Feb. 27, 1934. H. C. OTIS 1,949,323

METHOD OF AND APPARATUS FOR CONTROLLING GAS WELLS

Filed April 21, 1932

Fig. 1.

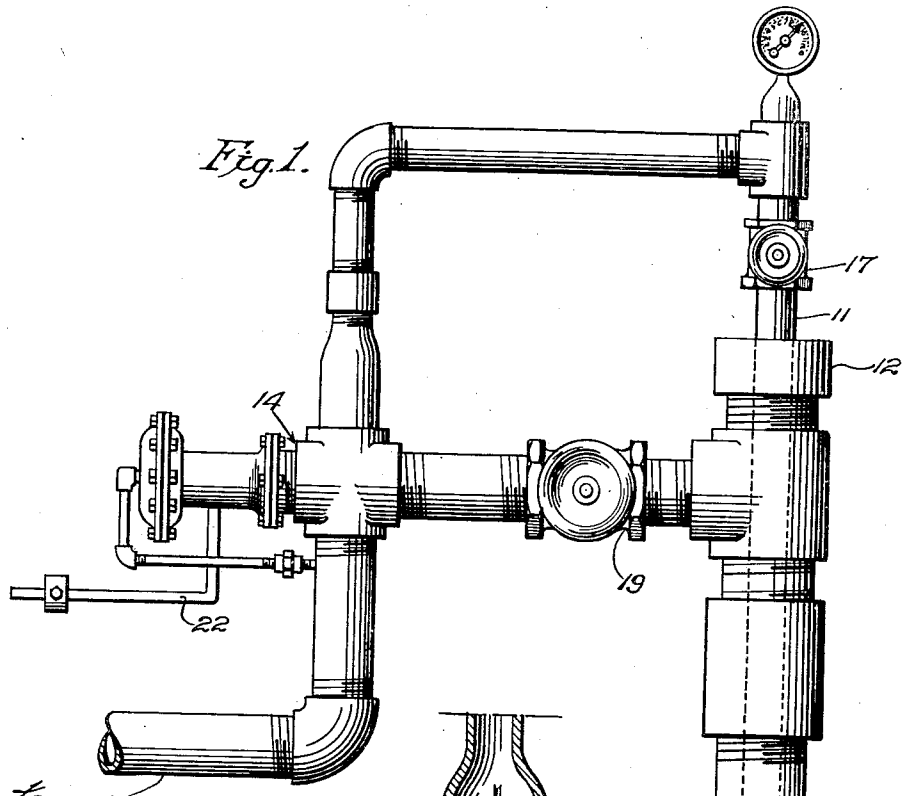
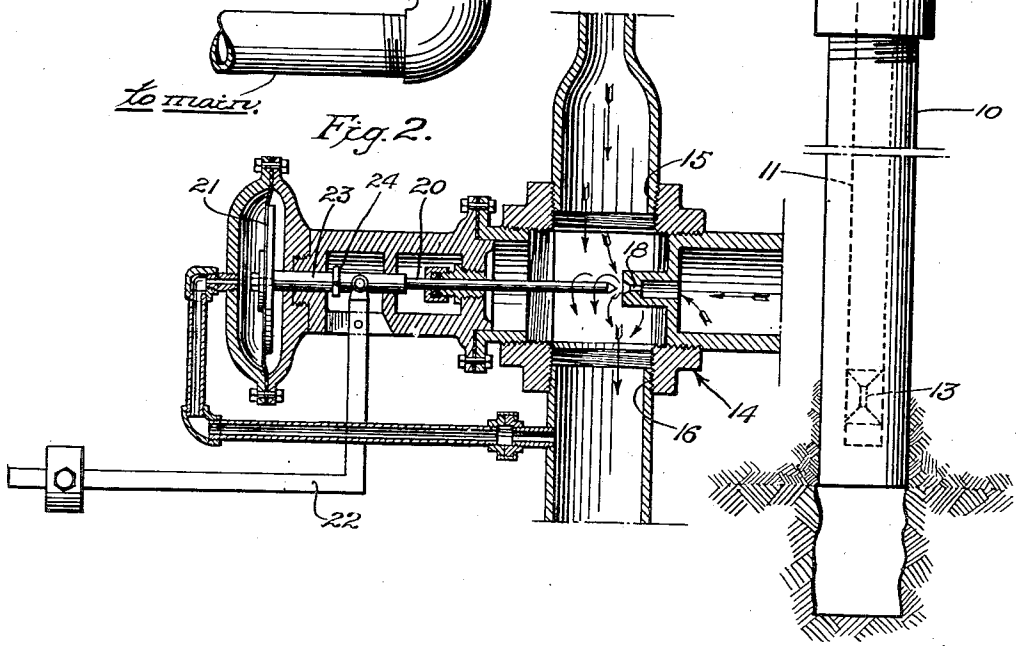


Fig. 2.



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METHOD OF AND APPARATUS FOR CONTROLLING GAS WELLS

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7 Claims. (Cl. 166—21)

This invention relates to a method of and apparatus for controlling deliveries from gas wells, and more particularly to a method and means for preventing freezing of fixtures and clogging of lines often occurring in gas wells where the delivered pressure of the gas greatly exceeds that of the main to which it is delivered.

In many gas wells the delivered pressure of the gas at the well, that is to say the pressure of the gas as it is withdrawn from the tubing of the well, is often greatly in excess of that maintained in the main to which the gas is being delivered. This necessitates use of reducing valves or the like to cut down the delivered pressure of the gas to the main pressure. The excess pressure of the delivered gas is often as high as 2,000 pounds; that is to say, the gas will be delivered by the well at say 2,350 pounds while the main pressure is only 350 pounds; thus, requiring a reduction of 2,000 pounds. Quite obviously, during such a reduction the gas is greatly expanded, with the result that there is a very sudden lowering of the temperature thereof. The reduction in temperature is often such that gas delivered from the well at a temperature of 65 degrees above zero will drop to a point well below zero. Natural gas, as delivered from the well, normally has some water which, by the sudden temperature drop, is precipitated collecting on the valves and other mechanisms and, because of the low temperature, freezing thereon. This results in eventual stoppage of the gas flow and complete inoperation of controlling mechanisms so that it is necessary to employ heaters to raise the temperature of the gas to a point such that the sudden expansion thereof will not cause freezing temperatures. Heaters of any sort associated with gas wells are so dangerous that they must be disposed at a point well away from the mouth of the well. Often more than one heater is necessary. The conditions at a high pressure gas well are at present such that the attendance of a man at the well is usually required at all times when the well is delivering to the main, and it is the usual practice to require the presence of two or more men at the time that the well is turned into the main. It is the usual practice with such wells to employ an inserted tubing from which the gas is withdrawn, said tubing having its lower end disposed at or adjacent the gas producing horizon.

An important object of the present invention is the provision of means to employ the tubing as a chamber in which the gas may be expanded with the actual expansion occurring at or near the producing horizon, thus employing the high temperature of the gas at this point to prevent freezing temperatures and the generally higher well temperatures to heat the expanded gas as it rises in the tubing.

A further object of the invention is to provide controlling means of this character which is sufficiently flexible to enable compensation for a considerable variation in withdrawals from the main.

A still further object of the invention is the provision of apparatus of this character which is entirely automatic in its operation and which, in event of excessive demands by the main, is checked in its operation so that there can be no possibility of freezing.

These and other objects I attain by the construction shown in the accompanying drawing wherein, for the purpose of illustration, I have shown a preferred embodiment of my invention and wherein:

Fig. 1 is an elevation showing a gas well incorporating control apparatus constructed in accordance with my invention; and

Fig. 2 is an enlarged vertical sectional view illustrating the means for controlling the admission of unexpanded gas to the expanded gas stream.

Referring now more particularly to the drawing, the numeral 10 generally designates the casing of a well and 11 an inserted tubing sealed to and extending through the upper end of the casing 10 as at 12. In accordance with my invention, at or near the bottom end of the tubing I dispose in the tubing a choke 13 which is preferably of the type illustrated in my copending application, Serial No. 445,963, filed August 20, 1931, for Method of setting chokes and plugs in oil wells, this choke having the bean or orifice diameter of a size sufficient to deliver the minimum quantity of gas ordinarily demanded from the well by the main to which the well is connected.

The tubing 11 and casing 10 are connected to the main through a control valve 14 which valve has ports 15 and 16 permitting the direct passage of gas from the tubing 11 to the main, subject, of course, to the control of a cut-off valve 17 at present shown as disposed in the tubing 11. The valve 14 has a further inlet orifice 18 communicating with casing 10 through a valve 19, the said orifice 18 being controlled by a valve element 20 which is subjected to the temperature of gas from tubing 11 which is passing through the control valve 14. Valve element 20 is con-

trolled in its movements by a diaphragm 21 subjected to the pressure of gas between the main and the control valve 14 and by a pivoted counterbalance lever 22. In the present showing, both diaphragm 21 and the lever 22 are shown as directly connected to the stem of valve element 20 by a reciprocatory bar 23 and as acting in opposition to one another so that when the pressure of delivered gases exceeds a predetermined amount the valve element 20 will be forced inwardly by the action of the diaphragm to close orifice 18 and when the pressure is less than the desired pressure, lever 22 will move the valve element outwardly to open this orifice. It will thus be seen that at all times when the demand is greater than the minimum demand for which the bean of choke 13 is set, the valve element 20 will be more or less open, depending upon the pressure, with the result that the gas flowing from the tubing 11 has intermingled therewith a certain percentage of gas withdrawn directly from the casing.

It will be obvious that since the pressure is reduced at the bottom of the well, it is reduced at a point where the temperature of the gas is very much higher than it is at the top of the well. In a five thousand foot well the temperature of gases at the bottom of the well is approximately 200 degrees F., with the result that there is no tendency whatever to freezing. Furthermore, the gas delivered at the upper end of the tubing, having been expanded in the heated zone, has a temperature higher than that of gas delivered from the casing. Gas delivered from these casings is, ordinarily, at a temperature of about 50 degrees while that delivered from the tubing is 20 degrees higher, or 70 degrees F. Since the gas from the tubing is not subjected to a pressure drop after it has passed through choke 13, there is no necessity for the use of heaters at the well and, as a matter of fact, the temperature of the gas from the tubing is such that it is possible to add to this gas by withdrawing hitherto unexpanded gas from the orifice 18. While there is a considerable pressure drop in the gas entering from the orifice 18, the temperature of the gas from the tubing flowing over the valve mechanism will tend to prevent too great a temperature drop and formation of ice about the valve element 20 or in the orifice. As a matter of fact, the gas which may be delivered through the orifice 18 may, even when a pressure drop of 2,000 pounds occurs, approximately equal the amount of gas delivered from the tubing before there is any tendency to freezing; thus, if the orifice of the choke 13 is sufficient to pass two million cubic feet of gas, approximately two million additional cubic feet may be drawn through the orifice 18 before there is any tendency to freezing. A stop 24 on bar 23 and coacting with a guide 25 for this bar serves to limit opening of valve element 20 before the gas admission at orifice 18 can produce dangerously low temperatures. Thus, by my method of expanding a portion of the gas in the heated zone, and then subsequently intermingling the expanded gas with unexpanded gas while expanding this unexpanded gas, I am enabled to provide a delivery sufficiently flexible to cover the demands in practically any instance without danger of the well becoming inoperative as a result of freezing.

It will, of course, be obvious that in some instances it may be desirable to deliver the tubing gas independently of any delivery from the casing.

Since both the method and construction are capable of modification to a certain extent, I do not wish to be understood as limiting myself thereto except as hereinafter claimed.

I claim:

1. The method of operating high pressure gas wells comprising expanding the gas to produce a desired reduction of the pressure therein at, or immediately adjacent, the horizon producing the same and subsequently injecting unexpanded gas into the stream of expanded gas to raise the pressure thereof.

2. The method of operating high pressure gas wells comprising expanding the gas to produce a desired reduction of the pressure therein at, or immediately adjacent, the horizon producing the same and subsequently injecting demand controlled quantities of unexpanded gas into the stream of expanded gas to raise the pressure thereof.

3. The method of operating high pressure gas wells comprising expanding the gas to produce a desired reduction of the pressure therein at, or immediately adjacent, the horizon producing the same, and subsequently injecting unexpanded gas into the stream of expanded gas to raise the pressure thereof while limiting the injection of unexpanded gas to the expanded gas stream to an extent such that undesirably low temperatures will not result from the expansion of such unexpanded gas.

4. The method of operating high pressure gas wells comprising expanding the gas to produce a desired reduction of the pressure therein at, or immediately adjacent, the horizon producing the same, and subsequently injecting demand controlled quantities of unexpanded gas into the stream of expanded gas to raise the pressure thereof while limiting the injection of unexpanded gas to the expanded gas stream to an extent such that undesirably low temperatures will not result from the expansion of such unexpanded gas.

5. In a gas well comprising a casing, a tubing within the casing and extending substantially to the producing horizon, the casing and tubing being sealed to one another at the upper end of the well, means at the lower end of the tubing to cause expansion of the gas as it enters the tubing, means to connect said tubing to a main including a valve casing having a substantially unobstructed through passage for the gas and having an orifice communicating with the space between the casing and tubing including a valve element to control said orifice which is subjected to the temperature of gases passing through the valve casing from the tubing.

6. In a gas well comprising a casing, a tubing within the casing and extending substantially to the producing horizon, the casing and tubing being sealed to one another at the upper end of the well, means at the lower end of the tubing to cause expansion of the gas as it enters the tubing, means to connect said tubing to a main including a valve casing having a substantially unobstructed through passage for the gas and having an orifice communicating with the space between the casing and tubing including a valve element to control said orifice which is subjected to the temperature of gases passing through the valve casing from the tubing, means controlled by the pressure of the combined gas from the tubing and casing for regulating the position of said valve element.

7. In a gas well comprising a casing, a tubing within the casing and extending substantially to

the producing horizon, the casing and tubing being sealed to one another at the upper end of the well, means at the lower end of the tubing to cause expansion of the gas as it enters the tubing, means to connect said tubing to a main including a valve casing having a substantially unobstructed through passage for the gas and having an orifice communicating with the space between the casing and tubing including a valve element to control said orifice which is subjected to the temperature of gases passing through the valve casing from the tubing, means controlled by the pressure of the combined gas from the tubing and casing for regulating the position of said valve element, and means limiting the opening movement of the valve element at a point preventing the introduction of gas from said space in quantities reducing the temperature of the combined gas to the freezing point.

HERBERT C. OTIS.