March 15, 1932. S. P. JOHNSON ET AL 1,849,932

METHOD AND APPARATUS FOR PREVENTING FIRE HAZARDS IN OPERATING UPON AND CLEANING CONTAINERS OF INFLAMMABLE LIQUIDS OR GASES

Filed July 25, 1928 2 Sheets-Sheet 1

Fig. 1.

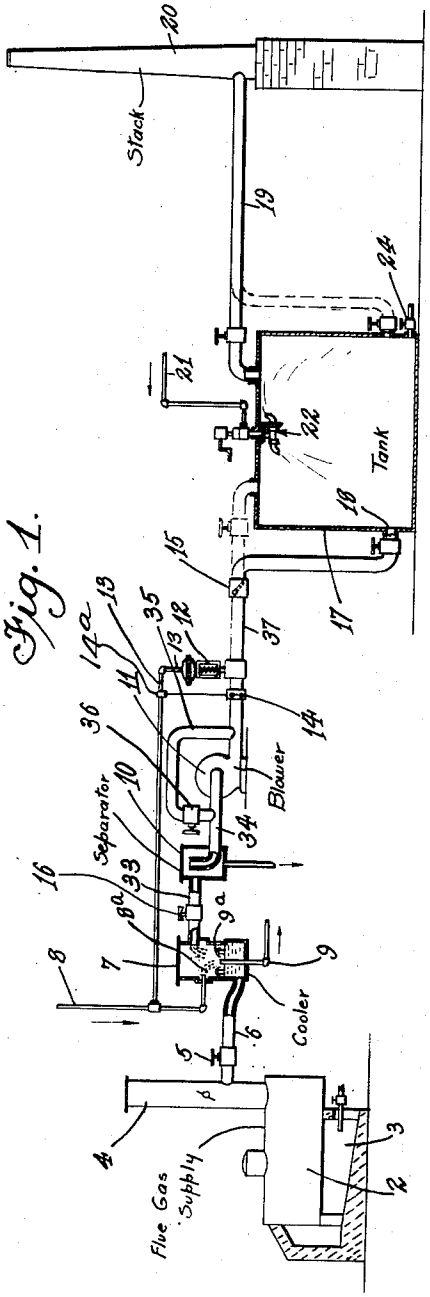
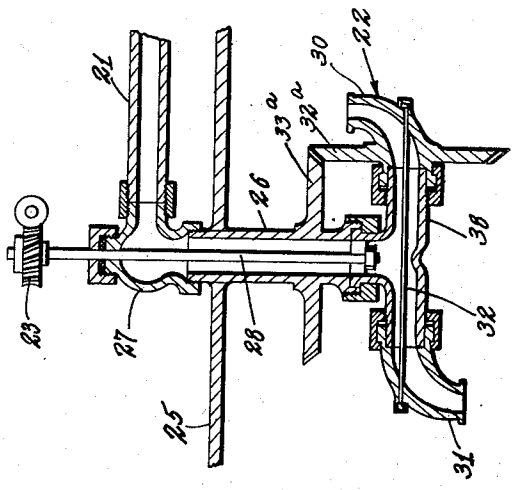


Fig. 2.



Inventor

Sidney P. Johnson

Philip S. Williams

By Lyon & Lyon

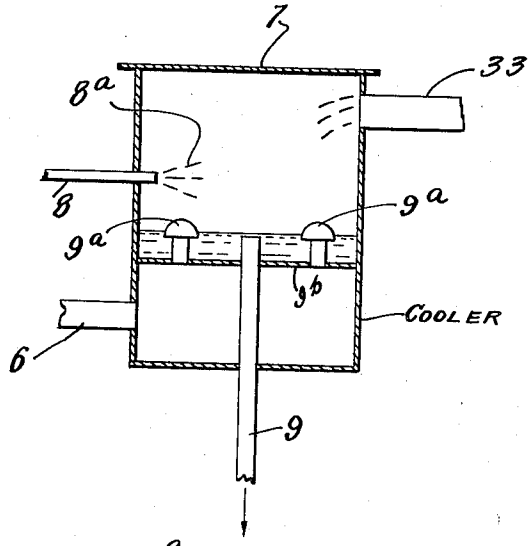
Attorneys

March 15, 1932. S. P. JOHNSON ET AL 1,849,932

METHOD AND APPARATUS FOR PREVENTING FIRE HAZARDS IN OPERATING UPON AND CLEANING CONTAINERS OF INFLAMMABLE LIQUIDS OR GASES

Filed July 25, 1928 2 Sheets-Sheet 2

Fig. 3.



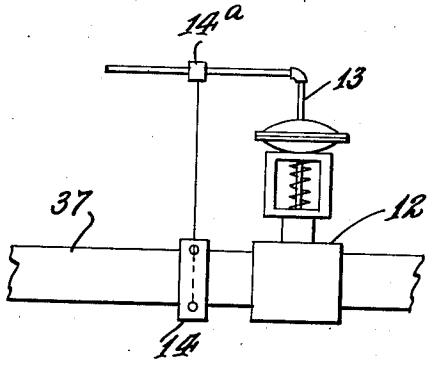


Fig. 4.

Inventors

Sidney P. Johnson

Philip S. Williams

By Lyon & Lyon

Attorneys

Patented Mar. 15, 1932

1,849,932

UNITED STATES PATENT OFFICE

SIDNEY P. JOHNSON, OF SAN FRANCISCO, AND PHILIP S. WILLIAMS, OF PALO ALTO, CALIFORNIA, DEDICATED, BY MESNE ASSIGNMENTS, TO THE PEOPLE OF THE UNITED STATES

METHOD AND APPARATUS FOR PREVENTING FIRE HAZARDS IN OPERATING UPON AND CLEANING CONTAINERS OF INFLAMMABLE LIQUIDS OR GASES

Application filed July 25, 1928. Serial No. 295,279.

In the storage, refining and transportation of petroleum and its products, the tanks and containers which are used may become a potential fire hazard for the reason of the presence of explosive vapors. Among the apparatus in which these fire hazards may exist, are field and refinery storage tanks, distributing tanks, stills, absorber towers, fractionating columns, pipe lines, compartments on tank ships, tank cars, tank trucks, and barrels and drums.

When the containers are properly constructed and maintained substantially full of liquid or gaseous hydrocarbons, the explosive hazard is negligible because such gases as may occupy the vapor spaces are generally too rich to burn, except in the presence of air. However, when the hydrocarbon contents are drawn off, the incoming air to replace the material withdrawn tends to dilute the rich gases in the vapor spaces, with the result that the containers may become filled or partially filled with high explosive mixtures of petroleum vapor and air. It is evident that during the process of freeing a container of inflammable gas and replacing such gas with air, there must be a period during which the relative amounts of air and gas are such as to constitute an explosive hazard.

The explosive hazards in containers of inflammable fluids is particularly high at the time when these containers are sought to be cleaned. At such time, it is generally customary to, at least as a final operation, replace the gas or vapors of the container with air. Since explosive mixtures of petroleum vapors and air may be formed when the relative amounts of the two gases or vapors are between approximately sixteen parts of air to one of petroleum vapor, and eighty-five parts of air to one of petroleum vapor, it is obvious that explosive mixtures may prevail, while there are possibilities of ignition from many causes, such as lighting of matches, accidentally struck sparks, static electricity or spontaneous combustion due to the character of the vapor itself. Spontaneous combustion is to be particularly feared in handling high sulfur oils such as those obtained from Mexico and West Texas fields. It appears that the vapors of these oils may be charged with hydrogen sulfide and other sulfur derivatives which tend to form pyrophoric compounds which may ignite spontaneously on contact with the oxygen of air. It is necessary, in cleaning the container, not only to remove the volatilized vapors within the container, but also the unvolatilized vapor forming hydrocarbons which cling to the walls and the bottom of the container. When such unvolatilized hydrocarbons are not removed, they may later vaporize and an explosive mixture be formed.

Heretofore, the method used for cleaning containers of the inflammable fluids, has generally been the steaming process. Due to its rapid condensation, steam is very ineffective for use in flushing out the volatilized combustibles and in practice, it is found that several prolonged steamings must be resorted to, involving great waste of heat and time before the inflammable vapors can properly be removed, and the container walls must be thoroughly washed down with a fire hose or chemicals between each steaming operation.

Furthermore, during the entire cleaning process, the container may, and frequently does, contain explosive mixtures of combustible vapor and air. Under these circumstances, the presence of men inside of the tank being cleaned, not only increases the possibility of explosions, but introduces the possibility of asphyxiation or poisoning due to the character of the vapor that may exist or be produced in the tank. The steaming process of cleaning tanks has the additional disadvantage that the heat of the steam causes certain residual materials in the oil, such as asphalt, to bake into enamel-like coatings on the tank walls.

It is a general object of the present invention to provide a method of handling and cleaning containers for inflammable fluids which will eliminate, to a large extent, explosive hazards. More particularly, an object of the invention is to provide a method and apparatus for operating upon and cleaning containers of inflammable vapors which includes the displacement of the inflammable vapors by oxygen-lean gases, so that the in-

flammable vapors may be removed from the tank without at any time forming an explosive mixture of vapor and air.

A further object of the present invention is to provide a method and apparatus by means of which flue gases may be economically and safely employed as the oxygen-lean gas used for displacing the inflammable vapors of the container.

Another object of the present invention is to provide a process and apparatus by means of which the unvolatilized materials within the container may be flushed off by a liquid, such as hot water, soap solutions, etc., simultaneously with the displacement of the inflammable vapors by an oxygen-lean gas and to provide a process and apparatus in which this may be accomplished without the necessity of workers entering the containers.

Various further objects and advantages of the present invention will appear from a description of a preferred form or example of a process and apparatus for handling or cleaning containers embodying the invention.

For this purpose, the preferred process and apparatus is hereinafter described in connection with the accompanying drawings, in which—

Figure 1 is a diagrammatic elevation.

Figure 2 is an enlarged vertical section of a solution distributor means within the container to be cleaned.

Figure 3 is a large vertical section of the cooler 7; and

Figure 4 is an enlarged detail of the safety valve structure.

Referring to the drawings:

2 represents a steam boiler or any suitable source of flue gases in which 3 is the fire box or combustion chamber of the steam boiler and 4 is a stack from which the products of combustion are withdrawn. The flue gases from stack 4 are taken by line 6 and passed through a valve 5 into a cooler 7. In the cooler 7, the gas is cooled to a temperature below the ignition temperature of the inflammable hydrocarbons within the container to be cleaned. In the cooler 7 the cooling is effected by having the gas bubble through cooling water, the cooling water being supplied by line 8, and discharged from the cooler through line 9. Inside of the cooler, the water is indicated as being sprayed by means 8—*a*, into the uprising flue gases.

The flue gases are further and more positively cooled by being passed through one or more decks of bubble caps similar to those used in fractionating columns. The gas passes from the pipe 6 into the lower section or compartment of cooler 7, thence upward through the deck by way of the bubble caps 9*a*, which caps cause the gas to reverse its direction of flow and bubble through the water held on the plate 9*b* at a predetermined depth governed by the height of the water overflow line 9 above the plate.

Means are provided for separating entrained moisture from the stream of gas leaving the cooler. This may be of the centrifugal separator type or any other type. The separator may be an integral part of the cooler or the line as it leaves the cooler, or it may be the individual piece of equipment shown as 10. For this purpose, a line 33 is indicated, which conveys the flue gases into a separator 10. It has been found desirable to use this moisture separator to insure that no slugs of water get into the blower to damage it or interfere with its operation. A further consideration is the removal of all entrained moisture carrying sulphur compounds such as sulphur dioxide or hydrogen sulfide which may be present in the flue gas and which might contaminate the oil in the tank 17 or have a corrosive effect on the metal, if flue gas were admitted during the course of normal operation. From the separator 10, the flue gases are drawn through the line 34 by a blower 11 which provides a means for forcing the flue gas through the remainder of the apparatus. In certain cases, the pressure on the flue gases may be sufficient for this purpose, without the addition of the blower 10, and hence, a line 35 is indicated bypassing the blower 11, which line is shown as provided with a valve 36.

The blower 11 and bypass line 35 are shown as connected by a line 37 with the tank 17 which is to be cleaned, by the process and apparatus of the present invention. Means are provided for insuring that the flue gas in line 37 will not be forced into the container 17 when said flue gas has not been properly cooled to the temperature below the ignition temperature of the vapors within the container. Said means includes a spring loaded safety valve 12 in the line 37 which is connected with the line 13 to be actuated by pressure drop by failure of cooling water supply in line 8. Thus, whenever the cooling water supply in the line 8 fails, the head on the safety valve 12 from line 13 drops and the valve closes, preventing flue gas of too high a temperature being delivered into the tank 17.

There is also preferably provided, as an additional safeguard, a fusible link 14 within the line 37, so that if the temperature of the flue gases in the line exceeds a predetermined point, the fusible link will melt and cause the pilot valve 14*a* to simultaneously shut off the water pressure or head on the safety valve 12 and vent the pressure line between the pilot valve 14*a* and the safety valve 12 to the atmosphere. Safety valve 12 being spring loaded against water pressure, the venting of the pressure line will permit the valve 12 to close.

There is also preferably provided, a means which will prevent the possibility of passage

of inflammable gases from the tank 17, backwards through the apparatus thus described, and working into the boiler stack 4. A preferred form of such means constitutes a check valve 15 in the line 37. As a further protection, a relief valve 16 is installed in line 33 adjacent the cooler 7, so as to vent the line 33 whenever the back pressure in the line exceeds that required to break down the water seal in the cooler 7 and permit the flow of inflammable gases into the boiler stack 4.

The flue gases entering the tank 17 from line 37 through the outlet 18, displace the hydrocarbon vapors from the tank and cause said vapors to discharge through line 19 and stack 20, from which they may be harmlessly released to the atmosphere. While the flue gas is shown as entering the bottom of the tank and the gases from the tank 17 discharging from the top, this arrangement may be reversed if desired.

It is also obvious that in place of releasing the mixed gases from the tank 17, as described, from the stack 20, the gases may be passed through suitable recovery apparatus for condensing and collecting the useful hydrocarbon vapors.

While the hydrocarbon vapors in the tank 17 are being displaced by the flue gas, a cleansing solution, or water, preferably hot is continually introduced into the tank from a line 21 by means of a rotary nozzle 22. The nozzle is swiveled so as to direct a moving stream of hot water against the interior surfaces of the tank, thus washing down or vaporizing such liquid hydrocarbons as may be adhering to the metal. The nozzle 22 is provided with means enabling the nozzle to cause each portion of the inner tank surface to be directly struck by a stream of flushing water, which thereby insures a complete cleaning of the tank of any hydrocarbons capable of thereafter vaporizing and forming combustible gases. A draw-off line and valve 24 is shown in the bottom of the tank 17 for removing the water and any liquid hydrocarbons which may have been washed down during the cleaning process.

The nozzle shown in Figure 2 may be used, which nozzle comprises a sleeve 26 mounted upon a plate 25 which may be the top plate of the tank or a plate of the same dimensions as a customary manhole cover of the tank, so that the plate 25 may replace the manhole cover during cleaning operations. The sleeve or tube 26 is rigid with the water supply line 21 at its upper end, and at its lower end, it supports the nozzle rotating tube 38. The nozzle rotating tube 38 provides a horizontal passage for water communicating with water passages in the sleeve 26 and the supply line 21. At its ends, the nozzle rotating tube 38 is provided with oppositely faced nozzles 30 and 31, which are revolvably mounted upon the rotating tube or distributing head so as to revolve relative to the tube 38, on an axis at right angles to the axis of revolution of the tube 38. The nozzles 30 and 31, therefore, have a sort of planetary motion in operation. In order to maintain the nozzles 30 and 31 in proper relationship and to drive the same, nozzles 30 and 31 are connected together by a rod 32 having square ends fitted in square sockets in the nozzles 30 and 31, so that the rotation of one nozzle rotates the other. Additionally, the nozzle 30 is integral with a beveled gear 32*a* engaging a bevel gear 33*a*, integral with the tube or sleeve 26 of the nozzle, so that rotation of the distributing head 38 relative to the sleeve 26 will cause a revolution of the nozzle tips 30 and 31 relative to the distributing head.

Preferably, a means is provided for driving the distributing head other than, or in addition to the force of water or liquid sent through the nozzle and for this purpose, the distributing head is indicated as connected by rod 28 to a means such as a gear 23 above the sleeve 26, where power may be applied for revolving the distributing head.

In operation of the nozzle, hot water is turned on from the supply 21, and the rod 28 is revolved, causing the distributing head 38 to rotate in a horizontal plane. As the distributing head moves, the tips 30 and 31 revolve with a planetary motion by reason of engagement of the gear 32*a* and the gear 33*a*.

Preferably, there is a difference in the number of teeth or gears 32*a* and 33*a* respectively, so that the helical path of the water discharged from the nozzle tips 30 and 31 will be in different positions at different successive revolutions of the distributing head 38, so that successive helical paths will not coincide and each portion of the surface of the tank will be struck by the discharging stream of water.

By means of the present invention, a process of removing unvaporized liquid hydrocarbons is carried out simultaneously with the operations of removing the hydrocarbon vapors, and such operations take place without the necessity of introducing air into the tank or without the necessity of an operator entering the tank, so that all portions of the hydrocarbon, both liquid and vapor, are removed from the tank without the formation of an explosive mixture.

After complete scavenging of the tank of its hydrocarbon content, the manhole to the tank may be removed and air admitted if desired, without this operation resulting in the danger of formation of explosive mixtures.

While the method and apparatus herein described for operating upon and cleaning tanks, containers or receptacles for hydrocarbons, liquid or gas, is well adapted for carrying out the objects of the present in-

vention, it is understood that the invention is not limited to the particular details of the preferred form of the invention, but the invention includes all such changes, modifications and substitutions or equivalents as come within the scope of the appended claims.

We claim:

1. A process of operating upon a container of inflammable vapors, which comprises displacing the inflammable vapors from said container by means of an inactive oxygen-lean gas, and simultaneously washing the interior of the vessel for the removal of any liquids capable of forming inflammable vapors.

2. A process of operating upon vessels containing liquid hydrocarbons capable of producing inflammable vapors, which comprises cooling flue gases to below the ignition temperature of the inflammable vapors, injecting said flue gases into said vessel for displacement of the hydrocarbon vapors, and simultaneously washing the interior surfaces of the vessel for removal of the liquid hydrocarbons.

3. A process of cleaning a container which has held a hydrocarbon capable of forming inflammable vapors, which comprises producing flue gases, cooling said flue gases below the ignition temperature of said inflammable vapors. introducing said gases into the vessel to be cleaned to displace the hydrocarbon vapors, and simultaneously washing the interior of the container with a hot washing liquid.

4. A process of cleaning volatile combustible substances from containers which includes, flushing said containers with a gas incapable of burning or supporting combustion, washing the walls of said containers with a liquid, simultaneously with the flushing of the volatile combustible vapors from said container, and then replacing the said gas by air.

5. A process of removing volatile combustible substances from a container, which includes cooling flue gases below the ignition temperature of the combustible vapors within the said container by passing said flue gases through cooling water, separating entrained moisture from said gases, introducing said gases into the container to be cleansed, simultaneously washing the interior surfaces of the vessel with hot water distributed successively as a jet over the different portions of the interior area of said container, and removing mixed gases from said container.

6. A process of removing volatile combustible substances from containers, including supplying a gas incapable of supporting combustion, contacting said gas with cooling water to cool the same below the ignition temperature of the combustible vapors within the said container, separating entrained moisture from said gas, introducing said gas into the container to be cleaned, simultaneously spraying the interior walls of said container with a liquid for flushing down said interior walls, drawing off the liquid, and removing the mixed gases and vapor.

7. In an apparatus for cleaning tanks, means for supplying flue gases, means for cooling said flue gases, means for introducing the flue gases into a tank to be cleaned, means for shutting off the supply of flue gases automatically on failure of said cooling means, and means for preventing the passage of inflammable vapors backward through the means for supplying and cooling the noncombustible vapors.

8. An apparatus for cleaning tanks which comprises, means for supplying flue gases, means for cooling said flue gases, a discharge line from said cooling means, a safety valve in the discharge line, means for closing said safety valve when said flue gases are incompletely cooled, means for separating from said flue gases, entrained water, means for introducing the flue gases cooled and separated from the water vapor into the tank to be cleaned, and means in said tank for spraying liquid upon the surfaces of said tank during the introduction of the flue gases.

Signed at El Paso, Texas, by SIDNEY P. JOHNSON, this 10th day of July, 1928.

SIDNEY P. JOHNSON.

Signed at San Francisco, California, by PHILIP S. WILLIAMS, this 13th day of July, 1928.

PHILIP S. WILLIAMS.