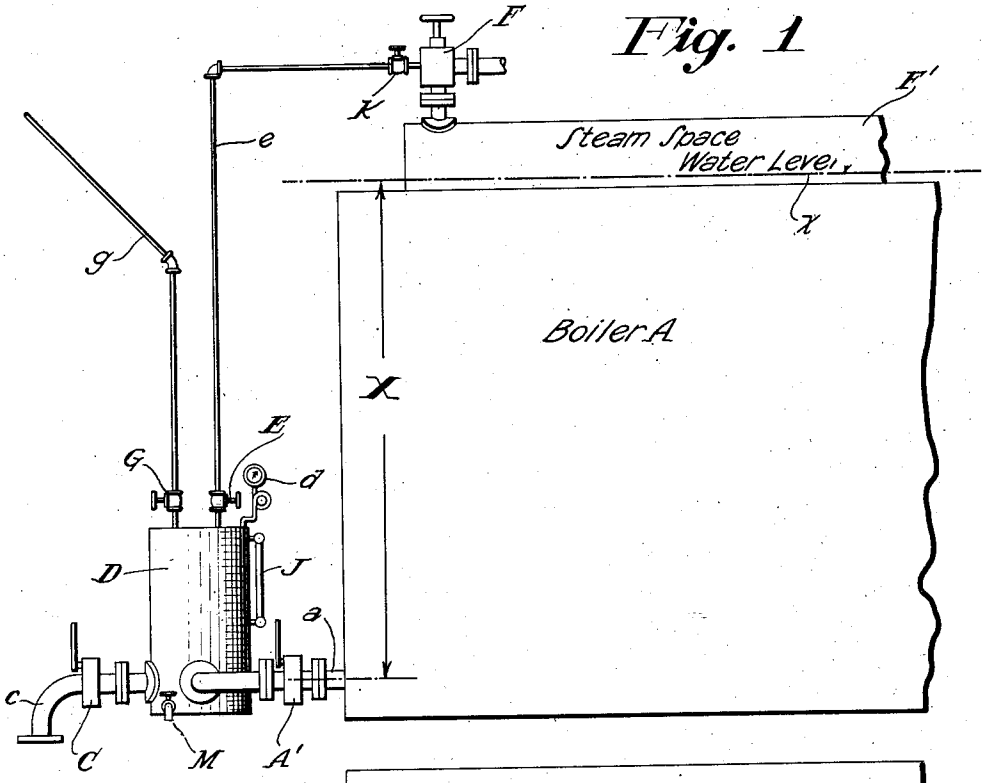
July 28, 1925. 1,547,708

W. G. WILSON

METHOD OF BLOWING OFF BOILERS

Filed Oct. 19, 1921 4 Sheets-Sheet 1

Fig. 1



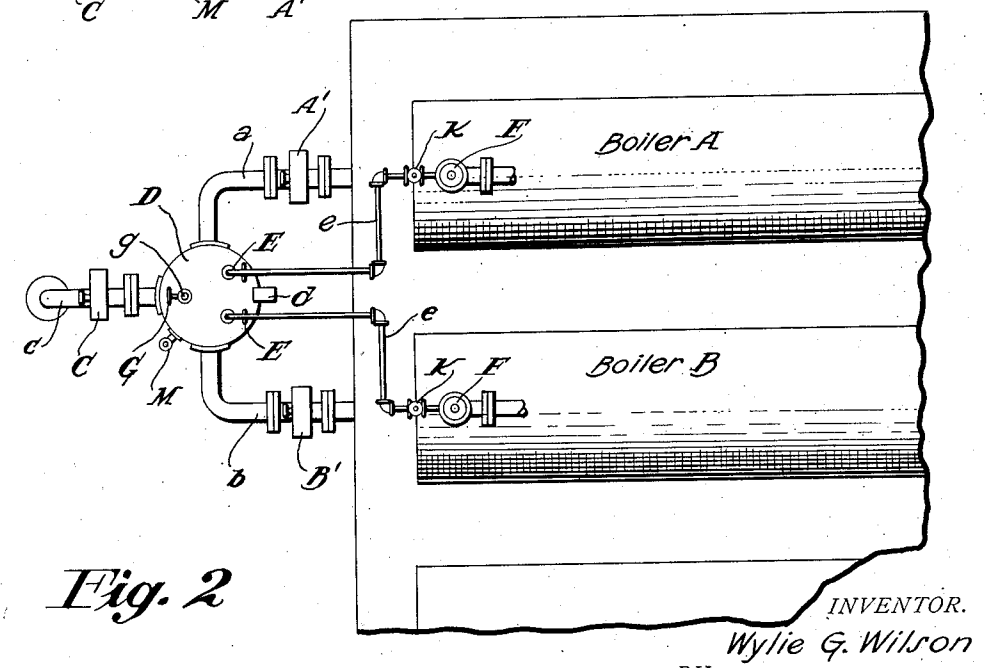


Fig. 2

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July 28, 1925. 1,547,708

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METHOD OF BLOWING OFF BOILERS

Filed Oct. 19, 1921 4 Sheets-Sheet 2

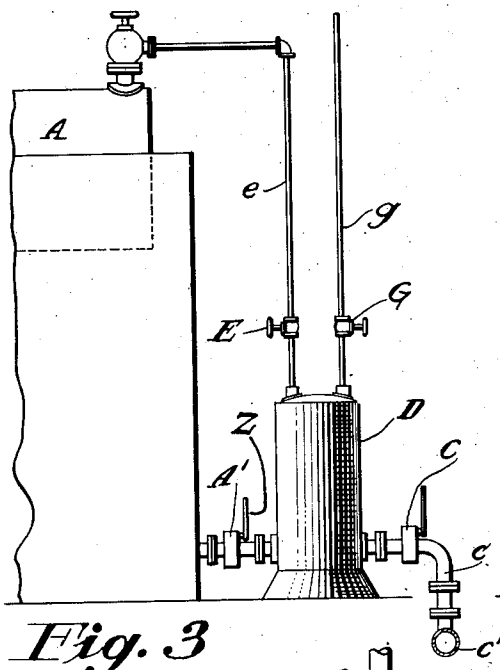


Fig. 3

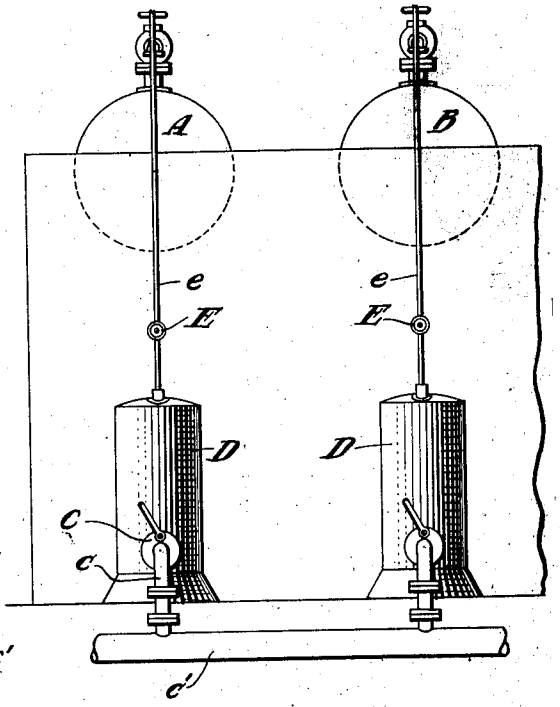


Fig. 4

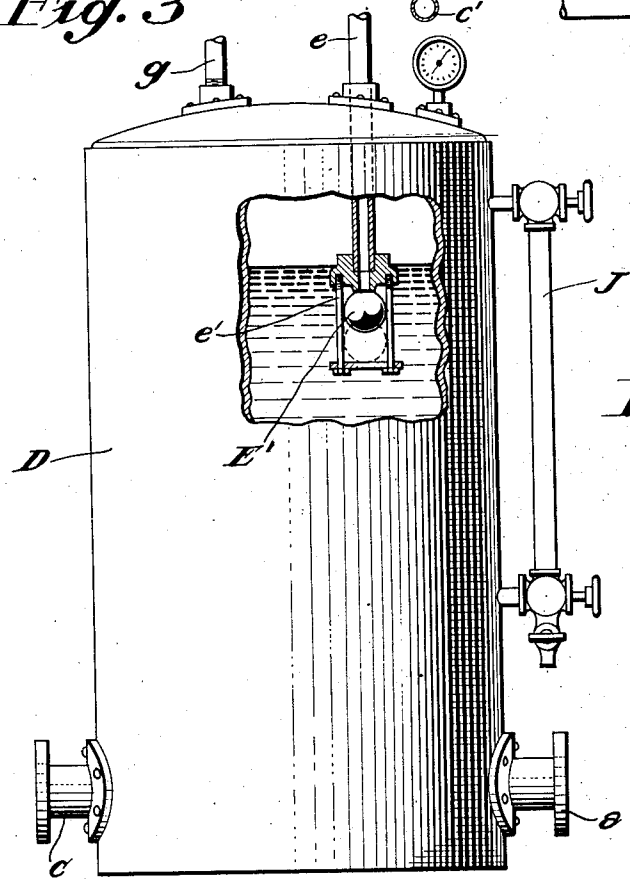


Fig. 5

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METHOD OF BLOWING OFF BOILERS

Filed Oct. 19, 1921 4 Sheets-Sheet 3

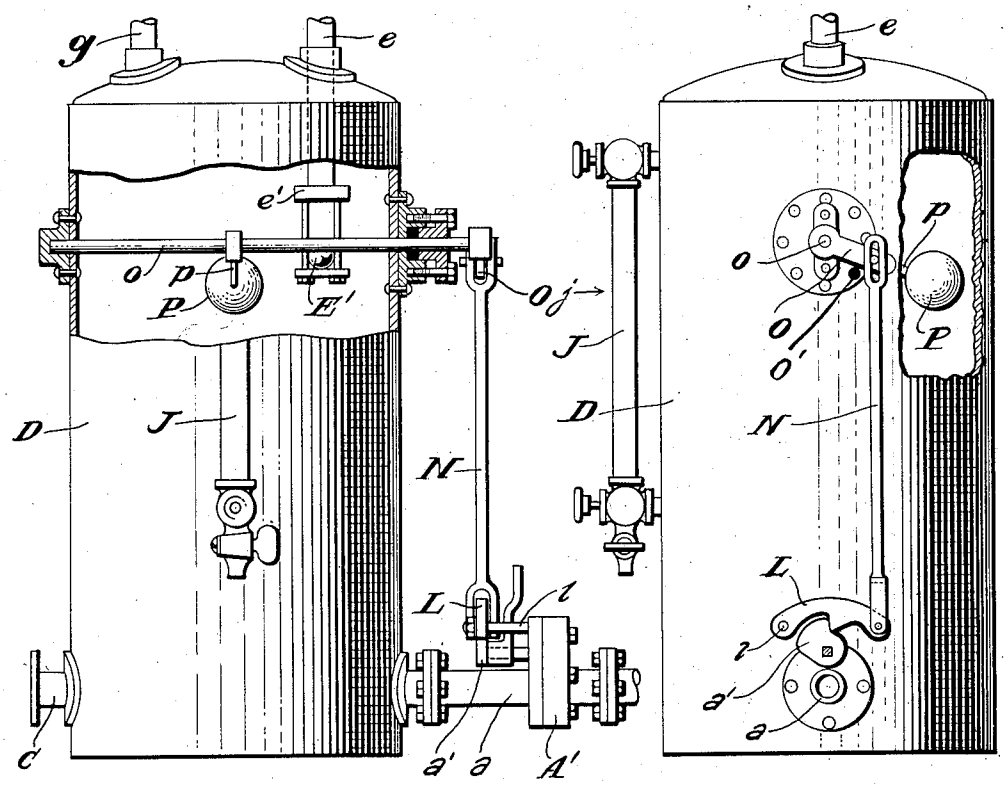


Fig. 6

Fig. 7

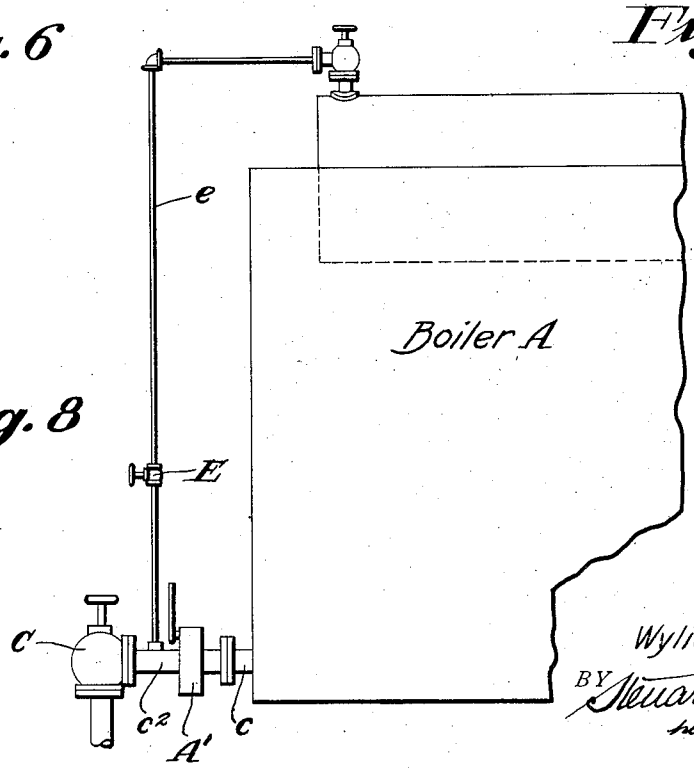


Fig. 8

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METHOD OF BLOWING OFF BOILERS

Filed Oct. 19, 1921 4 Sheets-Sheet 4

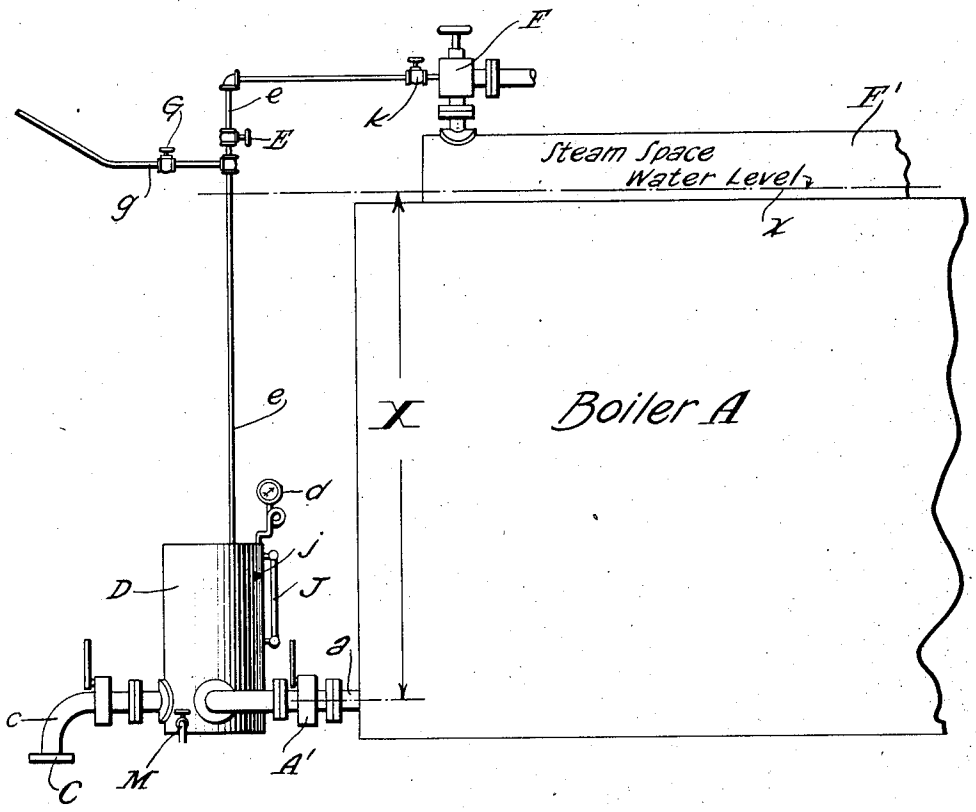


Fig. 9

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Patented July 28, 1925. 1,547,708

UNITED STATES PATENT OFFICE.

WYLIE G. WILSON, OF ELIZABETH, NEW JERSEY, ASSIGNOR TO LOOSE SEAT VALVE COMPANY, A CORPORATION OF DELAWARE.

METHOD OF BLOWING OFF BOILERS.

Application filed October 19, 1921. Serial No. 508,668.

To all whom it may concern:

Be it known that I, WYLIE G. WILSON, a subject of the King of Great Britain, and a resident of Elizabeth, in the county of Union and State of New Jersey, have invented certain new and useful Improvements in Methods of Blowing Off Boilers, of which the following is a specification.

This invention relates to an improved method or system for blowing off steam boilers to remove sludge, mud and accumulated sediment deposited in the base of the boiler, together with water in which such foreign matter is in suspension, or water whose density has been increased because it carries matter in solution. It contemplates particularly a method by which a portion of the water, sludge, mud, etc., may be withdrawn from the boiler from time to time so that information may be obtained of the condition of the contents of the boiler, with particular reference as to whether further discharge through the blow-off valve will materially improve the condition of the interior of the boiler. These results are accomplished under this method by providing means under which the flow of water blown off may be under control, as to the velocity at which the effluent is permitted to escape, as to the volume withdrawn, and as to the disposition of the fluid, sludge, etc., so withdrawn.

This method also has for its purpose the minimizing of certain objectionable features which are incident to boiler blow-off as practiced, to wit: "shock" which is incident to the closing of the exhaust valve, injury to the exhaust pipe line, particularly at points where such pipe line is formed with one or more shoulders or elbows, as well as effects due to the sudden heating of the pipe line causing expansion, etc., all of which is incident to the sudden rush of water, sludge, etc., at high temperature and great velocity through said pipe line. The valve interposed in the pipe line is also liable to injury, occasioned by what is known as "wire drawing" when the valve is opened or closed, and particularly when an effort is made to control the velocity of efflux by partially closing the valve. All of these incidents are present in the operation of blowing off steam boilers as at present constituted and, as stated, it is among the purposes of this method or system to provide means and to proceed by steps or stages to so operate said means as to overcome these difficulties and to establish a system under which a steam boiler may be blown off under conditions where the effluent is under perfect control, and also so that the operator may from time to time sample the contents of the boiler and from inspection of the effluent determine whether the boiler needs to be blown off and if so to what extent, etc.

Under present conditions of boiler practice, it is customary to provide each boiler with a blow-off valve adjacent the lowest point of the boiler. Dependent upon the conditions of the water employed in the plant, sludge, mud, scale and other impurities suspended in the water are, as the steam is generated, deposited at the bottom of the boiler. It is important for numerous reasons unnecessary to narrate here to remove the sludge or mud from time to time, and the removal is usually accomplished by opening the blow-off valve and permitting a part of the water in the boiler to escape. This, of course, is accomplished under steam and hydrostatic pressure, hence at great velocity. A portion of the mud or scale lying adjacent the exhaust port will be swept out with the efflux of water and in this way the boiler will be partially or wholly cleansed as the case may be.

In modern steam power plant practice it is becoming more and more customary to use high pressures and large boiler units. Until quite recent times, boilers were seldom operated at pressures over 200 pounds per square inch. Today more and more frequently in new installations the boilers are operated at a working pressure of 250, 300 and 350 pounds per square inch. In large boiler units, which are also now becoming customary, the blow-off valves are seldom smaller than 2½ inches in diameter.

In the operation of such boilers under the conditions named, it will be appreciated that the temperature of the water increases as the pressure increases. When the blow-off valve on a boiler under, say 250 pounds or over, is opened, the terrific rush of water through the valve and through the piping, and the discharge of quantities of very hot water at such high velocity through relatively cold piping systems is productive of many

detrimental and even dangerous consequences. Experience demonstrates that it is often desirable to operate the blow-off valves on boilers at least once a day and in some cases more frequently. It will be understood that water drawn from the boiler under the high pressures stated above is at a higher temperature and its expulsion is at a greater velocity than is the case in boilers operating at the lower pressures customary until recent years. It will be understood, therefore, that the difficulties and dangers incident to boiler blow-off under conditions of high pressure (and consequent high temperature) are greater than they have heretofore been under conditions of lower pressure and consequent lower temperature.

Under the conditions above named when it is desired to blow off a boiler, the blow-off valve is opened for a space of time which in the estimation of the engineer in charge will be sufficient to clear the boiler of sludge, scale, water of too great density, etc., as far as it is possible and advisable to remove these through the blow-off valve. In the operation of blow-off valves under the high pressures mentioned considerable danger to the life and limb of the operator is incident, both owing to the fact that the sudden efflux at high velocity (due to the high pressure) of this water carrying gritty particles wears out the valves and the pipe line at bends, and also due to the fact that the sudden flow of this high temperature water, through the pipe lines previously at a much lower temperature, produces a sudden expansion of those pipe lines, thus leading to leaks, etc.; further the large valves used under the high pressures mentioned offer great resistance to opening and closing, thus putting a tremendous stress on operating parts whose breakdown would render the valve inoperative—a most dangerous condition.

Under present conditions of boiler practice, there is no positive method by which the amount of water withdrawn from the boiler under boiler blow-off conditions can be definitely regulated and fixed. The amount will vary according to the size of the valve and the conditions of pressure and the time during which the valve is permitted to remain open. There is at present no satisfactory method by which the operator can tell whether the blow-off valve has been opened long enough so that the maximum amount of high density water, sludge, etc., which can be economically discharged from the boiler through the blow-off of valve has been discharged; or whether the valve has been open too long so that in addition to the necessary discharge of dense water, etc., an unnecessary quantity of hot water has been discharged, thus occasioning an unnecessary loss of money.

These and many other objections are incident to the present practice of boiler blow-off and it is the object and purpose of the method and system here disclosed to obviate said difficulties and to point out a way by which through certain steps and stages of operation the high steam pressures above referred to may be utilized to balance and control the blow-off operation, so that the amount of fluid withdrawn may be definitely and positively limited, so that the condition of the sludge or mud in the boilers may be from time to time inspected under such conditions that the fluid contained at the base of the boiler will be brought in position where it can be conveniently observed and tested, and so operated as to relieve detrimental stresses and strains on the interposed blow-off valve operating mechanism, and also to minimize the shock element incident to closing such valve; in other words so taming the violent elements above referred to as to bring the same under the absolute control and dominion of the master mind operating the boilers.

For the purpose of putting into operation a method or system of boiler blow-off which is the subject matter of this invention, it is essential that I employ certain mechanisms, all of which are old in their generic construction but which, when combined, form the means by which this method is performed. In the following drawings and description thereof, I have shown one form of mechanism which I regard as adapted for the purpose of carrying out this method, but it will be obvious to those skilled in the art that other forms of apparatus could be employed for this purpose.

Figure 1 is a diagrammatic elevation of the preferred form of boiler installation employed in the carrying out of the method of this invention.

Figure 2 is a diagrammatic plan view of the showing of Figure 1.

Figure 3 is a diagrammatic side elevation of a slightly modified form of construction.

Figure 4 is a diagrammatic front elevation of the construction shown in Figure 3.

Figure 5 is a diagrammatic showing of particular tank construction by means of which certain features of the invention may be practiced.

Figure 6 is a showing similar to that of Figure 5, but showing additional operating parts for the accomplishment of further features of the invention.

Figure 7 is a front elevation of the construction shown in Figure 6.

Figure 8 shows diagrammatically a modified form of boiler blow-off system by which the method of this invention may be practiced.

Figure 9 is an elevation the same as Fig-

ure 1 with a different arrangement of supply and exhaust conduits and valves for tank D.

Referring first to the system diagrammatically illustrated in Figures 1 and 2, A and B designate two boilers of a battery of any number. In the form of apparatus shown in these figures, I associate a balance tank D with each two boilers of the battery, though, manifestly, one tank might be associated with each boiler or with three or more boilers of the battery. The base of the water space of the boiler A is connected to the balance tank D by a pipe *a* and the base of the boiler B is similarly connected to the tank by a pipe *b*. The usual blow-off valves A′ and B′ are included in the pipes *a* and *b*, respectively. A discharge pipe *c* leads from the tank to the sewer and includes a drain valve C of any suitable type.

The tank D is connected by a pipe *e* to the steam space F′ above the water level of the boiler, either directly or through the main steam header valve F and the pipe *e* includes a valve E, the function of which is to control the passage of steam from the steam space F′ of the boiler to the balance tank and vice versa. The pipe *e* may also include an additional valve *k* adjacent the point of connection to the main steam header, as it is customary in all boiler installations to valve all pipes adjacent the boiler, but in the carrying out of the present invention, the valve K really performs no function.

The balance tank D is adapted to be vented when desired through a pipe *g* including the valve G, which may be regulated to permit the relief of pressure through the pipe *g* to the atmosphere or the venting of the tank D. In practice, the water level of the boiler is about that indicated at *x* in Figure 1 and the "head of water" with respect to the pipes *a* and *b* is designated by the reference X of Figure 1.

The balance tank D may be provided with a suitable pressure gage *d* and an appropriate gage glass J by means of which latter gage glass the water level in the balance tank may be observed. Said tank is furthermore preferably provided with a supplemental valved outlet M adjacent the bottom of the tank, the function of which will be hereinafter more fully explained.

In practicing the method of the present invention in an apparatus of the class described, all of the valves of the system excepting the valves F and K will be closed during the normal operation of the boiler. When it becomes desirable to blow-off any of the boilers, they are blown off one at a time in the manner next described.

The valve E is first opened, thereby allowing steam at boiler pressure to pass through the pipe *e* and enter the balance tank D, the interior of which, at this time, contains air at atmospheric pressure, with all other valves leading thereto closed. This steam warms up the tank D and gradually causes the pressure interiorly of the tank to become the same as the boiler pressure of the boiler to be blown off. The valves A′ and B′ will now have substantially the same pressure on their outer side as on their inner side and are consequently in approximate balance.

If it is assumed that the boiler A is to be blown off, the valve A′ is now opened and the water flows out of the boiler A through the valve A′ and through the pipe *a* into the balance tank D and this flow of water is occasioned purely by the hydrostatic pressure of the head *x* and is in no wise influenced by the working pressure of the boiler because of the fact that the same working pressure has been previously established in the balance tank.

This relatively slow flow of the water from the boiler into the balance tank carries with it the sediment, boiler scale, mud and other impurities contained within the boiler, so that these impurities are gradually washed from the boiler into the balance tank. The engineer in charge of the operation watches the gage glass J, until, in his opinion, or through experience, the desired water level has been reached, which, in the present instance, may be designated by an arrow or other mark as *j* (see Figure 9) on the pressure tank, whereupon the valve A′ is shut off and immediately thereafter the valve E, which has remained opened to allow the displaced steam to return to the boiler, is closed.

During both the operations of opening and closing the valve A′, this valve is practically in balance and the usual objectionable stresses to which such valves are subjected are removed from the operating parts thereof. If it should be desired for any reason whatsoever to cause the water to flow more rapidly through the blow-off valve A′ than would be due merely to the hydrostatic pressure of the head *x*, this velocity of efflux can be increased by closing the valve E while the water is flowing from the boiler and then slightly opening the valve G, so as to vent the tank. This will throw the interior of the tank out of balance by decreasing the pressure therein so that the pressure within the boiler will serve to speed up the flow of water therefrom.

In the manner described, the efflux of water through the blow-off valve A′ can be regulated as desired by either keeping the valve G closed and the valve E open to obtain the velocity due only to the hydrostatic pressure of the head, or by closing the valve E and opening the valve G to greater or lesser extent to govern the speed of

flow of the water. If the valve G has been opened to accelerate the flow to tank D that tank is normally brought back to boiler pressure by closing the valve G and opening the valve E before closing the blow-off valve A′. While a manually operated valve G is shown as controlling the conduit *g*, it will be obvious that such conduit may be controlled by an automatic valve, such as a float or ball operated to conform to water level in the tank, similar to the automatic valves described as associated with the conduit *e*. Moreover, the velocity of the water through the valve A′ can actually be regulated so as to be less than that normally caused by the head, by leaving the valve G closed and only partially opening the valve E. so as to throttle the outgoing steam in the tank D and thus cause back pressure in the tank D above the water, which pressure will become greater than the steam pressure in the boiler, thus retarding the flow through the valve A′.

After the valves E and A′ are sealed, the valve G is opened to vent the tank D and thereafter the valve C in discharge pipe *c* is opened to permit the contents of the balance tank to be discharged to the sewer.

It will be noted that if the drain valve C is not opened until the tank has been vented, the discharge will flow to the sewer quietly and at atmospheric pressure. If it is desired to discharge the water more rapidly through the drain pipe C, the valve G may be left closed and the rapidity of efflux of water through the drain pipe C can then be governed by opening the valve E more or less as desired; or the valve E may be closed and the pressure in the tank only partially vented by opening the valve G for a short time.

It will of course be understood that the boiler B may be blown off in exactly the same manner as that described with reference to the boiler A by manipulating the valve B′ instead of the valve A′, and regulating the valve E of the pipe *e* which leads to the boiler B instead of the corresponding valve in the pipe which leads to the boiler A.

After blowing off the boiler, the construction described is such as to permit the engineer in charge to ascertain whether sufficient water has been blown off to sufficiently cleanse the boiler. It is for this purpose that the valved outlet M is provided. After the blown off water has been entirely discharged from the balance tank D through the drain valve C, a test may be made as to the condition of the water remaining in the boiler (as it is and as it will be affected by further opening of the blow off valve) by closing the drain valve C and again opening the valve E to place the interior of the tank D once more in balance with the boiler to be tested. After the tank D is properly balanced, the blow-off valve A′ or B′, as the case may be, is opened and water is allowed to flow into the balance tank as before. After a sufficient amount of water for inspection purposes has flowed into the balance tank, the main blow-off valve and the valve E are closed. The valve G is then opened to vent the tank and thereafter the valved draw-off M is opened and the water which is contained within the balance tank is drawn off into any convenient receptacle, after which the valved outlet M and the valve G are again sealed.

The water thus drawn off can be thoroughly examined by the engineer in charge for the purpose of determining, by its condition, whether the amount of water which is being blown off from the boiler is too little or too much. By thus testing the condition of water blown off, the engineer in charge can arrive definitely and intelligently at the amount of water that should be blown off at each blow-off operation and can, without further inspection and tests determine how much water should be blown off per operation for weeks to come provided, of course, that the analysis of the feed water going into the boiler remains the same, and that the amount of water fed into the boiler per day remains the same—as is frequently the case.

In the construction of Figures 1 and 2, one balance tank is utilized to serve a plurality of boilers, but if desired, a balance tank may be associated with each individual boiler of a battery. Such an arrangement, I have shown in Figures 3 and 4 of the drawings. The operation of the system of Figures 3 and 4 is identical with that of Figures 1 and 2, except that each boiler has its own balance tank. In this arrangement, as well as in the arrangement of Figures 1 and 2, the drain pipe *c* of the several balance tanks may lead to a common header *c′* passing to the sewer.

An important feature with particular reference to this construction is that no appreciable back pressure is exerted upon the blow off system of any other boiler when one boiler of a battery is blown off, and, common both to this system and the one previously described, is the feature that when one boiler is blown off through a drain pipe common to all the other boilers of the battery, no appreciable back pressure is exerted in the drain pipe upon the blow-off valves of the other boilers. This condition is very desirable, and, in practice, it is particularly desirable that no steam pressure be brought to bear upon the blow-off valve of one boiler due to the blowing off of an-

other boiler, for the reason that the first boiler might be shut down for repairs and the steam pressure thus brought to bear on the blow-off valve would then be apt to leak through the valve and scald or injure workmen in the interior of the first boiler. When practicing the method described, the balance tank D is preferably vented, so that the water flowing through the drain to the sewer is under atmospheric pressure and accordingly serious back pressure cannot result.

It will be apparent from the foregoing description that the main blow-off valve of a boiler may, when the present invention is practiced, be opened and closed under properly balanced conditions in such manner as to minimize the detrimental effects of wire drawing to which such valves have been subjected in prior practice. I have, however, hereinbefore referred to shocks which are occasioned by the sudden closing of the blow-off valve when it is desired to conclude the blowing off operation. These shocks may be greatly minimized and practically precluded by closing the valve E, so as to preclude the escape of steam, while the blowing off operation is in progress and before the tank D has become filled with the blown off products. When this closing of the valve takes place, the further escape of steam from the tank into the boiler is precluded and the steam which remains in the tank is slowly compressed as the blow-off operation continues until the pressure of said residual steam substantially balances the steam pressure within the boiler plus the hydrostatic pressure of the head, whereupon water flowing through the blow-off valve will slowly come to a stop. The blow-off valve may then be closed without being subjected to the force of the blow of a moving column of water as heretofore, and without being subjected to any "wire drawing" effects.

The exhaust of steam from the tank may be controlled automatically. In the showing of Figure 5, the pipe *e* is shown as extended through the top of the balance tank D, and for an appreciable distance downwardly into the interior of the tank and on the lower end of this pipe a cage *e'* is supported, in which cage is positioned a ball valve E' in the form of a float. In this construction, it will appear that as the water level rises in the pressure tank, it will lift the ball valve E' and cause the same to seal the lower end of the pipe *e*. The flow of further water into the tank will manifestly compress the trapped steam therein until the pressure of this trapped steam becomes the same as the steam pressure in the boiler plus the hydrostatic pressure of the head, and meanwhile the flow of water through the blow-off valve will be cushioned and come to a stop, after which the blow-off valve may be closed without effecting any shock whatsoever.

The method of this invention further contemplates the coordination of cooperating mechanisms in such manner that if desired the blow-off valves may be positively locked against closing until such time as they may be closed without producing shocks.

In Figures 6 and 7, apparatus is shown for accomplishing this result. In these figures, the operating post of the main blow-off valve A' is provided with a locking cam *a'* fixed to the operating post. The cam is provided with a shoulder with which a shoulder dog L is adapted to engage. The dog L which is pivoted at one end at *l* is secured at its opposite end to the lower end of a link N, the upper end of which has slotted engagement with an arm O fixed on a rock shaft *o* which passes into the tank D and is provided with a suitable stuffing box to preclude leakage of pressure, and a suitable stop *o'* to limit its downward movement. The rock shaft *o* carries on the interior of the tank an arm *p* to the outer end of which is fixed a float P. In this construction, the tank is also provided with the ball valve E', shown in Figure 5. As the water flows from the boiler into the balance tank D, it simultaneously raises the ball valve E', and the float P, and the link N is of such length that the float will not influence the dog L until the valve E' has become seated. As the water level in the balance tank continues to rise and places the trapped steam under a pressure equal to the steam pressure in the boiler plus the hydrostatic pressure of the head, the length of the link is so proportioned that at this time the link will be elevated and lift the dog L free from the shoulder on the cam. Up to this time, the operating stem of the valve has been locked, so that the valve could not be closed, but as soon as the dog is raised, the valve may be easily moved to a closed position.

The mechanism described is simple in construction and efficient in its operation, since, when once properly regulated, it will positively operate to lock the valve against closing until such time as the pressures are balanced and the flow of water through the valve A' ceases. When this mechanism is employed, shocks which have been heretofore common are rendered impossible.

There is another feature connected with the operation of the blow-off valve which is complementary to this arrangement, and that is that the valves being balanced, and consequently easy to operate, at the time when they should be operated, can be equipped with operating means such that at all other times than the time they should be open, they cannot be opened by the ordinary

operating means. It is thus impossible for a careless or stupid operator to make a mistake as to which blow-off valve, or which valve, he should open to blow off a given boiler which he has prepared to blow-off under this system. Referring to Figure 3 let us designate by Z the lever by which the blow-off valve A′ is operated.

Under ordinary blow-off conditions the lever Z must be made long enough so that a man of ordinary strength can, by means of it, open the valve A′ when the boiler is under full steam pressure and the valve—unbalanced—is under the same pressure. Therefore, at any time, a man of ordinary strength can open the blow-off valves of any boiler, in cases where the ordinary operating means is left attached to the valves between the periods of blow-off.

Using the system described in this specification with the specific addition now described, it is not possible for anyone by using the ordinary operating means, to open any blow-off valve of a boiler under pressure unless and until he has prepared that boiler for blow-off by putting the balancing means into operation. As the valves open practically without resistance when they should be opened, the operating lever Z (or an equivalent hand wheel in the screw operated type of valve) can be made so small that only when the valve is in balance can it be opened by a man of normal strength using the attached and regular operating means; and furthermore it is practicable to deliberately insert a breaking point into the operating mechanism so that if anyone attempts, by the use of long levers fastened on to the regular operating means, to open the valve when it is not in balanced condition, the operating means will part from the valve or break off, leaving the valve in perfectly unharmed condition as a valve, but now operable only by calling on the engineer in charge who has the necessary supplementary apparatus of special character by which the valves can be operated.

In the apparatus hereinbefore described, a balance tank is provided for the efficient carrying out of the method of this invention, but I have found that many advantages may be obtained without necessarily employing the balance tank and by using apparatus of the general character shown in Figure 8 of the drawings. In this construction, the balance tank may be omitted between the valves A′ and C and these valves connected by a length of pipe c^2 with which the steam pipe e connects. In this construction, the valve C may be of any desired type and may be in leaky condition without affecting the proper operation of the apparatus, provided, however, that the pipe e is of sufficient size to furnish steam to the pipe c^2 in excess of the steam which can leak through the valve C.

In carrying out the present invention with the form of apparatus shown in Figure 8, the valve E is first opened, so as to allow steam at boiler pressure to enter the pipe c^2. When the pressure in the pipe c^2 has attained approximately the working boiler pressure (and this condition may be ascertained by a steam gauge on the pipe c^2, or otherwise), the valve A′ may be unsealed since at this time it will be in substantially balanced condition. As soon as the blow off valve A′ is opened, the valve E is closed and the valve C may be opened so as to blow-off the boiler directly through the drain pipe. When, in the opinion of the engineer, sufficient water has been blown off to properly cleanse the boiler, the valve C is closed and the valve E again opened and left opened, whereupon the opposed fluid pressures of water and steam assume an approximate balance and the valve A′ may then be closed or closed later when the fluids are at rest. The valve E can be subsequently closed.

The method when practiced with the construction of Figure 8 will prolong the life of the valve A′ by minimizing erosion due to wire drawing and will also minimize the probability of breakdown of the operating mechanisms of the valve A′ by relieving them of stress since said valve is in substantially balanced condition during the opening and closing thereof. It will be apparent, however, that while this construction is a marked advance over prior practice, it is not capable of performing the important functions of the balance tank D, which, in accordance with this invention, preferably forms a part of the blow-off mechanism.

In Figure 9 is illustrated another system of conduits and valves for controlling the pressures in the tank D. By this arrangement the interposed valve A′ is balanced by reason of both hydrostatic and steam pressure. In this construction the pipe e forms a connection between the steam dome of the boiler and top of the tank D and the valve E is interposed therein above the water level in the boiler X. A pipe g is then connected with the pipe e below the valve E and between that valve and the plane of the water level in the boiler X, a valve G is interposed in said pipe g.

The method is operated under this construction as follows: The valve G being closed and the valve E open, the valve A′ is placed in substantial balance as heretofore described. When the valve A′ is opened the water from the boiler is blown off against the steam pressure and the water rises in the tank D and pipe e until it finds its level in a plane corresponding with the water

level in the boiler X at which time it ceases to flow and the valve A′ is in practically complete balance as the steam pressure plus the hydrostatic pressure are equal on either side of the valve and under these conditions said valve may be opened or closed with the minimum of resistance. When under such conditions the valve A′ is closed, the valve E can be closed and the valve G opened to the atmosphere so that the tank D may be drained.

From what has been said with reference to Figure 8, as well as to certain other figures of the drawing, it will be manifest that the method of this invention embodies different series of operations certain of which may be practiced without necessarily practicing them all in sequence. Accordingly, the invention is to be understood as not limited to all of the steps enumerated, but is be construed as broadly novel as is commensurate with the appended claims.

The foregoing is a preferred arrangement of apparatus adapted for the performance of the various steps or stages of the method or system of boiler blow-off above described. As previously stated, the same may be varied to accomplish the same result. One of the notable variations which in fact reduces the operation down to its elemental principle will be obvious when consideration is given to an arrangement wherein all those means previously described for introducing into the tank D gas or steam under pressure are eliminated, and the tank D is considered as a container filled with air under atmospheric pressure. In such case, assuming that the valves E, G, C and M are closed, and that the tank D is full of air at atmospheric pressure, the opening of the valve A′ will permit the efflux of water from the boiler into said tank D, and such efflux will be cushioned by the air within said tank until said air reaches a stage at which it balances the steam and hydrostatic pressures in the boiler. The valve A′ can then be closed, the same being in a state of balance. As no efflux is taking place no shock will result from such closure. The valve G can then be opened to vent the tank D and a portion of the contents or the whole contents can be withdrawn from the tank D for the purpose of inspection and test, and any balance withdrawn through the pipe e under its own hydrostatic pressure. The operation can be repeated from time to time until the drawn off water is found to be of proper consistency. This I regard as an elemental feature of my invention. When I introduce steam or other gaseous pressure into the blow-off tank D through the medium of the valve E, I bring into play another element incident to my method by means of which, as heretofore stated, I throw the valve A′ immediately into an approximate state of balance between the steam pressure and the hydrostatic pressure plus the steam pressure, so that said valve A′ can be opened or closed in approximate balance, and furthermore, through the medium of said valve E, I can according to the operation above described control the rapidity of the efflux of the water from the boiler to the blow-off tank, and through the medium of the automatic valve devices heretofore described I can automatically control the valves employed by utilizing the water level in the tank for such purpose, that is to say through the medium of a float I can lock the valve so as to prevent its closure during a predetermined period, and through the ball valve I can cut off the exhaust from the tank D. As illustrated in Figure 8 I may vary the apparatus and accomplish partial results by eliminating the tank D and confining the operations to the pipes C^2 and e as stated.

As previously stated, one of the objects of my invention is to provide a method by which the powerful elements with which it is necessary to deal can be brought into absolute control to accomplish the end desired. The primary object in blowing off a boiler is to eliminate the sludge or scale and dense water which accumulates at the base of the boiler. To accomplish this result it is important that the efflux from the boiler should be absolutely under control, so that it may be caused to move slowly, to the end that it will carry with it the body of heavy sludge or scale or mud lying at the base of the boiler, as opposed to an unrestrained rapid efflux through the exhaust with the result previously stated that the water, instead of carrying off the mud or other sediment, will form apertures through the same and find its way to the exhaust without the accompaniment of the heavier elements referred to. The word "slowly" used above with reference to the rate of speed at which the efflux shall be permitted is of course a relative term, and it is therefore intended that through the medium of the operation of the valves E and G the rate of this efflux should be entirely under the control of the operator, in order to produce the best results. Under some conditions it is conceivable that it may be desirable to limit the efflux to one rate of speed, while under other conditions, it might be desirable to increase or diminish that rate. It will be obvious that by experiment under each set of conditions, it will be found possible to regulate and determine what degree of velocity is most efficient in scavenging the boiler.

The statement has been made that one of the objects of the invention is to relieve the interposed blow-off valve of undue pressures, so as to avoid injury to the valve operating mechanisms moving the sealing member to the open or closed position under

the great stresses due to the boiler pressure. I accomplish this result in the operation of my invention by the approximate balance which I establish between the steam and hydrostatic pressure on one side of the valve and the steam pressure on the other, thus leaving the valve in approximate balance and by so doing, making it possible to operate the valve to open and close the same under conditions of the minimum of resistance. By the establishment of the foregoing conditions of balance particularly when combined with cessation of flow before the valve is closed, it will be apparent that I also minimize the element of shock which, under other conditions, is brought about when the valve is closed because of the fact that the effluent column of water operates as a hydraulic ram.

That these are all beneficial results will be obvious, but I desire to point out specifically the method that I recommend for the ascertainment at any time of the state of the fluid in association with the heavier materials which accumulate at the base of the boiler and particularly as to whether enough—too much—or too little has been blown off. To attain this result I proceed in the manner heretofore indicated and draw off a portion of water from the boiler—this may be more or less. Preferably in the first instance I may fill the blow-off tank D and, having exhausted the same, I repeat the operation, but instead of drawing the full capacity of the tank I may draw only a few gallons of water from the boiler. This water coming, as stated, at a predetermined rate of speed from the boiler will be a practically accurate sample of the effluent when blowing off, and a repetition of this process successively will demonstrate how much water should be blown off to bring the boiler contents to the desired condition, that is to say, an observation or test of the water will show that the density of the water and the amount of sludge or residue is becoming less and less, until the observer is satisfied that the water in the boiler is sufficiently free of foreign matter and too dense water to satisfy the requirements of the case, as far as they can be economically satisfied by blowing off. Further:—by sampling the effluent at various speeds of discharge from the boiler the speed which gives the maximum discharge of sludge, scale, etc. from the boiler can be ascertained and used.

From the foregoing it will be understood that the operator is in a position at any time to observe the general condition of the fluids, etc. lying in the base of the boiler adjacent the blow-off valve, and to accurately determine what will be the result of drawing off more or less water at each blow-off operation and thus can for the first time in boiler history, accurately control the blow-off so as to get the best results with the minimum loss of hot water (now hot water is equivalent to coal, and coal is equivalent to money).

The operator is able to obtain these results because he is able to find out at what speed of efflux maximum scavenging takes place with minimum expenditure of hot water, and is also able to scientifically determine the amount of water which should be drawn off through the blow-off valve in any given period, and, having ascertained the best conditions he is able—by this invention—to obtain them.

Under present methods it is impossible to ascertain the facts, and even if the facts were ascertained it is practically impossible to obtain the necessary control without subjecting the blow-off valves to such severe conditions that their life as operating valves would be exceedingly short.

The foregoing observations lead to a consideration of the advantages of this method from the standpoint of economy of boiler operation. As previously stated, under the present system of boiler blow-off practice it is impossible for the operator to ascertain with any degree of certainty the amount of water which should be withdrawn from the boiler during the operation of blowing off, and too little blown off might have most detrimental results. He therefore makes sure that he blows off plenty, the result being that a large amount of heated water is frequently unnecessarily withdrawn; in so far as such excess is unnecessary it is an extravagant waste of heat units; that is to say, losses of heat (which are equivalent to losses of coal, which are equivalent to losses of money) due to the blow-off valve being open too long and these losses will be much greater under conditions of 350 pound pressure than under conditions of 200 pound pressure or less. Loss of water is much more serious than the loss of the same volume of steam because every cubic foot of water is the equivalent of approximately twenty cubic feet of steam, so that, as stated, the loss of a given volume of hot water from a boiler is always more serious than the loss of a similar volume of steam, as will be apparent from the following comparison of the loss due to blowing off one gallon (roughly 8 cubic feet) of water at 434° Fahrenheit, being equivalent to a working pressure of 350# per square inch, with the loss due to the escape of 8 cubic feet of steam at 434° Fahrenheit being the temperature equivalent to a working pressure of 350# per square inch.

8 cubic feet of water weighs roughly 8 multiplied by 63 or 504#.

The temperature of the water when it entered the boiler was probably 200° Fahrenheit. Consequently in the boiler the

water has been raised from 200° Fahrenheit to 434° Fahrenheit, or 234° Fahrenheit.

To raise 504# of water 234° Fahrenheit requires 234 multiplied by 504 B. t. u.'s or 117,936 B. t. u.'s.

8 cubic feet of steam at 350# (one cubic foot weighing .79# say .8) weighs 6.4#.

The latent heat (heat required to transform one pound of water at 434° Fahrenheit into steam at 434° Fahrenheit) of steam at 350# pressure is a trifle under 800 B. t. u.'s. Let us call it 800 B. t. u.'s.

The latent heat therefore of 8 cubic feet of steam is 6.4 multiplied by 800 or 5120 B. t. u.'s.

We assumed, however, before, that the water entering the boiler was at 200° Fahrenheit and that 6.4# of water had to be raised from 200° Fahrenheit to 434° Fahrenheit before the conversion into steam started.

234° multiplied by 6.4# equals 1497.6 B. t. u.'s. Call it 1498 B. t. u.'s.

Heat lost in 8 cubic feet of water from the boiler is shown to be 117,936 B. t. u.'s, heat lost from 8 cubic feet of steam escaping from the boiler has just been shown to be 1498 plus 5120 or 6618 B. t. u.'s.

The foregoing will demonstrate the importance of conserving the volume of water blown out of the boiler for the purpose of scavenging the same. One of the objects of the method and system which forms the subject matter of this invention is to conserve the volume of water permitted to escape so as to limit the same to the minimum amount of water necessary for the accomplishment of the result. For this purpose I provide a blow off tank as D, which may in fact form the unit of measure of the amount of water that I elect to draw from the tank at one time, and I may repeat this operation as often as it may be found necessary, or as previously stated, I may limit the flow of water to the tank D so as to withdraw from the boiler only a few gallons of water sufficient for the purpose of observation and test, so that in the operation of the method the operator is in complete control of the volume of water permitted to escape from the boiler and the velocity of its escape so that he is also in control of the effluent water so as to bring the same under conditions where it will be the most efficient agent in conveying the sediment from boiler into the blow-off tank.

Aside from the economic and mechanical advantages secured by the method, or methods, or procedure described, attention is called to the fact that the various operations can be carried out with relatively little danger to the operator, whereas the present methods of operation are extremely dangerous and quite frequently result in serious accidents and loss of life. It is manifest, therefore, that the present invention embodies a distinct advance from the standpoint of conserving the safety and life of steam boiler operators and associated workers.

It will be understood that the invention described will be capable of modification by those skilled in the art, such as by the substitution of equivalent steps or operations, without departing from the spirit or substance of the invention, the scope of which is commensurate with the appended claims. Moreover, the apparatus and mechanism herein described constitutes a part of the present broad invention.

Having thus fully described the invention, what I claim as new and desire to secure by Letters Patent is:

1. The method or system of boiler blow-off which consists in releasing the water under pressure against a gaseous cushion confined within a suitable container, then cutting off such supply of water, and venting the container of gaseous fluid, then drawing off the fluid from the container for purposes of observation, test and discharge.

2. The method or system of boiler blow-off practice which consists in providing a sealed tank, and means for creating and regulating gaseous pressure within said tank, and a conduit interposed between the tank and the base of the boiler to permit the efflux of water from the boiler to the tank, with a valve interposed in said conduit, then admitting gaseous pressure into the tank and conduit to approximately balance the boiler pressure on the opposite side of the valve and to control the flow of the water which is adapted to flow from the boiler to the tank after said valve is opened, then opening said valve to permit the flow of water from the boiler to the tank, then closing said valve, while in approximate balance, and diminishing the gaseous pressure within the tank, and drawing off the contents of the tank for purposes of observation and discharge.

3. The method or system of boiler blow-off which consists in providing an auxiliary receptacle or chamber connected to the boiler blow-off pipe, which connection is controlled by a suitable valve, then connecting said auxiliary chamber to a source of gas under pressure sufficient to approximately counterbalance the pressure of the water adapted to pass to the chamber through the boiler blow-off connection, and, from the source of gas, filling said auxiliary chamber with said gas under pressure, then opening the valve to permit the flow of water from the boiler to the auxiliary chamber, controlling the rate of such flow of water by controlling the escape of gaseous pressure from the auxiliary chamber, then closing the valve to shut off the flow of water from the boiler, then shut-

ting off the course of gaseous pressure, and then venting the auxiliary chamber of such gaseous pressure, and drawing off the contents of the auxiliary chamber for purposes of observation and discharge.

4. The method or system of boiler blow-off which consists in releasing the liquid under pressure against a steam cushion taken from the dome of the boiler and contained within a suitable container, then cutting off the supply of liquid flowing from the boiler as well as the steam pressure from the boiler, and venting the container of the steam contained therein, then drawing off the liquid from the container for purposes of observation, test and discharge.

5. The method or system of boiler blow-off which consists in providing an auxiliary receptacle or chamber connected to the boiler blow-off pipe, which connection is controlled by a suitable valve, then connecting said auxiliary chamber to the steam dome of the boiler, and, through the last mentioned connection, transmitting steam pressure to said auxiliary chamber, then opening said valve and permitting the efflux of water from the boiler to the chamber, such flow being controlled by permitting the steam to return at a desired rate to said dome from said chamber through the connection between the same, then closing the valve controlling the flow of water while said valve is in a state of balance and shutting off the source of steam supply, and then venting the tank of such steam pressure to the atmosphere and drawing off the contents of the tank for purpose of observation and discharge.

6. The method or system of boiler blow-off which consists in releasing the liquid from the blow-off pipe against a gaseous cushion contained within a suitable container, such cushion being formed by steam taken from the boiler and controlled as regards the extent of its pressure to approximately balance an interposed valve and to control the speed of the flow of the liquid from the boiler, then controlling the liquid flow until the liquid comes to a state of quiescence, then closing the valve, then drawing off the liquid from the container for purposes of observation, test and discharge.

7. The method or system of boiler blow-off which consists in communicating gaseous pressure through a suitable container to a boiler blow-off valve so as to place said valve in a state of approximate balance, then opening said valve, while in balance, to permit liquid to flow from said boiler into said container and at the same time cushioning the flow of liquid against said gaseous pressure to control the rate of the flow thereof, then increasing said gaseous pressure to arrest said flow until the column of liquid is brought to a state of approximate quiescence, then closing said valve while in balance, then releasing said gaseous pressure so that the liquid may be withdrawn from the container under normal gravity flow.

8. The herein described method of blowing off a boiler through a valved outlet into a substantially closed chamber, which consists in sending gas under pressure into said chamber and said outlet before the blow-off valve is opened, so as to place the valve in substantial balance before opening the same, thereupon opening the valve to permit water to flow from the boiler into the chamber, and thereafter permitting a portion of said gas under pressure to flow out of the chamber until substantially the amount of water which it is desired to draw off from the boiler has entered the chamber, then sealing the chamber to preclude the exit of further gas, so that the flow of further water into the chamber compresses the trapped gas and produces sufficient back pressure to stop the flow of water from the boiler into the chamber, then closing the blow-off valve, and then permitting the water in the chamber to flow out of the same.

9. The herein described method of blowing off a boiler through a valved outlet into a substantially closed chamber, which consists in sending gas under pressure into said chamber and said outlet before the blow-off valve is opened, so as to place the valve in substantial balance before operating the same, thereupon opening the valve to permit water to flow from the boiler into the chamber, and thereafter permitting said gas under pressure to flow out of the chamber until substantially the amount of water which it is desired to draw off from the boiler has entered the chamber, then sealing the chamber to preclude the exit of further gas, so that the flow of further water into the chamber compresses the trapped gas and produces sufficient back pressure to stop the flow of water from the boiler into the chamber, then closing the blow-off valve, then venting the chamber, and then permitting the water in the chamber to flow out of the same under substantially atmospheric pressure.

10. The method or system of boiler blow-off which consists in communicating steam pressure, led from the boiler and through a container, to a blow-off valve positioned in a connection between the boiler and the container so as to place said valve in a state of approximate balance, then opening said valve while in balance to permit the flow of liquid from the boiler to the container through said connection, and cushioning said flow of liquid against said steam pressure to control the rate of the flow thereof, then causing an increase of said steam pressure to arrest said flow and to bring the liquid to a state of substantial quiescence, then closing said valve while in balance,

then releasing said steam pressure on said withdrawn liquid and permitting the liquid to flow from the container by gravity.

11. The herein-described method, which consists in blowing off a boiler into a substantially closed chamber and controlling the velocity of the flow of water from the boiler into said chamber by regulating the gaseous pressure within the chamber, then cutting off the flow of water from the boiler to the chamber, and regulating the velocity of the exhaust of water from said chamber by controlling the gaseous pressure within said chamber.

12. The method herein described which consists in blowing off a boiler into a closed chamber, said chamber being filled with supply of gas under pressure, and the degree of such gaseous pressure being under control, and regulating such gaseous pressure within the chamber to control the velocity of the flow of water from the boiler into the chamber, then cutting off the supply of water to the chamber and regulating the velocity of the exhaust of water from said chamber by controlling the gaseous pressure within said chamber.

Signed by me at New York, N. Y., this 17th day of October, 1921.

WYLIE G. WILSON.

Witnesses:
DOROTHY FRANK (SCHEIBER),
SADIE H. OLIKER.