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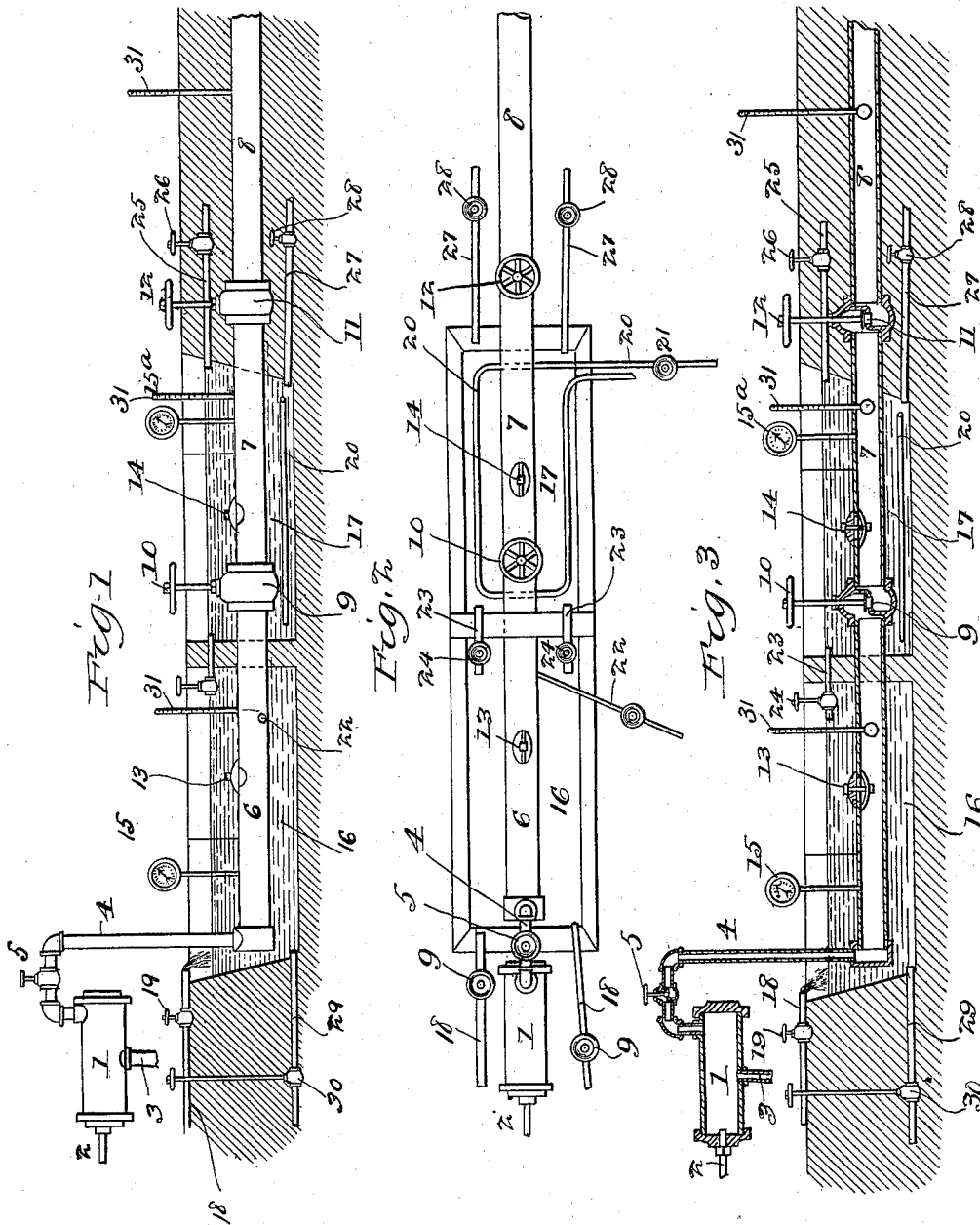
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J. S. SMITH.

METHOD OF AND APPARATUS FOR DEHYDRATING GAS.

(Application filed Oct. 17, 1898.)

(No Model.)



Witnesses
Arnold B. Bant
Edward B. Bant

Inventor
Jacob S. Smith
by Elliott & Hopkins
Attys

UNITED STATES PATENT OFFICE.

JACOB S. SMITH, OF CHICAGO, ILLINOIS.

METHOD OF AND APPARATUS FOR DEHYDRATING GAS.

SPECIFICATION forming part of Letters Patent No. 625,126, dated May 16, 1899.

Application filed October 17, 1898. Serial No. 693,747. (No model.)

To all whom it may concern:

Be it known that I, JACOB S. SMITH, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Methods of and Apparatus for Dehydrating and Maintaining Gas Against Precipitating Vapors in Transit, of which the following is a full, clear, and exact specification.

10 This invention relates to means for and method of removing the vapors from gas, and more particularly natural gas, the best method for which has heretofore consisted in compressing the gas as it comes from the well to a degree that will squeeze out the vapors and then freezing the compressed body and subsequently removing the ice from the condenser and the discharge-passage thereof to the pipeline, which removal is made by melting and 20 blowing out the ice by means of steam or by raising the temperature of the compressed gas until the ice is melted and then blowing off the gas, as fully set forth in my pending application, filed April 30, 1897, Serial No. 634,571. 25 While the means and method shown and described in that application are entirely successful in accomplishing the desired end, there is, commercially speaking, loss of time by the resulting intermittent process in both instances, added to which the necessity for employing a refrigerating plant, with its attending cost and running expenses, all of which it is desirable to avoid.

30 Natural gas discharging from a well is saturated to a greater or less degree with aqueous or other vapors, which in transportation through pipes and mains are affected by pressure and changes in temperature and precipitate in the form of liquids when subjected to reduction in temperature or increase in pressure and either in liquid form, frost, or ice obstruct the pipes through which the gas is transported.

35 The degree of saturation of gas with aqueous and other vapors depends upon the space occupied by the gas—that is to say, if fully-saturated gas at any given pressure is subjected to double that pressure and forced to occupy half of its original space such pressure will force out and condense one-half of the aqueous and other vapors originally in suspension—as, for example, when saturated nat-

40 ural gas discharges from a well at one hundred pounds pressure into a compressor and subjected to two hundred pounds pressure it will have half its moisture squeezed out in the form of condensations. On the other hand, temperature varies the degree of this vaporous saturation—as, for example, when gas is cooled below its normal temperature its vapors are condensed, while, on the other hand, when gas is maintained at the temperature at which vaporous saturation exists no condensation will take place, and whenever this temperature is raised then the gas acquires a condition enabling it to take up more moisture, and this ability to take up more moisture under an increased heat exists, although the pressure may remain the same or even be increased.

45 The object of my invention is to render the gas discharged into the main pipe or line incapable of precipitating vapors while in transit and by a simple and effective means and this without the necessity of a refrigerating plant.

50 With these ends in view my invention consists in certain features of novelty in the construction, combination, and arrangement of parts by which the said objects and certain other objects hereinafter appearing are attained, all as fully described with reference to the accompanying drawings and more particularly pointed out in the claims.

55 In the said drawings, Figure 1 illustrates a longitudinal section of an apparatus embodying my invention. Fig. 2 is a top plan view of the same, and Fig. 3 is a vertical central longitudinal section thereof.

60 1 indicates the compressor-cylinder, 2 the piston-rod thereof, and 3 a pipe connection with the gas-well or other source of gas to be compressed.

65 The discharge of the compressor-cylinder consists of a pipe 4, in which is an ordinary globe valve or cock 5 for controlling the discharge, and 6 is the cooling-chamber, 7 the heating-chamber of my apparatus, and 8 is the main or line pipe, which three several devices, as shown, are formed of a continuous length of pipe or coupled lengths of pipe and are respectively separated, the cooling-chamber from the heating-chamber, by an ordinary globe valve or cock 9, manipulated by the

usual hand-wheel 10, and the heating-chamber from the main by a similar globe valve or cock 11, actuated by a hand-wheel 12, the cooling-chamber being provided with a man-hole 13 and the heating-chamber with a man-hole 14, closed by the usual cap, for access to these chambers, and the cooling-chamber with an ordinary pressure-indicator 15 and the heating-chamber with a similar indicator 15^a.

10 The cooling-chamber is submerged in a vat or tank 16 of cold water and the heating-chamber in a similar vat or tank 17 of warm water, the water to the cooling-tank 16 being supplied through a pipe 18, controlled by an ordinary cock or valve, as indicated at 19, and connected with any suitable source of supply, and in the bottom of the tank 17 is a steam pipe or coil 20, controlled by an ordinary globe valve or cock 21 and for the purposes of heating the contents of the vat 17.

As shown, the cooling-chamber projects partly into the vat 17 of the heating-chamber, and while it would be no substantial departure from my invention to confine the cooling-chamber to its own vat and have the valve 9 between the walls separating the cooling from the heating chamber or to have the two chambers separated between their ends, but connected by a bent pipe and having a controlling-valve located therein, the construction shown is preferred, for the reason that any possibility of the obstruction of the valve by frost or ice due to the reduction of pressure of the gas in the cooling-chamber in discharging it into the heating-chamber, as will hereinafter be explained, is entirely avoided.

In the operation of this apparatus gas entering the compressor is compressed and discharged into the cooling-chamber at a substantially greater pressure than its normal pressure, and after being compressed and cooled by the cold water surrounding the chamber the resulting condensations from the vapors precipitated thereby are drawn off through the drain or drip pipe 22, following which the valve 9 is opened and the compressed gas is discharged into the heating-chamber 7, and in so doing its pressure is reduced until a uniform pressure is established in both chambers, at which time the valve 9 is closed, and the gas in its resultant expanded condition and reduced pressure is then heated by the warm water surrounding the heating-chamber, after which it is discharged into the main by opening the valve 11, the pressure of this discharge being sufficient to force the gas through the main to its destination.

By a proper manipulation of the valves 5, 9, and 11 a continuous flow may be had throughout the apparatus and through the pipe-line, and any desired difference in the pressure of the gas may be maintained within the cooling and heating chambers, and so also the valves may be wide open and the dehydrated and heated gas allowed to expand within the pipe-line if the back pressure of

the pipe-line is sufficient to cause the pressure to rise in the chambers to the desired degree, especially when the temperature of the pipe-line is high or the distance to which the gas is transported is short.

When the gas is compressed in the compression-chamber 6 by double the normal pressure it has when it comes from the well, it is forced to occupy about half of its original space, and as a result about half of its vapors are condensed, and if this compression is very high in proportion to a correspondingly high pressure in the well the sudden expansion of the gas in its discharge into the heating-chamber will have a tendency to freeze the valve 9; but this, however, is entirely avoided, no matter how high the pressure, by having the valve located in the vat of the heating-chamber, and it is for the purposes of adapting my apparatus to the employment of practically unlimited and to say the least very high pressures that I preferably locate and submerge the valve 9 in the watery contents surrounding the heating-chamber. In this connection, however, it is proper to add that where the normal pressure from the well is not high and subsequently the pressure in the compression-chamber is correspondingly low the valve 9 may be located at a point between the cold and warm water vats.

While it is true that the gas in the chamber 7, owing to its lesser pressure and therefore expanded condition as compared with what it previously had in the compression-chamber, will not when discharged into the main precipitate its vapors under ordinary circumstances, yet in order to insure against any such precipitations under extreme variations in temperature in the main line I find that by heating the gas after its discharge from the compression-chamber and before it enters the main or at the beginning of its entrance thereto the gas is so expanded and the vapors reduced to such a condition that there will not possibly be any precipitations while the gas is in transit however much variation there may be in temperature in the main or in the reduction of the pressure of the gas throughout the main.

The condition of the gas when released from the heating-chamber into the main after being subjected to heat may be defined by stating that it is rendered capable of reabsorbing precipitations and vapors under changes in temperature and reduction in pressure to which it is ordinarily subjected to a degree rendering it incapable of precipitating vapors at the greatest extremes of temperature and reduction in pressure in the longest of pipe-lines and in the severest of climates.

Another advantage accruing to the application of heat to the gas at a given pressure is that by heat expansion its delivery through the pipe is promoted.

From the foregoing it will be understood that the important feature of my invention is the heating of the gas immediately prior to

its discharge into the main line, and therefore that my invention is not restricted by the fact that the gas may be compressed to remove moisture prior to its discharge into the heating-chamber, nor is my invention limited to the particular construction of chamber or chambers shown and the arrangement thereof and the various valves and discharging devices, and it may also be stated that in many instances the water surrounding the cooling-chamber may be heated by the compressed gas to a degree that when discharged into the vat of the heating-chamber it will be sufficiently warm to accomplish the desired end, and to this end the two vats may be connected by a pipe 23, drawing off the surface water from the cooling-vat and controlling the same through means of an ordinary stem valve or cock 24. The heating-vat may also be provided with an overflow-pipe 25, controlled by a valve or cock 26 for maintaining the water-level below the top of the vat, and likewise water may be drawn from the bottom of the vat when the steam-coil 20 is used by means of a drain-pipe 27, controlled by an ordinary valve 28, and so the cooling-vat 16 may have at its bottom a drain-pipe 29, controlled by a valve 30.

The simple cooling of gas by cold water while under pressure in excess of its normal pressure and then after removing the precipitated vapors again reducing the pressure and subjecting the gas to heat accomplishes the same end as that accomplished by refrigeration with an absence of heat—that is to say, renders the gas incapable of precipitating vapors in the longest of lines under the greatest reduction in pressure and variation in temperature therein to which it is ever subjected—although in some instances, as before stated—that is to say, in short lines and where the variation in temperature and reduction in pressure are not extreme—the compression in the chamber 6 may be omitted and the process be confined to heating the gas as it discharges into the main. It may also be observed that it would be no departure from my invention to omit the heating-chamber 7 and to perform the entire method of compression to a degree precipitating vapors, removing the condensations, and heating the gas all in the same chamber and thence discharging it directly into the main, and my invention includes the substitution of any liquid other than water and also air and gas as a medium for respectively cooling and heating the chambers 6 and 7, or either of them.

For the purpose of at any time ascertaining the temperatures in the compressing-chamber, the heating-chamber, and the main, thermometer 31, of any preferred construction, may be employed, as indicated in the drawings.

Having thus described my invention, what I claim as new therein, and desire to secure by Letters Patent, is—

1. The herein-described method of rendering gas incapable of precipitating vapors in transit, the same consisting in first compressing the gas above its normal pressure and to a degree precipitating vapors, removing said precipitations from the gas, then heating the gas while under said pressure, and finally discharging the gas into a pipe-line in a heated condition and under pressure, substantially as described.

2. The herein-described method of rendering gas incapable of precipitating vapors in transit, the same consisting in first precipitating and separating vapors from gas, then heating the gas and finally discharging it into a pipe-line under pressure and in a heated condition.

3. The herein-described method of rendering gas incapable of precipitating vapors in transit, the same consisting in first removing vapors therefrom by a compression in excess of its normal pressure, then heating the gas at a reduced pressure, and finally discharging into a pipe-line in a heated and expanded condition, substantially as described.

4. The herein-described method of rendering gas incapable of precipitating vapors in transit, the same consisting in compressing gas to an excess of its normal pressure, cooling the gas while so compressed, then heating the gas, and finally discharging into a pipe-line under pressure, substantially as described.

5. The herein-described method of rendering gas incapable of precipitating vapors in transit, the same consisting in compressing gas to an excess of its normal pressure, cooling the gas while so compressed and then heating the gas at a reduced pressure and discharging it into a pipe-line in a heated condition and under pressure, substantially as described.

6. In a gas-dehydrating apparatus, the combination with a main of a gas-compression chamber, means for removing precipitations due to the compression of gas therein and means for heating the contents of said chamber, substantially as described.

7. In a gas-apparatus the combination with the main and a cooling-chamber, of an intermediate gas-heating chamber, and means for respectively cooling and heating said chambers, substantially as described.

8. In a gas apparatus the combination with the main and an adjacent gas-heating chamber, of a cooling-chamber, one end portion of which projects into the heating medium of the heating-chamber, substantially as described.

9. In a gas apparatus the combination of a gas heating and cooling chamber, of a valve or gate connection between such chambers, said valve being located at a point within the heating medium of the heating-chamber, substantially as described.

10. In a gas apparatus the combination with the cooling-chamber 6, a compressor 1, and a

pipe and valve connection therefor, of a heating-chamber 7 and a valve or gate connecting said chambers and located in the heating medium of the chamber 7, substantially as
5 described.

11. The herein-described method of rendering gas incapable of precipitating moisture in transit, the same consisting in compressing gas to a degree precipitating vapors therein,
10 removing said precipitations from the gas

and then discharging the dehydrated gas into the main at a reduced pressure and applying heat to the gas during said discharge and at a point between the compressor and the main, substantially as described.

JACOB S. SMITH.

Witnesses:

JNO. G. ELLIOTT,
EDNA B. JOHNSON.