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GAS WASHER OVERFLOW APPARATUS

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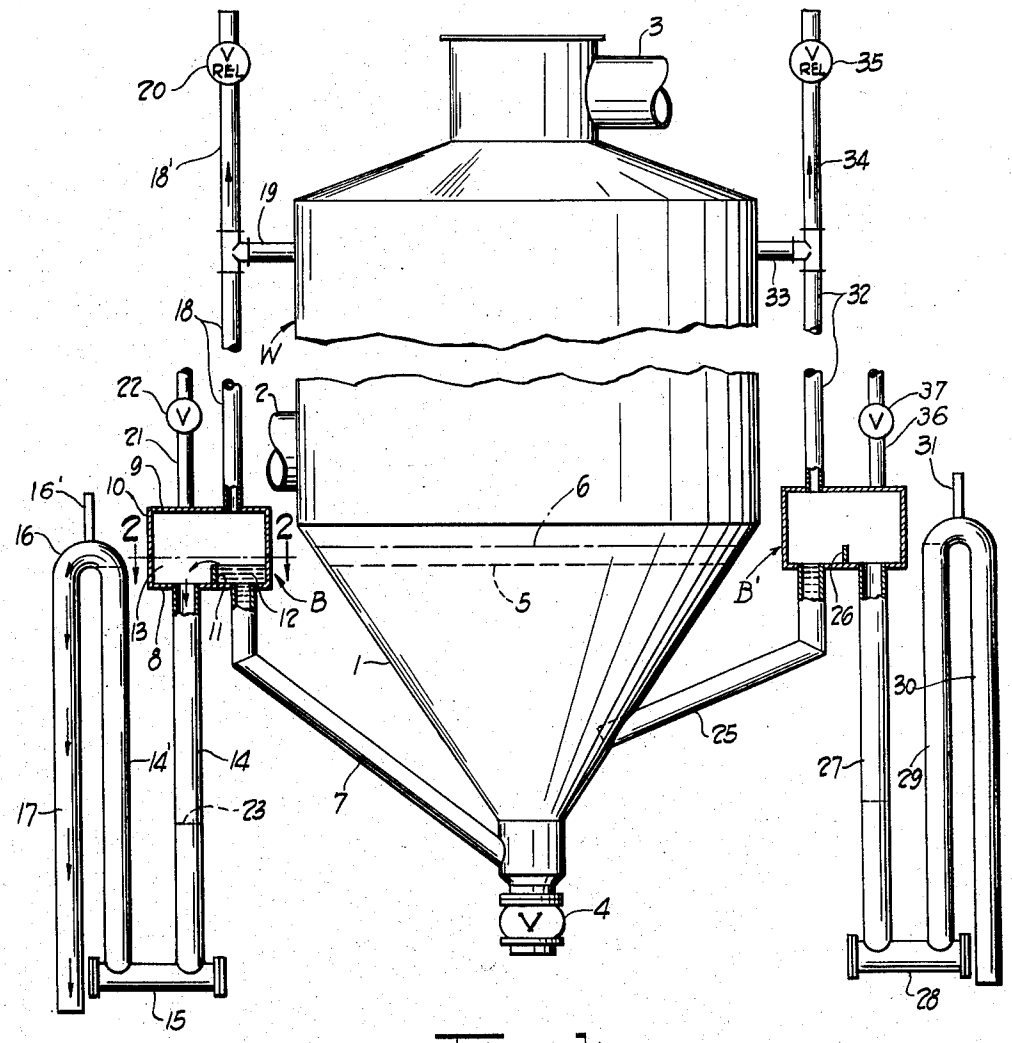

FIG. 1

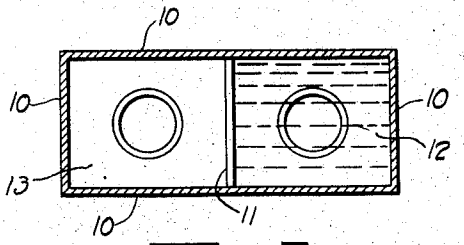

FIG. 2

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GAS WASHER OVERFLOW APPARATUS

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3 Claims. (Cl. 137—177)

This invention relates to liquid level control apparatus and more particularly to an improved overflow and level control means for closed vessels having a sump or the like in the lower portion thereof and operating with a higher than atmospheric gas pressure in the vessel above the liquid level.

My invention is particularly adapted for blast furnace gas washers of the type which comprise a large, generally cylindrical closed tank or vessel having a hopper type bottom portion or sump and are provided with a gas inlet a short distance above the sump portion and a gas outlet from the upper part of the vessel. In the operation of this type of gas washer, blast furnace gas containing entrained solids enters the vessel through the inlet and passes upwardly through a water spray or other liquid contact means which is supplied by suitable piping from a source of water under pressure. The water removes a large portion of the entrained solids and the cleaned gas passes out of the upper gas outlet. Water and entrained material collects in the bottom of the hopper or sump portion of the washer where some of the solids settle out and are removed from time to time.

Prior to the advent of so-called high top pressure blast furnace operation the above described type of gas washer was provided with a water level and overflow control which consisted merely of an overflow pipe extending from the bottom portion of the hopper upwardly to the proper elevation to establish the desired water level in the washer bottom. The outlet of this pipe was under atmospheric pressure and it conveyed the overflow water to a suitable place of disposal. This arrangement was merely a simple water seal and, although the water level inside the washer necessarily varied with variation in gas pressure conditions within the washer, it was satisfactory for the low pressures involved. However, this type of overflow is not suitable for use with high top pressure blast furnace operation and various arrangements of float controlled valves, etc. have been proposed for maintaining the desired water level in a gas washer under so-called high top pressure conditions.

It is an object of the present invention to provide an overflow control and liquid discharge means for closed vessels, such as blast furnace gas washers, which requires no moving parts or mechanical or electrical controls. Further objects of my invention include the provision of a blast furnace gas washer liquid level and overflow control apparatus which may be made up of relatively simple piping and structural elements, which requires substantially no upkeep, which will effectively maintain the same water level in a gas washer during either normal low pressure or high top pressure operating conditions, which will effectively prevent substantial variations in water level due to variation in gas pressure conditions within the washer, which will provide an efficient seal against undesired discharge of gas up to the maximum pressures encountered during high top pressure blast furnace operation, which includes means for relieving extraordinarily high gas pressures which might occur momentarily during a furnace slip or the like, and which also provides an emergency overflow control which will automatically become effective in the event the normal overflow control apparatus should become clogged or otherwise ineffective.

The above and other objects of my invention will appear from the following description of one embodiment thereof, reference being had to the accompanying drawings in which:

Figure 1 is a somewhat diagrammatic elevational view, partly in section, of a blast furnace gas washer incorporating my improved water level and overflow apparatus, and

Figure 2 is an enlarged cross sectional view of one of the weir boxes taken substantially on line 2—2 of Figure 1.

The gas washer illustrated in Figure 1 consists of a closed, generally cylindrical tank or vessel W having a conical hopper portion 1, a gas inlet pipe 2 above the hopper portion 1, and a cleaned gas outlet pipe 3 at the top of the washer unit. In Figure 1 the washer is shown broken apart at its central portion in order to condense the drawing but it will be understood that the height of the entire unit will be such as is necessary to provide the desired capacity, etc. It will also be understood that the washer will be provided with a suitable cleaning water line connected to spray nozzles or other gas and water contact means disposed in the upper portion of the vessel W so that entrained particles will be removed from the gas as it moves upwardly through the vessel W. Such liquid gas contact means are well known in the art and accordingly are not illustrated in the drawing.

The cleaning water moves downwardly counter-current to the upwardly moving gas and collects in the conical hopper portion 1 of the vessel W. A discharge valve 4 at the bottom of the hopper portion 1 provides means for intermittently discharging settled solids from the bottom of the hopper in the usual manner.

The normal water level which it is desired to maintain in the bottom of the washer is indicated by the dotted line 5 while the dot-and-dash line 6 indicates the emergency overflow level which is preferably slightly higher than the normal overflow level for reasons which will be later explained.

The normal overflow pipe 7 extends upwardly from the bottom portion of the conical hopper 1 of the washer W. At the upper end of pipe 7 is a closed weir box or chamber, generally indicated at B. This weir box, as illustrated, is of rectangular form having a bottom wall 8, a top wall 9 and side walls 10, but the term "weir box," as used in this specification and the appended claims, is intended to cover and include any enclosure or chamber adapted to house a weir or overflow member. Extending transversely across the box B is a plate 11 which projects upwardly from the bottom wall 8 and constitutes a weir or dam which establishes the normal water level in the washer W. This weir 11 divides the weir box B into an upstream portion 12 and a downstream portion 13, and, as clearly seen in Figure 1, the normal overflow pipe 7 extends into the upstream portion 12.

Thus as the water level rises in the washer W it will also rise in the normal overflow pipe 7 and in the upstream portion 12 of the weir box B until it overflows the weir 11 into the downstream portion 13 of the weir box. The normal outlet pipe 14 extends downwardly from the downstream portion 13 of weir box B and receives the water which overflows the weir 11. This outlet pipe 14 has a transverse bottom portion 15 and an upwardly extending portion 14' and thus forms a U-tube which, as will be more fully described later, provides a

water seal to prevent the discharge of gas from the washer W through the water overflow system. A 180° bend **16** connects the upwardly extending leg **14'** of outlet pipe **14** to the waste pipe **17** which discharges into a sump or other suitable place of disposal for the overflow water.

Extending upwardly from the top of the weir box B is a gas pressure equalizing pipe **18** which has a connection **19** into the washer W adjacent the upper part thereof. Above the pipe **19** is an extension **18'** of pipe **18** having a pressure relief valve **20** therein. The upper discharge end of pipe **18'** is open and at an elevation sufficiently high above the ground level and working areas that any blast furnace gas which may be discharged therefrom will be dissipated into the atmosphere without danger to the operating personnel.

In order to fill the U-tube water seal **14—14'** before starting the apparatus in operation, and to maintain water in said water seal at all times during operation, a priming water supply pipe **21** enters the weir box B, preferably above the downstream portion thereof, and is adapted to discharge water into the seal pipe **14—14'**. A control valve **22** is provided to regulate this supply of priming water which preferably is permitted to flow continuously during operation of the apparatus.

The operation of the normal overflow and water level control apparatus described above is as follows. During operation of the washer, water is constantly discharged thereinto through the spray nozzles or other gas-liquid contact means referred to above. This water collects in the conical bottom hopper portion **1** of the washer W and also rises in the normal overflow pipe **7** until it reaches the top of the weir **11**. When this occurs water will overflow the weir **11** and pass into the discharge pipe **14**. Thus the water will not rise in the washer W above the level indicated by the dotted line **5** which is at the elevation of the top of weir **11**. As the gas pressure within the closed weir box B is maintained the same as the gas pressure within the washer W by virtue of the equalizing connections **18—19**, fluctuations in gas pressure within the washer W will not cause substantial variation in the water level **5**.

The vertical length of the pipes **14—14'** is such that a U-tube water seal is provided of sufficient height to prevent blowing of the water out of this U-tube seal by any pressure which is expected to be built up in the washer W during operation of the apparatus. This U-tube water seal is primed by water from the supply pipe **21** which extends into the weir box B above the downstream side thereof and which, although provided with a control valve **22**, preferably continuously discharges water so that there will be no danger of the U-tube water seal becoming empty.

Depending on the gas pressure in the washer W and weir box B, the level of water in the leg **14** of the U-tube will be depressed. For a given pressure condition this level is indicated at **23** and it will be understood that this level will rise or fall depending upon the pressure in the washer and weir box. Water which overflows the weir **11** and flows down the pipe **14** will pass through pipe **15**, up through pipe **14'**, and overflow at the top thereof into the waste pipe **17**. The 180° bend **16** at the top of pipe **14'** is preferably vented to atmosphere, as by a vent pipe **16'**, to prevent siphoning.

From the above description it will be seen that the water level in the washer W will be maintained without substantial fluctuation at the level **5** and that any anticipated increase in washer gas pressure will be taken care of by the U-tube **14—14'** which is of such length that it will not "blow" and lose its water seal with resultant discharge of objectionable gas through the waste pipe **17**.

If, however, the pressure in the tank W should rise to an unusually high value, as might occur momentarily during a severe slip or other unusual occurrence in the blast furnace, the relief valve **20** would open and vent the washer W and the weir box B to atmosphere. This relief valve is preferably set to open at a pressure somewhat less than that which would be required to blow the water column from the U-tube **14—14'**. Thus, if the water column is designed to accommodate a pressure of 10 pounds per square inch the relief valve **20** might be set to open at 9 pounds per square inch and an effective safety factor is provided against blowing the water seal in the U-tube **14—14'**. As pressures which would open the relief valve **20** are unusual occurrences and of only very short duration, only a relatively small quantity of gas would be discharged from the upper end of pipe **18'** and, as explained above, would be discharged into the atmosphere at an elevation where no harm would be done.

On the right hand side of the washer W I have illustrated an emergency water level and overflow control apparatus. This includes an emergency overflow pipe **25** which extends through the wall of and into the conical bottom portion **1** of the washer W at an elevation somewhat above the connection of the normal overflow pipe **7** to the washer. The object of the emergency overflow apparatus is to provide means for controlling the overflow water level in the washer in case the normal overflow should become clogged as by the accumulation of solids in the bottom of hopper **1**, or inoperative for any other reason.

The emergency overflow pipe **25** extends upwardly into the emergency weir box B' which is provided with a weir **26**, similar to weir **11**, but disposed at a somewhat greater elevation than weir **11**. Thus weir **26** is adapted to maintain a water level in the washer W as indicated by the dot-and-wash line **6** on Figure 1. However water will never rise in the emergency weir box B' and flow over weir **26** unless the normal overflow **7** is clogged, overloaded or otherwise ineffective. The emergency outlet pipe **27**, **28**, and **29** is in the form of a U-tube similar to the water seal of outlet pipe **14—14'** previously described, and the outlet or waste pipe **30** is similar to and performs the same function as waste pipe **17**. The atmospheric vent **31** at the top of pipes **29** and **30** is also similar to vent **16'**.

The emergency weir box B' is connected to the washer W by equalizing pipes **32** and **33** and the upwardly extending vent pipe **34** is provided with a pressure relief valve **35**. These perform the same functions as the similar parts on the normal overflow apparatus previously described as does the emergency control priming water supply pipe **36** and its control valve **37**.

When the emergency overflow apparatus is in operation due to blocking of the normal overflow system it functions in substantially the same manner as that described in explaining the normal overflow control operation. Due to the provision of the pressure equalized weir box B' and the U-tube water seal **27—29**, the operation of the emergency overflow is entirely automatic and it is always ready and effective to take over and maintain the water level in case the normal system is inoperative for any reason. This desirable result is obtained without any float valves, mechanical or electrical controls, interconnecting means, manual manipulations, or attention by an operator.

Although I have described my invention in association with a blast furnace gas washer it will be understood that it may be used with other types of closed vessels. Furthermore it will be recognized that modifications and variations may be made in the specific arrangement and disposition of the various elements of my apparatus without departing from the spirit of my invention. Accordingly I do not wish to be limited to the exact form and application of my invention herein illustrated and described herein but claim as my invention all embodiments thereof coming within the scope of the appended claims.

I claim:

1. Liquid overflow control apparatus for a closed vessel operating under super-atmospheric gas pressure comprising, a closed weir box having a normal overflow weir therein at the elevation of the normal overflow level of said closed vessel, said weir dividing said weir box into upstream and downstream portions, a normal overflow pipe connecting said upstream portion of said weir box to said closed vessel at a point adjacent the lowermost portion thereof, a normal outlet pipe leading from said downstream portion of said weir box and including a liquid seal portion, a pressure conducting conduit connecting said closed vessel above said overflow level to said closed weir box whereby the gas pressure therein will be equalized, a second closed weir box having an emergency overflow weir therein at an elevation above said elevation of the normal overflow level of said closed vessel, said emergency overflow weir dividing said second closed weir box into upstream and downstream portions, an emergency overflow pipe connecting said upstream portion of said second weir box to said closed vessel below said normal overflow level but above the connection of said normal overflow pipe to said vessel, an emergency outlet pipe leading from said downstream portion of said second named weir box and including a liquid seal portion, and a pressure conducting conduit connecting said closed vessel above said overflow level to said second closed weir box whereby the gas pressure therein will be equalized.

2. Liquid overflow control apparatus for a closed vessel operating under super-atmospheric gas pressure comprising, a closed weir box having a normal overflow weir therein at the elevtion of the normal overflow level of said closed vessel, said weir dividing said weir box into upstream and downstream portions, a normal overflow pipe connecting said upstream portion of said weir box to said closed vessel at a point adjacent the lowermost portion thereof, a normal outlet pipe leading from said downstream portion of said weir box and including a liquid seal portion, a pressure conducting conduit connecting said closed vessel above said overflow level to said closed weir box whereby the gas pressure therein will be equalized, a second closed weir box having an emergency overflow weir therein at an elevation above said elevation of the normal overflow level of said closed vessel, said emergency overflow weir dividing said second closed weir box into upstream and downstream portions, an emergency overflow pipe connecting said upstream portion of said second weir box to said closed vessel below said normal overflow level but above the connection of said normal overflow pipe to said vessel, an emergency outlet pipe leading from said downstream portion of said second named weir box and including a liquid seal portion, a pressure conducting conduit connecting said closed vessel above said overflow level to said second closed weir box whereby the gas pressure therein will be equalized, and pressure relief valve means having fluid pressure conducting connections to said weir boxes and adapted to relieve the gas pressure therein at a predetermined value less than the pressure required to blow said liquid seal portions.

3. Liquid overflow control apparatus for a closed vessel operating under super-atmospheric gas pressure comprising, a closed weir box having a normal overflow weir therein at the elevation of the normal overflow level of said closed vessel, a normal overflow pipe connecting said weir box to said closed vessel at a point below said normal overflow level, a normal outlet pipe leading from said weir box and including a liquid seal portion, means for equalizing the pressure in said closed vessel and said closed weir box, a second closed weir box having an emergency overflow weir therein at an elevation above said elevation of said normal overflow level of said closed vessel, an emergency overflow pipe connecting said second weir box to said closed vessel below said normal overflow level but above the connection of said normal overflow pipe to said vessel, an emergency outlet pipe leading from said second named weir box and including a liquid seal portion, and means for equalizing the pressure in said closed vessel and said second named closed weir box.

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