Jan. 5, 1960 F. H. POETTMANN 2,919,655

GAS LIFT CONTROL DEVICE

Filed July 27, 1953

Fig. 1.

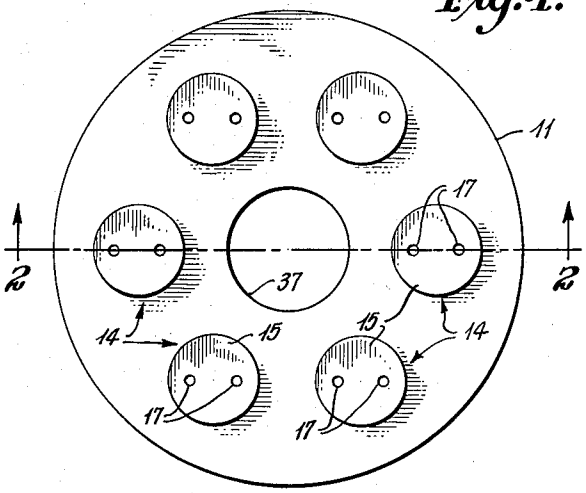


Fig. 6.

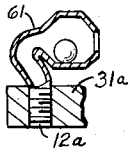


Fig. 5.

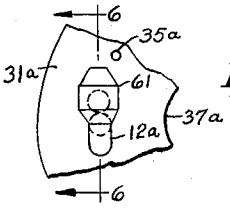


Fig. 2.

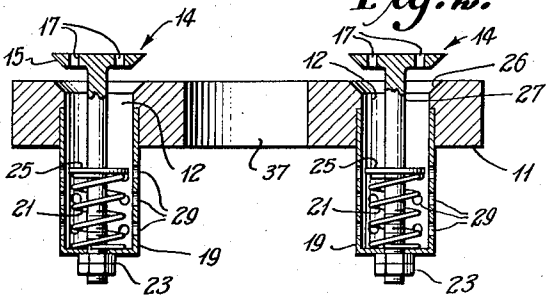


Fig. 4.

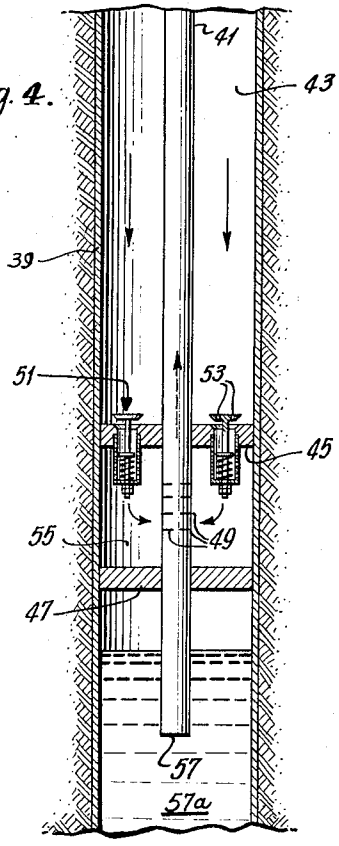
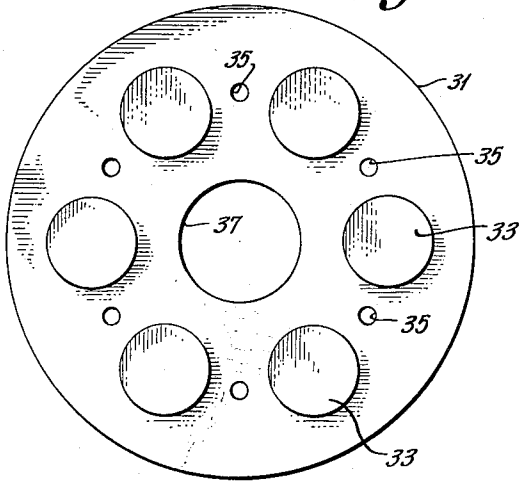


Fig. 3.



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United States Patent Office 2,919,655
Patented Jan. 5, 1960

2,919,655

GAS LIFT CONTROL DEVICE

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Application July 27, 1953, Serial No. 370,592

15 Claims. (Cl. 103—232)

This invention relates to a method and apparatus for operating gas lift oil wells. In one aspect it relates to a method and apparatus for preventing gas lift oil wells from dying. In another aspect it relates to a method and apparatus for starting production from a gas lift oil well and maintaining production from a gas lift well under conditions which normally would permit the well to die.

In the production of oil from deep wells by gas lift methods it is very important to keep oil flowing through the production tubing. As long as sufficient gas is forced into the production tubing and into the oil, oil will be lifted up the tubing. The weight of the column of fluid in the production tubing above the point of gas inlet is dependent upon several factors among which are the rate of the oil inlet into the tubing and the rate of gas inlet into the tubing. When the ratio of the gas to oil is large the weight of the column of fluid will be smaller than when the ratio of gas to oil is less. For normal operation it is desired to introduce gas under pressure at a constant rate into the bottom end of the production tubing or into one or more perforations in the tubing at some point within the body of oil within the well. When this condition exists production of oil will be relatively constant.

Many things can happen which will cause a gas lift well to die. By the term "die" when referred to gas lift oil wells is meant the condition or conditions under which the production of oil through the tubing stops. Production of oil through the tubing may stop by reason of failure to supply sufficient power gas under all conditions into the gas lift mechanism at the bottom of the well. For example, when there is a sudden drop in the pressure in the tubing at a low liquid flow rate a sudden surge of gas into the tubing from the annulus will occur. Because of this sudden increased flow of gas from the annulus between the casing and tubing into the tubing, gas pressure in the annulus becomes reduced. If this pressure reduction is too great, gas from the annulus will cease to flow into the tubing until the pressure in the annulus has been built up. The well will die during the time the gas pressure is being built up. Once a well has died it is frequently difficult to start production since during the period of stoppage, oil enters the tubing to such a height that the weight of the column of oil above the point of gas inlet is so great that an excessively high gas pressure is required for lifting purposes. The excessively high gas pressure will then expel the oil and again the column may be lightened by the rapid expulsion of the oil and again the well may die. It is the purpose of this invention to overcome this dying when the above events occur.

Various and sundry means including complicated equipment have been devised for preventing dying of gas lift wells. Special kick-off means have been devised for starting wells which have inadvertently or otherwise died. Some means have proven at least more or less satisfactory while others have not.

One method of eliminating the dying of gas lift wells is to run a separate string of small diameter pipe into the well at the same time the tubing is run. The lower end of this string of small diameter pipe terminates as an L or other pipe fitting in such a manner that the interior of this pipe communicates in a gas tight manner with the interior of the production tubing at a desired point of gas inlet. In this manner the volume of the power gas under pressure in the well is relatively small and no opportunity exists for blowing out the liquid contents of the tubing to lighten the load to such an extent that the well dies. By the use of the apparatus of my invention the running and use of such an auxiliary string of small diameter tubing is unnecessary.

My invention provides a device which reduces the volume of power gas suddenly released into the tubing by provision of auxiliary openings through the packer or openings in valve heads in the packer which openings are intended to function when the valves are closed. Thus when the valves are closed power gas for oil lifting purposes will still flow but at a greatly reduced rate.

One object of my invention is to provide a method and apparatus for preventing gas lift wells from dying.

Another object of my invention is to provide a method and apparatus for starting a gas lift well once it has died from any reason whatever.

Still another object of my invention is to provide a relatively simple apparatus for preventing gas lift wells from dying.

Yet another object of my invention is to provide an apparatus which is relatively inexpensive to manufacture for preventing gas lift wells from dying.

Still other objects and advantages of my invention will be obvious to those skilled in the art from reading the following disclosure and drawing which respectively describes and illustrates preferred embodiments of my invention.

In the drawing:

Figure 1 is a plan view, in diagrammatic form, of a well packer with elements of my invention.

Figure 2 is an elevational view, partly in section, taken along the lines 2—2 of Figure 1.

Figure 3 is a plan view of a well packer illustrating another embodiment of my invention.

Figure 4 is an elevational view, partly in section, of a section of well casing containing the apparatus of my invention.

Figure 5 is a plan view of a portion of a well packer illustrating use of a ball-type excess flow valve.

Figure 6 is a sectional view taken on the line 6—6 of Figure 5.

Referring now to the drawing and specifically to Figure 1 a packer **11** can be any suitable type of packer desired. This packer is provided, of course, with a centrally positioned opening **37** for accommodation of the production tubing. One or more additional openings **12** are provided as illustrated in Figure 2. Disposed in these openings **12** are poppet valve assemblies **14**. A poppet valve assembly **14** comprises a more or less conventional valve head **15** mounted on a valve stem **27**. At a point approximately midway from the valve head to the opposite end of the stem is a plate **25**. This plate **25** acts as a stop against which a compression spring **21** rests. A perforate cage **19** is rigidly attached to the packer and extends therefrom in the direction illustrated for attachment of one end of the valve stem. Lock nuts **23** are provided for holding the valve rigidly to the cage **19**. These lock nuts also serve as adjustment means for adjusting the compression of the spring and for setting the valve. The cage **19** is provided with a plurality of openings **29** through which gas can flow as described

hereinafter. The valve head 15 is provided with one or more openings 17.

Figure 3 represents another embodiment of my invention in which reference numeral 31 identifies a packer more or less similar to packer 11 of Fig. 1. This packer 31 is provided with openings in which are positioned poppet valves 33 having solid heads, that is, no openings like openings 17 of valve 15 of Fig. 1. While Fig. 3 illustrates poppet valves without such openings, it is within the scope of my invention that poppet valves with openings, as openings 17 can be used. An opening 37 is provided for accommodation of the production tubing. One or more openings 35 are provided in the packer 31, there being 6 such openings illustrated in Figure 3.

In Figure 4 is illustrated an assembly of apparatus parts of my invention positioned in a well casing such as would be used in operating a gas lift oil well. Reference numeral 39 identifies a section of well casing which for explanatory purposes can be assumed to be positioned in an oil well. Centrally disposed within this casing is a joint of production tubing 41 extending into a body of well liquid 57*a*. The annular space between the tubing and casing is identified by reference numeral 43. A packer 47 is set in the annular space as shown and forms a seal between the casing and the tubing. A second packer 45 is set at a point above packer 47. These two packers, the casing and the tubing enclose a substantially gas tight space identified in Figure 4 by reference numeral 55. For convenience this gas tight space may be termed a reservoir. The section of tubing 41 disposed between packers 45 and 47 is provided with one or more perforations 49.

The upper packer 45 is fitted with one or more valve assemblies 51. In view of the construction and operation of these valve assemblies they can be termed excess flow valves. These excess flow valves 51 can be identical to the valve assemblies 14 of Figure 2. When the valve assemblies are constructed like valve assemblies 14 reference numeral 53 is intended to identify openings in the valve heads similar to openings 17 in the valve heads 15 of Figure 2. The bottom end of the tubing 41 is open and this open tubing end is identified by reference numeral 57.

The valve assemblies 51 and 14 are intended to operate in such a manner that when gas flowing downward through openings 12, Figure 2, exceeds a certain optimum rate the valves will close against the compression of springs 21 thereby preventing excessive gas flow. Since these valves are provided with small openings 17 a small quantity of gas will still flow through the valves. The use of these openings 17 in valve heads 15 in Figure 2, openings 53 in the valve assemblies 51 of Figure 4 and openings 35 in the packer 31 of Figure 3 are very important. The function of these openings will be explained during the explanation of the operation of this apparatus herein below.

In the operation of the apparatus of my invention gas for oil lifting purposes is introduced into the annulus 43 at the well head and from a source, not shown. This gas is of course under pressure. Gas from the annulus flows through the valve or valves 51 into the reservoir 55 and through the opening or openings 49 in the tubing. The packers 47 and 45 are so positioned in the well that the oil will rise in tubing 41 to a point above openings 49. This condition is necessary because the pressure gas entering the tubing through openings 49 has to be under the oil for lifting it up the tubing.

During normal operations when gas flows through the spring loaded valves at a constant rate and oil enters the tubing at a constant rate and a constant discharge pressure is maintained on the head of the production tubing, production of oil will be constant.

According to my invention I provide openings such as openings 35 in packer 31 of Figure 3 or openings 17 in the valve heads 15 of Figure 2 and with these valves and openings when the tubing pressure suddenly decreases at low liquid flow rates the well will not die. For example when the weight of the column of fluid in the tubing above openings 49 is lightened and gas from annulus 43 rushes through the valves 51 of Figure 4, these valves will close since it is intended that these valves operate as excess flow valves. If openings 53 (Fig. 4), or openings 17 of Figure 2 or openings 35 of Figure 3 were not provided, the valves would close and could not be opened. Thus, after gas flow has been completely stopped there is no positive way of again starting oil production. About the only way to start production would be to vent gas pressure from the annulus at the well head until the valves open or pull the packer and manually open the valves. Since I provide openings through the top packer or through the valve heads a restricted volume of power gas continues to flow through these openings even when the valves are closed. Thus some gas always passes through the top packer for entry into the tubing through openings 49. This small flow of gas continues through these auxiliary openings until the pressure in the reservoir space 55 becomes sufficiently great that the compression springs open the excess flow valves. When these valves open normal operation of the gas lift apparatus is then started.

The compression springs for use with the poppet type valves herein illustrated are so selected and so adjusted that the valves will close before the pressure in the annulus 43 has been decreased to such an extent it cannot lift the normal load of oil up the production tubing.

Materials of construction of the apparatus parts may be selected from among those commercially available, taking into consideration strength of such materials and their resistance to corrosion.

Other types of excess flow valves may be used in place of the poppet type valves herein explained. Ball type excess flow valves 61, assembled in openings 12*a* of an upper packer 31*a* of Figure 6, can be adapted for this use and when such valves are used the valves must be so designed that a ball is lifted to a point against a seat for closing off the flow of an excess volume of gas. Openings 35*a* through the upper packer 31*a* will then permit equalization of pressure from the annulus above the packer to the space between the packers and when pressure is nearly equalized the valve ball will unseat and normal flow of gas is then permitted. The upper packer has an opening 37*a* for a production tubing.

The use of the lower packer 47 of Figure 4 is not critical hence it may be omitted. When not used, the openings 49 in the tubing can be omitted and the oil to be lifted and the power gas enter the open end 57 of the production tubing. The space then between packer 45 and the level of the oil at the end of the tubing becomes the reservoir space. However, when not using this lower packer, the openings 49 can be used and in that case power gas can enter the tubing via these openings while the oil to be lifted enters through the open end 57.

While certain embodiments of my invention have been described for illustrative purposes the invention obviously is not limited thereto.

I claim:

1. A gas lift well flow device including, in combination, a well tubing, a well casing surrounding said tubing, a packing means disposed operably between said casing and said tubing, a passage extending through said packing means from top to bottom thereof, an excess flow valve communicating with said passage, said valve being adapted to restrict excessively rapid flow only of gas downward therethrough, an opening in said tubing below said packing means, a separate opening extending through said packing means from top to bottom thereof, this latter opening being adapted to bypass said valve with a smaller volume of gas than passed by said valve.

2. A gas lift well flow device including, in combination, a well tubing, a well casing surrounding said tub-

ing, a packing means disposed operably between said casing and said tubing, a plurality of passages extending through said packing means from top to bottom thereof, a plurality of excess flow valves, each valve of said plurality of valves communicating with a separate passage of said plurality of passages, said valves being adapted to restrict excessively rapid flow only of gas downward through said passages, an opening in said tubing below said packing means, a separate opening extending through said packing means from top to bottom thereof, this latter opening being adapted to bypass said valves with a smaller volume of gas than passed by said valves.

3. A gas lift well flow device including, in combination, a well tubing, a well casing surrounding said tubing, a packing means disposed operably between said casing and said tubing, a plurality of passages extending through said packing means from top to bottom thereof, a plurality of excess flow valves, each valve of said plurality of valves communicating with a separate passage of said plurality of passages, said valves being adapted to restrict excessively rapid flow only of gas downward therethrough, a plurality of separate openings extending through said packing means from top to bottom thereof, these latter openings being adapted to bypass said valves with a smaller volume of gas than passed by said valves, and an opening in said well tubing below said packing means.

4. A gas lift well flow device including, in combination, a well tubing open at its lower end extending into a body of well liquid in a deep well, a well casing surrounding said tubing, a packer disposed operatively between said casing and said tubing, said packer being so positioned as to form a reservoir therebelow, a passage extending through said packer from top to bottom thereof, a poppet-type, spring-loaded excess flow valve communicating with said passage, said valve being adapted to restrict excessively rapid flow only of gas downward therethrough, an opening extending through said valve, said opening being adapted to bypass said valve with a smaller volume of gas than passed by the valve, and a separate opening in said well tubing within said body of well liquid.

5. A gas lift well flow device including, in combination, a well tubing open at its lower end, a well casing surrounding said tubing, a packing means disposed operably between said casing and said tubing, said packing means being so positioned as to form a reservoir therebelow, said well tubing being positioned in said well so that its bottom end terminates within a body of oil, a passage extending through said packing means from top to bottom thereof, an excess flow valve communicating with said passage, said valve being adapted to restrict excessively rapid flow only of gas downward therethrough, and a separate opening extending through said packing means from top to bottom thereof, said separate opening being adapted to bypass said valve with a smaller volume of gas than passed by said valve.

6. A gas lift well flow device including, in combination, a well tubing open at its lower end, a well casing surrounding said tubing, a pair of packing means disposed operatively between said tubing and said casing and at a spaced distance apart, a first opening in the wall of said tubing at a point intermediate said packing means, said packing means, said casing and said tubing intermediate said packing means defining the ends, the outer wall and the inner wall of an annular space, said tubing being disposed in said well at such a depth that oil in said well rises in said tubing to a point above said opening, a passage extending through the upper packing means of said pair from top to bottom thereof, an excess flow valve communicating with said passage, said valve being adapted to restrict excessively rapid flow only of gas downward therethrough, and a second opening extending through said valve, said second opening being adapted to bypass said valve with a smaller volume of gas than passed by said valve.

7. A gas lift well flow device including, in combination, a well tubing extending into a body of well liquid in a deep well, a well casing surrounding said tubing, a packer disposed operatively between said casing and said tubing, said packer being so positioned as to form a reservoir therebelow, a passage extending through said packer from top to bottom thereof, a poppet-type, spring-loaded excess flow valve communicating with said passage, said valve being adapted to restrict excessively rapid flow only of gas downward therethrough, an opening extending through said packer from top to bottom thereof, said opening being adapted to bypass said valve with a smaller volume of gas than passed by said valve, and a separate opening in said well tubing within said body of well liquid.

8. A gas lift well flow device including, in combination, a well tubing extending into a body of well liquid in a deep well, a well casing surrounding said tubing, a packer disposed operatively between said casing and said tubing, said packer being so positioned as to form a reservoir therebelow, a passage extending through said packer from top to bottom thereof, a ball-type excess flow valve communicating with said passage, said valve being adapted to restrict excessively rapid flow only of gas downward therethrough, an opening extending through said packer from top to bottom thereof, said opening being adapted to bypass said valve with a smaller volume of gas than passed by said valve, and a separate opening in said well tubing within said body of well liquid.

9. A gas lift well flow device including, in combination, a well tubing open at its lower end and extending into a body of well liquid in a deep well, a well casing surrounding said tubing, a first packer disposed operatively between said casing and said tubing, a second packer disposed above said first packer and operatively between said casing and said tubing, said packers being spaced from each other so as to form a reservoir therebetween, a passage through said second packer and extending from top to bottom thereof, a poppet-type, spring-loaded excess flow valve being disposed in communication with said passage so as to restrict excessively rapid flow only of gas downward therethrough, a first opening from top to bottom of said second packer for unrestricted flow of gas, said first opening being adapted to bypass said valve with a smaller volume of gas than passed by said valve, a second opening in said tubing at a level intermediate said packers, and said tubing being so positioned in said well that the static level of said well liquid is above said opening in said tubing.

10. A gas lift well flow device including, in combination, a well tubing open at its lower end and extending into a deep well, a well casing surrounding said tubing, a first packer being disposed to form a seal between said casing and said tubing, a second packer being disposed above said first packer to form a seal between said casing and said tubing, said packers being positioned at a spaced distance from one another in such a manner as to form a reservoir therebetween, a passage extending through said second packer from top to bottom thereof, a poppet-type, spring-loaded excess flow valve being disposed in said passage in such a manner as to restrict excessively rapid flow only of gas downward therethrough, a first opening in said poppet-type valve, said first opening being adapted to bypass said valve with a smaller volume of gas than passed by said valve, a second opening in said tubing at a point intermediate said packers to provide communication between said reservoir and the interior of said tubing, and said tubing being so positioned in said well that the static level of said well liquid in said well is above said opening in said tubing.

11. A gas lift well flow device including, in combi-

nation, a well tubing open at its lower end and extending into a body of well liquid in a deep well, a well casing surrounding said tubing, a packer disposed operatively between said casing and said tubing, said packer being so positioned as to form a reservoir therebelow, a passage extending through said packer from top to bottom thereof, a poppet-type, spring-loaded excess flow valve communicating with said passage, said valve being adapted to restrict excessively rapid flow only of gas downward therethrough, a first opening through said valve for bypassing said valve with a smaller volume of gas than the volume passed by the valve, and a second opening in said tubing below said packer and below the static head of well liquid in said well.

12. A gas lift well flow device including, in combination, a well tubing, a well casing surrounding said tubing, a packing means disposed operatively between said casing and said tubing, a passage extending through said packing means from top to bottom thereof, an excess flow valve communicating with said passage, said valve being adapted to restrict excessively rapid flow only of gas downward therethrough, an opening through one of said packing means and said excess flow valve, said opening being adapted to bypass said valve with a smaller volume of gas than passed by said valve, and a separate opening in said well tubing below said packing means.

13. A gas lift well flow device including, in combination, a well tubing open at its lower end and extending into a body of well liquid in a deep well, a well casing surrounding said tubing, a first packer disposed operatively between said casing and said tubing, a second packer disposed operatively between said casing and tubing and above said first packer so as to form a reservoir therebetween, a passage through said second packer from top to bottom thereof, an excess flow valve communicating with said passage in such a manner as to restrict excessively rapid flow only of gas downward therethrough, a first opening in one of said second packer and said excess flow valve, said first opening being adapted to bypass said valve with a smaller volume of gas than passed by said valve, and a second opening in said tubing at a level intermediate said packers, and said tubing being so positioned in said well that the static level of said well liquid is above said second opening in said tubing.

14. The gas lift apparatus of claim 13 wherein said excess flow valve is a ball valve.

15. A gas lift well flow device including, in combination, a well tubing disposed in an oil well, a casing surrounding said tubing, a packer disposed operatively between said tubing and casing in said well, a passage through said packer from top to bottom thereof, an excess flow valve communicating with said passage, said valve being adapted to restrict excessively rapid flow of gas downward therethrough, a first opening in said valve, said first opening being adapted to bypass said valve with a smaller volume of gas than passed by said valve, and a second opening in said tubing below said packer for inlet of well liquid into said tubing.

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