prevent pressure from the chamber H or pipe I passing back into the pipe O.

The automatic operation of the equilibrium or balance valves Q and V is as follows:—The full live steam pressure is constant (when the apparatus is in work) through F onto the top side of piston Q which when forced downward admits same live steam through the conduits T. U. G. H. I. and P to the under side of the piston Q and thus equal steam pressure will exist on both top and bottom of piston Q and so the latter is brought into equilibrium and can then be easily controlled by the second valve V and their respective connections. The valve V is now at its uppermost position and on the top side thereof has applied thereto the pressure coming through D from the "coil" C. The steam valve Q being already in equilibrium (in its lowermost position) as just previously explained the least pressure or force exerted on the top of V (sufficient to overcome friction) will force down V to its lowermost position and through the pivoted lever Y and the respective piston rods X′ and X will thereby move up the valve Q to its uppermost position while in the case of the valve V as soon as it passes the apertures T′ steam pressure will be thereby admitted to the upper side of the valve V. With the valve Q thus at its uppermost position and the valve V at its lowermost position—the full live steam pressure from B and F remains constant on the top of Q while the steam pressure remaining in the parts I, J, K and P is prevented from passing back by means of the back pressure valve *b* and as this steam pressure dies away in the parts I, J, K and P (by reason of radiation, condensation or by a special exhaust, &c.), the pressure through the pipe P on the under side of the valve Q will decrease and then as soon as the constant pressure on the top of the valve Q is greater than the resistance of the valve V plus the remaining pressure under the valve Q plus friction then the piston Q will be forced down and a fresh charge of live steam suddenly passed through R. T. U. G. H. I. and P and the cycle repeated as before. To assist the quick action of the balance valve so that immediately the valve Q has begun to move down it shall continue its movement rapidly—I may use what I term a dash-pot or regulating device such as illustrated and consisting of a by pass *e f* in the cylinder W as shown in dotted lines in Fig. 3 acting in conjunction with the valve gear beneath the valve V as shown in Fig. 3 to automatically permit exhaust from beneath valve V at the desired moment; viz: The valve V carries on its under side the extension forming a smaller plunger *g* closed at its bottom end *h* and having openings *i* at its top end and openings *j* at its lower part this lower part passing through a gland *k* so that immediately the apertures *j* in the side walls of *g* pass below the closely-fitting part of gland *k*; then the steam beneath valve V is exhausted. The action of this partial equalizing of the valve V is as follows:— Assuming the valve V to be at its lowermost position in the cylinder W it will cover and close the end *f* of the by-pass and also the apertures *j* will lie clear of the gland *k* and therefore no pressure will now exist below valve V. As soon as the valve Q is forced down and consequently lifts the valve V against the pressure pipe in D—then the apertures *j* are brought inside of gland *k* and consequently closed. At the same moment the end *f* of the by-pass is uncovered by the upward movement of the valve V and therefore pressure above and below valve V will be partially equalized and consequently part of the resistance to valve Q at first offered by valve V is now suddenly removed and thereby the valve Q will perform the rest of its travel downward at a greatly increased speed. On the return movement that is when the valve V is moved downward (and thereby lifting the valve Q) the movement of valve V is slow owing to the pressure under valve V coming through the by-pass *e f* but as soon as valve V closes *f* and exhaustion is permitted at *j* then no resistance will remain under valve V and consequently the latter will perform the rest of its travel at a greatly accelerated speed. This arrangement or equivalent will be found of great utility especially in cases where great variations may exist from time to time between the boiler pressure and the pressure in pipe D during the working of the apparatus.

In cases where a great difference normally exists between the boiler pressure and the pressure in "coil" C and its outlet D—then this difference may be compensated for by weighting the end Y′ of the lever Y or by altering the relative sizes (areas) of the valves Q and V — for instance the latter might be of much larger area than Q—as hereinafter further explained.

The operation of the whole apparatus is as follows:—The water of condensation—from the "coil" C—(or other water to be returned or fed to the boiler A) coming through the outlet D (which may or may not be on a decline for this purpose) passes through the T-piece M and accumulates in the reservoir N and pipe O. As soon as the reservoir H has been emptied of its last charge, steam pressure is equalized in both top and bottom of H by the valve V being forced down (as before described) and thereby whatever steam pressure exists in the pipe G and reservoir H will pass through the parts U T′ W and D to M and N. Thus pressure being equalized all through these last named parts—the water accumulated in N will now by gravity descending through O past the back pressure valve *c* and fill or partially fill the reservoir H. I would here remark that the parts E. H. J and N and their connections are shown in Figs. 1 and 2 on a much larger scale in pro-

portion to the other parts of these Figs. 1 and 2—this being done for the sake of clearness. Figs. 3 and 4 represent the valve apparatus. As soon now as the pressure under valve Q has died away or decreased sufficiently the live steam in branch steam pipe F will force down valve Q (as before explained) and thereby the apertures T are uncovered by valve Q and a charge of live steam is delivered from F through the parts R. T. U and G to the upper surface of the water in the reservoir H which is thereby suddenly driven out of the reservoir H and as it cannot escape back through the back pressure valve *c* it is therefore driven past *b* through the pipe I to the reservoir J which latter reservoir J is and always must be placed at a height above the water level in the boiler and should be of a capacity somewhat larger than the reservoir H. Having got the charge of water up to this elevated position (in the reservoir J) much above the water level in the steam generator A it will thus be easily seen and understood that, as such water in the elevated reservoir J will have the full steam pressure from the pipes B and F through the pipe I behind it, the pressure from the boiler at *a* will be equalized—while the weight of the water in the reservoir J (that is gravity) will cause the said water to readily pass through the feed pipe K (past the back pressure valve *a*) into the boiler A. The live steam supply to the pipe I lasts a sufficient time to do its work and as soon as same is cut off and the pressure in the pipe I begins to decrease then the pressure from the steam generator A will close the back pressure valve *a* and consequently no water can come back from the said boiler A into the pipe K; and thus as no water from boiler A can come back past *a* consequently no water column is thereby formed in the pipe K. Meantime while the pressure has been dying away in the pipe I the further accumulation of water in the reservoir N has emptied itself into the reservoir H and live steam being again admitted to the upper part thereof this charge is driven through the parts I. J and K into the boiler A and so on—the whole cycle being automatic and automatically and periodically repeating itself so that very large quantities of water can be by my apparatus steadily returned into the boiler.

It is for the especial purpose of being able to return large or small quantities of water to boilers at more or less varying pressure that my present invention was more especially designed and in practice I have found it to work equally well with either large or small quantities of return water where very great difference exists between boiler pressure and the "coil" or feed water and for these and other reasons giving great advantages over apparatus previously designed for similar purposes.

Referring to the modified construction of valve apparatus shown in Figs. 5, 6, 7 and 8:—Fig. 5 is a horizontal section on the line 3—3 Fig. 6. Fig. 6 is a vertical section on line 4—4 Fig. 5. Fig. 7 is a vertical section on line 5—5 Fig. 5. Fig. 8 is a cross section on line 6—6 Figs. 6 and 7. The letters D. E. F. G. P. and U respectively designate the same parts as in Figs. 3 and 4.

Referring to Figs. 5 to 8:—*q* is the steam valve (corresponding to Q). *r* is cylinder in which *q* operates (corresponding to R). *s* is piston rod on *q* slotted to receive the end of arm *t* see Fig. 6. *t* is arm on the axle shaft *u*—which arm *t* is connected to *s* as shown in Fig. 6 or in any other suitable way. *u* is axle shaft mounted with glands or stuffing boxes or in other suitable steam tight manner in the casing E. *v* is second valve (corresponding to V). *w* is piston rod on *v*. *x* is arm connected to *w* similar to *t* and also keyed or otherwise fixed to shaft *u*. *y* is an arm or lever also fixed at right angles on the shaft *u*—by which means a counter balance may be used or a dashpot attached thereto to control the valves as desired. *z z* are oil feed cups to keep the internal working parts of this valve apparatus lubricated.

It will thus be seen that the valves *q* and *v* are connected through the shaft *u* and connecting arms *t* and *x* so that when the valve *q* is forced down the valve *v* is thereby forced up and vice versa.

The operation is as follows:—The full steam pressure coming through pipe F forces down the valve *q* clear of the passage U whence the steam pressure passes as before through G into H. I. J. and K, while as soon as equal steam pressure attains at P the valve *q* is brought into equilibrium and the pressure at D acting on top of *v* will thereby force down *v* and consequently raise *q* and thus cut off steam from F passing to U while as soon as the top of *v* clears passage U the steam therein remaining can exhaust back into the "coil" and at the same time may act on *v* to accelerate its downward movement.

The apparatus shown in Figs. 5 to 8 will thus be seen to be very simple in construction and action and will be found to work well in cases where the variation between the pressure in F and D is constant or approximately constant. Where however the pressure in D is liable to great variation it will be found necessary to adopt and use a compensating arrangement such as illustrated in Fig. 3 or in the alternative a greatly increased length of rise in pipe I so as to give a greatly increased height to J and consequently increased fall from J to A—as further explained hereinafter.

The advantage of having the bush or lining S in the cylinders R and W (Figs. 3 and 4) with small apertures T T′ therein into passage U—is that split piston rings or packing rings may be used on Q and V, whereas in the arrangement such as shown in Figs. 5 to 8 such packing rings could not be used.

Some lap should be given to the steam valve Q or *q* and also to the equilibrium or balance

valve V or *v* so that the one closes before the other opens and to reduce leakage, &c.

It will be readily understood that where the "coils" are on a higher or different level from the water level of the boiler the proper position can be easily found where the above conditions apply. Further the apparatus may be arranged and mounted at any convenient point (within practical limits) more or less distant from the boiler.

Weighting the steam valve against the live steam may be adopted and has several advantages for instance as a means of regulating the stroke of the valves and to retard the live steam from acting again too quickly.

The amount of weight required to balance the balance valve of the coil outlet side can naturally be much reduced by making said valve of smaller diameter and this is of advantage where the pressure from the coils is comparatively high compared to the steam, or again instead of unduly reducing the size of this valve the excessive weighting to balance may be overcome by making the valve in itself partially self balancing. This may be effected by making a pressure area on the under side of the valve of any given amount.

When the pressure from the coils is very low in comparison to that of the boiler the size of the outlet valve may be increased beyond that of the steam valve so as to be more sensitive to this very low pressure. The advantage of thus making the valve more or less self balancing as against the amount of dead weight required is readily seen by a simple example of calculation.

If the valves are of equal area say one inch, the steam valve being in equilibrium, the boiler pressure sixty pounds and the outlet from coil thirty pounds per inch—the weighting necessary will be thirty pounds or its equivalent by leverage. If however the valve be made partially self balancing say the area of pressure on the under side be made half that on the upper the amount of weighting will be one half of the former case, *i. e.*, fifteen pounds or its equivalent by leverage. Further if the area of this valve be reduced to say half inch area the weighting without the self balancing would be fifteen pounds or its equivalent by leverage and with the self balancing to the above proportion seven and one-half pounds or its equivalent by leverage. Again the lower pressure area (on the valve V) may be made three-fourths of the area of the upper so that in the case of the one inch valve the downward pressure would be thirty pounds and the upward three-fourths of thirty (equal to twenty-two and one-half)—that is, the amount of the balance by weighting would be thirty minus twenty-two and one-half (equal to seven and one-half) pounds. With the area one half inch the downward pressure would be fifteen, the upward three-fourths of fifteen, equal to (eleven and one-fourth;) so the amount to be balanced by dead weight would be fifteen minus eleven and one-fourth (equal to three and three-fourths) pounds. The conditions under which this dead weight may be disregarded are readily seen by studying for a moment the valve on the steam side, *i. e.*, the steam driven valve Q. For example take the steam valve of say three inches area as against the last example of the other side which gave (with thirty pounds' pressure at "coil" outlet) an effective downward pressure of three and three-fourths pounds. Consider the weight removed altogether. On the steam side the boiler pressure of sixty pounds would open the valve and steam would pass round to the under side and also to the upper reservoir but it is manifest that the steam on the under side cannot rise to the sixty pounds as before, as the valve Q would be shut off by the action of the three and three-fourths pounds on the other valve V. Now the area of the steam piston Q has been taken at three inches; therefore when the steam on the under side rises to sixty minus one-third of three and three-fourths (equal to sixty minus one and one-fourth, equal to fifty-eight and three-fourths) the steam valve Q will be in equilibrium and as it rises above this the valve V will again open to the coil C. Now as the steam has thereby been shut off before the boiler pressure was reached a sufficient extra drop from the upper reservoir J will have to be allowed (this amounts to weighting the valve against the live steam.)

It will be readily seen that the larger the steam valve or the greater its leverage is compared to the "coil" valve—taking their effective pressure areas—the more control has the former over the latter, this control in the above case amounting to dispensing with the weight on the steam side; and with the upper reservoir at a sufficient height the pressure in the "coil" may vary greatly without affecting the action of the valve in forcing the water back to the boiler.

As I have already stated I may use a dash-pot or other device for regulating. This may be put in the coil side of the valve itself and is shown in Fig. 3 where by a by-pass it is effected that when the coil valve V is closed (*i. e.* up) it is in the state of partial equilibrium described but when it is open (*i. e.* down) it has the full area of the top pressure only so that the pressure on the steam side has to fall lower (below the steam piston) in order that it may allow the steam pressure on the top of steam side to open.

In the above case it was shown that when the steam on the under side of steam valve was fifty-eight and three-fourths equilibrium was established the balance of one and one-fourth being the equivalent of the three and three-fourths on the coil side. The by-pass however throws off the bottom pressure so that when the "coil" valve is open it has the full area of pressure—viz., fifteen pounds—so that the steam has to fall one-third of fifteen (equal to five) before equilibrium is estab-

lished on the steam valve thus delaying the action of the steam exactly as required.

It will be obvious that my present invention may be carried into practice and modified in various ways without departing from the nature of my invention—as various details of construction and arrangement of parts may be altered or modified according to the varying conditions under which my invention may be required to act and as to which any one skilled in the art or other competent person would be able to decide according to the surrounding circumstances.

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

1. In apparatus for automatically returning water of condensation feed or other water into steam boilers having a circuit or continuous pipe system consisting of the main steam supply pipe the "coil" or steam using device and the return pipe leading into the boiler below the water level thereof—the combination with and introduction into such circuit or system (between said steam using device and the return pipe) of a valve apparatus consisting of a steam valve having direct communication on one side thereof with and actuated in one direction by the main steam supply and on the other side thereof communicating with the return pipe and connected to a second and separate valve so that the movement of one valve causes movement of the other the said second valve having communication with and actuated in one direction by the pressure existing or remaining in the "coil" or steam using device substantially in the manner and for the purposes hereinbefore described.

2. In apparatus of the character described having a back pressure valve such as *a* close to the inlet into boiler—the arrangement and combination therewith of valve apparatus having a steam valve working in a cylinder connected on one side of the valve to the full steam supply and on the other side thereof with the return pipe, a steam passage from such cylinder controlled by said valve and leading to the accumulated water in a reservoir pipe or chamber such as H interposed between said steam passage and the return pipe, and acting in conjunction with a back pressure valve such as *c* so that such water is driven by such steam through the return pipe and higher reservoir J substantially in the manner and for the purposes hereinbefore described.

3. In an apparatus of the character described, the combination with a steam generator and a feed water supply, of a valve apparatus consisting of a steam valve with live steam connection to the generator, and a second valve moving synchronously with and in reverse direction to said steam valve, and connected to the feed supply, reservoirs connected to each other and to said valves, back pressure valves between said reservoirs, a feed pipe connecting the last reservoir and the steam generator, and a back pressure valve in said feed pipe, substantially as and for the purposes described.

4. In an apparatus of the character described, the combination with a steam generator and a feed water supply, of a valve apparatus consisting of a casing provided with connections to the generator and to the feed supply, two valves mounted in said casing and adapted to move synchronously, the said valves being provided with ports and connecting passages, substantially as shown; a reservoir H beneath said valve casing, and connected to each of said valves; a reservoir N connected to said feed supply and to one of said valves; a reservoir J connected to the other of said valves and to the said generator, the said reservoir J being at a higher level than the water in said generator; and back pressure valves between each pair of said reservoirs and between said reservoirs J and said generator, substantially as and for the purposes described.

5. In an apparatus of the character described, the combination with a steam generator, a steam using device and means of condensing the steam used in said device, of a valve apparatus consisting of a steam valve with live steam connection to the generator, and a second valve moving synchronously with and in reverse direction to said steam valve and connected to the exhaust, reservoirs connected to each other and to said valves, back pressure valves between said reservoirs, a feed pipe connecting the last reservoir and the steam generator, and a back pressure valve in said feed pipe, substantially as and for the purposes described.

6. In an apparatus of the character described, the combination with a steam generator, a steam using device, and means of condensing the water used in said device; of a valve apparatus consisting of a casing provided with connections to the generator and to the exhaust, two valves mounted in said casing and adapted to move synchronously, the said valves being provided with ports and connecting passages, substantially as shown; a reservoir H beneath said valve casing and connected to each of said valves; a reservoir N connected to said exhaust and to one of said valves, a reservoir J connected to the other of said valves and to said generator, the said reservoir J being at a higher level than the water in the said generator, and back pressure valves between each pair of said reservoirs and between said reservoir J and said generator, substantially as and for the purposes described.

LEWIS JOHNSTONE.

Witnesses:

HENRY BIRKBECK,

34 *Southampton Buildings, London, England.*

THOMAS LAKE,

17 *Gracechurch Street, London.*