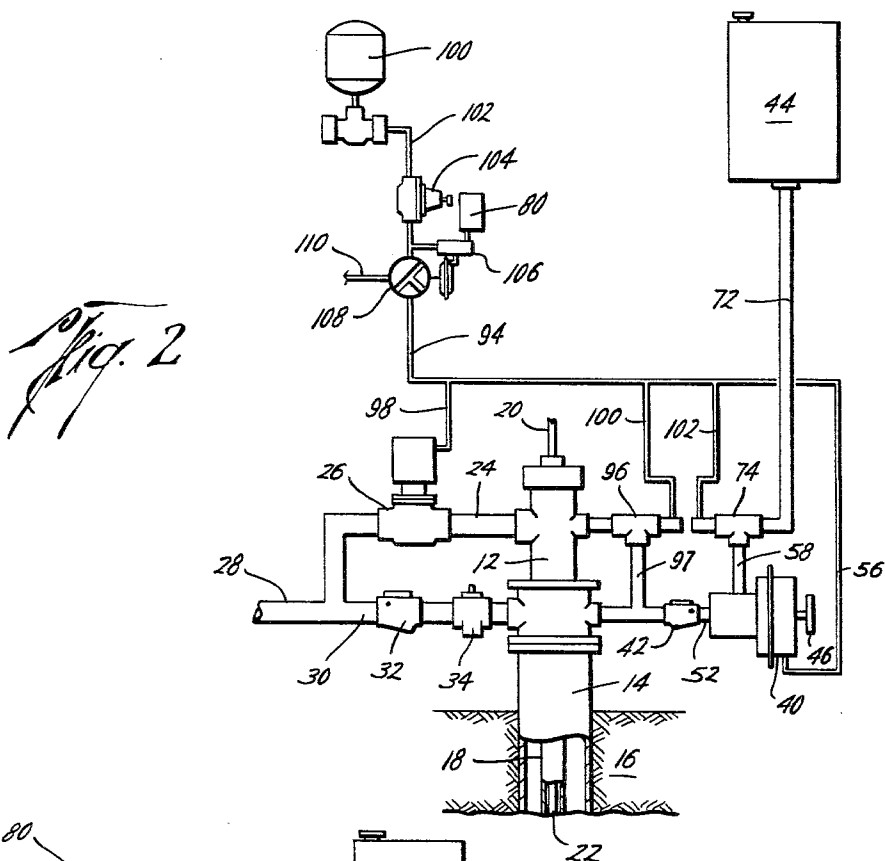
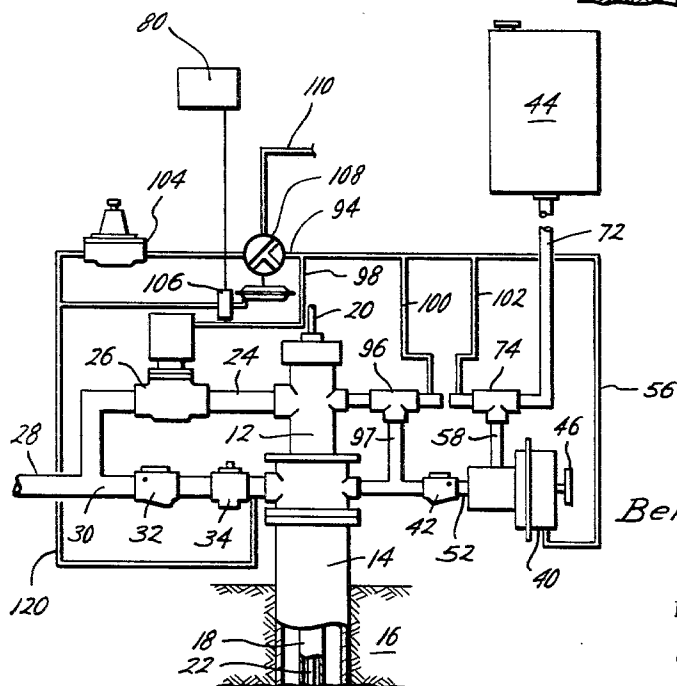


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AUTOMATIC CHEMICAL INJECTION APPARATUS FOR WELLS

Filed Jan. 30, 1963

3 Sheets-Sheet 2



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Jan. 11, 1966

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3,228,472

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Filed Jan. 30, 1963

3 Sheets-Sheet 3

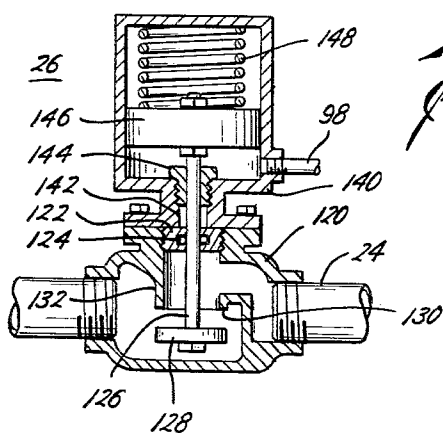
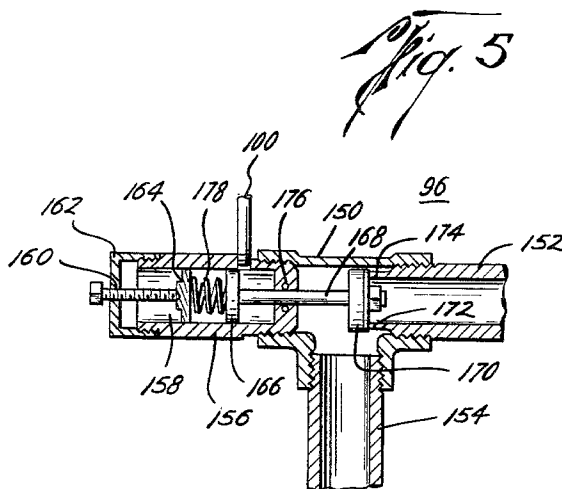
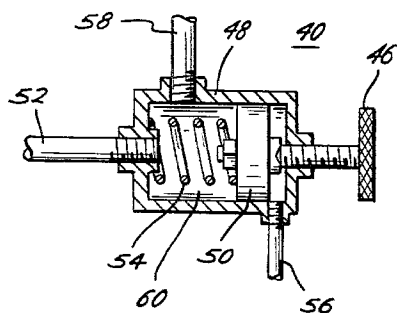


Fig. 6



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AUTOMATIC CHEMICAL INJECTION APPARATUS FOR WELLS

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Filed Jan. 30, 1963, Ser. No. 254,883

6 Claims. (Cl. 165-64)

This invention pertains generally to well apparatus and particularly to well apparatus for injecting fluids into wells.

In many oil and gas wells it is necessary to add some material or chemical substance for counteracting corrosion in the well casing, in the production tubing or in other production equipment. Various chemical compositions have provided satisfactory service in inhibiting corrosion and maintaining production of oil and gas wells. However, past practice generally has utilized individual operators who approach a well, measure out a determined volume of chemical, pour the chemical into the well annulus, and then switch valves at the well to divert produced fluids down the annulus to flush the chemical to the bottom of the well. After a certain interval of time, the individual operator again switches the valves at the well back to their original positions so that fluids produced from the well are delivered to the stock tanks.

Not all known chemical injection has been performed manually inasmuch as certain semi-automatic systems and apparatus have been provided with limited success. For example, U.S. Patent 2,773,551 issued December 11, 1956 to Robert L. Warden and Kenneth W. Robertson discloses an automatic inhibitor injection system for pumping wells. A metering pump is provided and actuated by a reciprocating lever arm or other means whereby chemical is pumped to a flushing chamber. The use of such flushing chamber permits the periodic injection of a batch or slug of a chemical agent into the well. Likewise, U.S. Patent 3,053,320 issued September 11, 1962 to Sammy B. Steincamp discloses fluid injection apparatus for wells. Steincamp is directed to correcting inaccuracies in the amount of chemical being injected, reducing the time needed for operating personnel to inject the chemical into a well, and reducing expense from the standpoint of the amount of additional equipment which must be employed to inject the chemical into a well.

While known apparatus and methods have achieved some automation and have represented an improvement over manual injection of chemicals into wells, such known apparatus and methods have left much to be desired in the control of the quantity of chemical injected and the frequency of injection. Known apparatus and methods have required substantially complex mechanism, particularly with regard to timing and determining the amount of chemical to be injected. Also, the chemical to be injected has been passed through a metering pump or other apparatus thereby causing corrosion of apparatus through which the chemical is passed. Known apparatus and methods for chemical injection further have not been fail safe in many instances because the timer which is used to control the amount of chemical may fail thereby allowing chemical to be injected into the well without regard to the quantity or frequency of injection.

Thus, an object of the present invention is to provide improved apparatus for injecting fluids into wells.

Another object of the present invention is to provide fluid injection apparatus for wells in a simple yet fail-safe manner and without the fluid injected into the well having to be passed through metering pumps or other apparatus which may be damaged if the injected fluids are corrosive chemicals.

A still further object of the present invention is to pro-

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vide a chemical injection system for wells wherein accurate control is maintained of the amount of chemical injected into a well and the frequency of injection also is closely controlled.

Still a further object of the present invention is to provide a chemical injection system which may be easily adapted to many operating conditions in the field without sacrifice of accuracy, reliability, and without increased expense.

Yet another object of the present invention is to provide a chemical injection system which is adaptable to wells which are either pumped or flowing and which is equally effective when used on either type of wells.

In the drawings, FIGURE 1 is a combined sectional-elevational, schematic representation of one embodiment of the present invention;

FIGURE 2 is another embodiment of the present invention shown in a combined sectional-elevational, schematic representation;

FIGURE 3 is a combined sectional-elevational, schematic representation of another embodiment of the present invention;

FIGURE 4 is a sectional plan view of a valve member which may be utilized as a component in practicing the present invention;

FIGURE 5 is a sectional plan view of another valve member which may be utilized as a component in practicing the present invention; and

FIGURE 6 is a sectional plan view of a chamber member which may be used in practicing the present invention.

Briefly stated, the present invention provides apparatus and methods for automatically injecting a selected volume of fluid into a well at selected time intervals with such fluid being flushed to the bottom of the well by diverting production from the well back into the well for a brief period of time while the selected volume of fluid is being injected. Flushing of the selected volume of fluid such as a chemical into the well also can be accomplished by combining the fluid with a source of liquid such as water previously produced by the well and stored in a nearby tank. A suitable chamber member or a volume regulator is used for providing accurate measurement of the amount of fluid to be injected into the well at the selected time. Timing means are used for controlling the frequency and duration of fluid injection and flush into the well. Such timing means may be a mechanically or pneumatically wound spring driven or electrically driven clock which is well known in the art.

Referring now to the drawings in detail, FIGURE 1 shows a typical producing well structure including a wellhead assembly 12 having coupled thereto a well casing 14 which is cemented in a bore hole in the earth 16. A production tubing string 18 extends downwardly into the casing 14 to a position near the bottom of a well where a pump may be secured to the lower end of the tubing string 18. The top of the tubing string 18, or the top of wellhead assembly 12 is closed in a conventional manner as by a stuffing box which surrounds a polished rod 20 mounted for vertical movement through the stuffing box. The polished rod 20 is coupled to a string of sucker rods 22 which is positioned within the tubing string 18 and extends downwardly to the bottom of the well where it actuates the plunger of a pump. Normal production from the well passes through line 24 through normally open valve 26 to line 28. Line 28 is coupled to line 30 which is coupled through valves 32 and 34 to the wellhead assembly 12.

A volume regulator and injector 40 is coupled through check valve 42 to the wellhead assembly 12. The purpose of the volume regulator and injector 40 is to regulate the amount of fluid, such as chemical from a tank

44, to be injected during a particular flush cycle into the well. Volume regulator and injector 40 also may be referred to as a chamber member. The volume of chemical injected can be controlled by suitable adjusting means such as threaded screw 46 on the volume regulator and injector 40. The function and operation of screw 46 will become apparent when the volume regulator and injector unit 40 is explained in greater detail subsequently.

As shown in FIGURE 6, the volume regulator and injector 40 includes a housing 48 having screw 46 extending therein at one end thereof through a threaded opening in housing 48. Reciprocating means including a piston 50 are disposed in housing 48 and piston 50 is positioned in substantial alignment with line 52. Suitable biasing means, including a spring 54 are disposed intermediate the opening to line 52 and piston 50. It is apparent that screw 46 limits the travel of piston 50 in its movement toward screw 46. When suitable pressure is applied through opening 56, piston 50 moves toward the opening of line 52. Line 58 is coupled intermediate the piston 50 and line 52 and line 58 provides a source of fluid such as a chemical mixture to be stored temporarily in chamber 60 of housing 48. When chemical is to be injected into the well, pressure is applied to the reciprocating means including piston 50 through line 56 which is coupled to hydraulic means including a pump 70 as shown in FIGURE 1. When pressure through line 56 is released, spring 54 returns piston 50 to a normal position determined by the setting of screw 46. When piston 50 returns to its normal position, chemical from tank 44 is sucked into chamber 60 through line 72, normally-open valve 74, and line 58.

Timing means 80 control the frequency of chemical injection into the well. Timing means 80 may include a mechanically or pneumatically wound, spring-driven or electrically driven device such as a clock well-known in the art. The timing means 80 also control the duration of the flush cycle wherein chemical is injected into a well and flushed to the bottom thereof. Frequency of injection, for example, may be controlled by suitable means such as removable pins that may be inserted at the proper point on a first rotational wheel of the timing means. The duration of the flush cycle may be controlled by adjusting a second rotational wheel or by adjusting the "on" period of the clock. Output from the timing means 80 may be a pneumatic or electrical signal. The output signal from the timing means 80 of FIGURE 1 is used to energize an electric motor 82 from a suitable source of electrical energy not shown. Electric motor 82 is coupled to a shaft 84 which is coupled to a hydraulic pump 70. Hydraulic pump 70 is coupled through line 86 to a hydraulic storage tank 88. Hydraulic storage tank 88 has a relief valve 92 coupled thereto through line 90.

The pressure output from the hydraulic pressure means including hydraulic pump 70 is used for driving the reciprocating means including piston 50 of the chemical injector and volume regulator 40 through conduit 56 which is coupled to conduit 94. The pressure provided by hydraulic pump 70 is also used for actuating control means which may include control valves 26, 96, and 74, and the control lines 98, 100 and 102 which are used to open and close the valves. Valves 26, 96 and 74 control the flow of chemical and the liquid used for flushing the chemical into the well. Valve 96 is coupled to the wellhead assembly 12 and is a normally-closed valve. Valve 96 opens when suitable pressure is applied through line 100. When valve 96 opens, fluids produced from the well re-enter the well through valve 96 and conduit 97 thereby flushing the injected chemical to the bottom of the well. Valve 26, which is normally open, closes when pressure is applied through line 98 thereby shutting off flow of produced fluids from the well through valve 26 and to the flow line 28. Thus, sufficient pressure is provided for flushing the chemical into the well. Valve 74

is a normally-open valve which closes when pressure is provided through line 102 so that chemical is injected into the well when the piston of regulator 40 moves. The chemical stored in the chamber of regulator 40 cannot feed back to chemical tank 44 through line 72 since valve 74 is closed. Check valve 42 prevents chemical from flowing into regulator 40 while the chemical is being flushed to the bottom of the well.

The pressure in line 94 is released by stopping the hydraulic pump 70 by a signal from timing means 80. When the pressure is released upon a signal provided by the timing means 80, the control means assume normal operation thereby allowing the well to produce in a normal manner. The chemical reserve tank 44 is in communication with the chemical injector 40 through valve 74 so that when the piston in regulator 40 returns to its initial position, chemical from tank 44 will be allowed to enter the storage chamber of the regulator 40. Valve 74 is normally open so that no restriction is encountered when moving the highly viscous chemical from tank 44 to the chamber of regulator 40.

It will be apparent that although the well assembly shown in FIGURE 1 is adapted for a pumping well, the operation of the chemical injector system will be equally effective if the well is either pumping or flowing. The operation of the chemical injector system of the present invention is not dependent upon a specific number of strokes of a pump or other apparatus of the well for effective operation. Likewise, the particular positioning of elements of the present invention is not dependent upon gravity, or hydrostatic head and therefore the elements of the present invention may be positioned at any convenient location.

FIGURE 2 is a combined sectional-elevational, schematic representation of another embodiment of the present invention with the elements shown in FIGURE 2 functioning in substantially the same manner as those shown in FIGURE 1. In FIGURE 2, however, pneumatic pressure means including a source 100 is coupled through line 102 to a regulator 104. Timing means 80 are coupled to a solenoid 106 on valve 108. Valve 108 has a bleed line 110 which is used to vent the compressed air which has accumulated in line 94 when the pressure in line 94 is to be removed so that the control means including valves 26, 96, and 74 function in a normal manner. Thus, when the control valves assume their normal position, the well produces in a normal manner and the piston in regulator 40 returns to its normal position so that a new quantity of chemical enters the evacuated chamber of regulator 40 through line 58.

FIGURE 3 is a combined sectional-elevational schematic representation of another embodiment of the present invention. The embodiment of FIGURE 3 is similar to that described in conjunction with FIGURE 2. However, in FIGURE 3 it is assumed that the pneumatic pressure means has a source of pneumatic pressure available from the well. Therefore line 120 is coupled through regulator 104 to valve 108. Valve 108 has a bleed line 110 which functions in the same manner as described previously in connection with FIGURE 2. Timing means 80 are coupled to solenoid 106 of valve 108 and valve 108 operates the system in a manner previously described. Regulator 40 may have a suitable independent source of power to provide forced injection of chemical into the well where the pressure from the well is not adequate.

FIGURE 4 is a sectional plan view of the normally open valve 26 shown in FIGURES 1, 2, and 3. The valve includes a lower housing 120 having an opening at each end, each of such openings having threads which are adaptable for coupling to suitable conduits or lines, such as line 24. Member 122 may be threadedly engaged in the upper portion of the valve housing 120. Member 122 has an aperture therein sealed by suitable sealing means such as an O-ring 124 adapted for positioning around the circumference of a rod 126. The lower por-

tion of rod 126 has coupled thereto member 128 which seats on edges 130 and 132 when the valve is in a closed position. Coupled to housing 120 through suitable fastening means is housing 140. Threadedly disposed in housing aperture 142 is a member 144 having a central aperture adapted for passage of rod 126. Coupled to rod 126 at its upper portion is a piston 146 and disposed between the upper portion of piston 146 and the upper part of housing 140 are biasing means such as a spring 148. Thus, as will be apparent from viewing FIGURE 4, biasing means 148 exert downward force on piston 146 and rod 126 so that member 128 normally is not seated on seats 130 and 132, thereby allowing free flow of fluid through the valve. Obviously, when pressure is applied through line 98 so that the biasing force of means 148 is overcome, piston 146 will be moved upwardly to cause member 128 to seat on seats 130 and 132 thereby closing the valve.

FIGURE 5 is a sectional plan view of normally closed valve 96. Valve 96 includes a housing 150 having three threaded openings to which lines 152 and 154 may be coupled as shown. The other threaded opening of housing 150 has a structure 156 coupled thereto. Structure 156 includes an aperture or chamber 158 and disposed in such chamber is a threaded adjustment screw 160. Screw 160 is threadedly coupled at one end to end member 162. End member 162 may be threadedly coupled to structure 156. Adjustment screw 160 is coupled at one end to a plunger 164. Also disposed in chamber 158 is piston 166 which is coupled to a rod 168. Rod 168 has a member 170 coupled thereto adapted for seating on edges 172 and 174 of line 152.

Disposed intermediate plunger 164 and piston 166 are biasing means such as a spring 178. Spring 178 has the effect of maintaining sufficient force on piston 166 and member 170 so that line 152 is closed, thereby causing valve 96 to be a normally-closed valve. Obviously when sufficient pressure is applied through line 100 to overcome the force of spring 178, member 170 is unseated from seats 172 and 174 and therefore line 152 is opened for communication with line 154. Sealing means such as an O-ring 176 is provided to assure proper sealing of chamber 158 as rod 168 moves as a part of the reciprocating means which open and close the valve. Obviously, the positioning of adjustment screw 160 varies the pressure applied to piston 166 and therefore the valve 96 may be effectively utilized when various pressures are available through line 100.

Also while referring to FIGURE 5, it will be apparent to those skilled in the art that valve 96 may be converted to a normally open valve such as valve 74 shown in FIGURES 1, 2, and 3 by merely reversing the positions of line 100 and biasing means 178 with respect to piston 166. Thus, to change valve 96 to a normally-open valve such as valve 74 biasing means 178 would be positioned between piston 166 and seal 176 so that member 170 would be normally out of contact with seats 172 and 174 thereby providing an opening through line 152. Line 100 would be moved substantially to the position shown for biasing means 178 in FIGURE 5 so that when pressure is applied through line 100, piston 166 would move toward seats 172 and 174 thereby closing the valve.

Thus, the present invention provides improved apparatus and methods for automatically injecting a selected volume of fluid such as a chemical mixture into a well at a selected time. The chemical is flushed into the well for a selected time period by diverting fluid produced from the well back into the well along with the selected volume of chemical. The present invention is not dependent upon gravity positioning of any of the component parts and the present invention is equally effective when used with a flowing well or with a pumping well. A minimum number of components are required and the components are easily adjustable to various operating conditions so that components may be taken from one

well and used with minimum modification but with equal effectiveness on other wells.

Although preferred embodiments of the invention have been shown and described, it will be apparent to those skilled in the art that many modifications may be made without departing from the spirit of the invention as defined by the following claims. Although such claims may be presented in indented format to facilitate reading and understanding thereof, such indented format is not to be construed as a structural or functional limitation of elements or steps recited in the claims.

What is claimed is:

1. Apparatus for injecting fluid from a source into a well having a production conduit, said apparatus including in combination
 - hydraulic pressure means,
 - chamber member means coupled in fluid communication to said hydraulic pressure means, to said source, and to said well,
 - control means coupled in fluid communication to said hydraulic pressure means and to said chamber member means, and
 - timing means coupled to said hydraulic pressure means for periodically actuating the same to allow a selected volume of fluid to flow into said chamber member means from said source, said control means providing injection of the selected volume of fluid in said chamber member means into the well as produced fluids from the well flush said selected volume of fluid to the bottom of the well.
2. Apparatus for injecting fluid from a source into a well having a production conduit, said apparatus including in combination
 - pneumatic pressure means,
 - chamber member means coupled in fluid communication to said pneumatic pressure means, to said source, and to said well,
 - control means coupled in fluid communication to said pneumatic pressure means and to said chamber member means, and
 - timing means coupled to said pneumatic pressure means for periodically actuating the same to allow a selected volume of fluid to flow into said chamber member means from said source, said control means providing injection of the selected volume of fluid in said chamber member means into the well as produced fluids from the well flush said selected volume of fluid to the bottom of the well.
3. Apparatus for injecting fluid from a source into a well having a production conduit, said apparatus including in combination
 - pneumatic pressure means coupled to the well to receive actuating pressure therefrom,
 - chamber member means coupled in fluid communication to said pneumatic pressure means, to said source, and to said well,
 - control means coupled in fluid communication to said pneumatic pressure means and to said chamber member means, and
 - timing means coupled to said pneumatic pressure means for periodically actuating the same to allow a selected volume of fluid to flow into said chamber member means from said source, said control means providing injection of the selected volume of fluid in said chamber member means into the well as produced fluids from the well flush said selected volume of fluid to the bottom of the well.
4. Apparatus for injecting fluid from a source into a well having a production conduit, said apparatus including in combination
 - hydraulic pressure means,
 - chamber member means coupled in fluid communication to said hydraulic pressure means, to said source, and to said well,

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- control means including first, second, and third valves, said first valve being a normally-open valve coupled to the production conduit of the well, said second valve being a normally closed valve coupled between the production conduit of the well and said chamber member means, said third valve being a normally-open valve coupled to said chamber member means and to the source of fluid to be injected into the well, and
- timing means coupled to said hydraulic pressure means for periodically actuating the same to allow a selected volume of fluid to flow into said chamber member means from said source, said control means providing injection of the selected volume of fluid in said chamber member means into the well as produced fluids from the well flush said selected volume of fluid to the bottom of the well.
5. Apparatus for injecting fluid from a source into a well having a production conduit, said apparatus including in combination
- pneumatic pressure means, chamber member means coupled in fluid communication to said pneumatic pressure means, to said source, and to said well,
- control means including first, second, and third valves, said first valve being a normally-open valve coupled to the production conduit of the well, said second valve being a normally closed valve coupled between the production conduit of the well and said chamber member means, said third valve being a normally-open valve coupled to said chamber member means and to the source of fluid to be injected into the well, and
- timing means coupled to said pneumatic pressure means for periodically actuating the same to allow a selected volume of fluid to flow into said chamber member means from said source, said control means providing injection of the selected volume of fluid in said chamber member means into the well as produced fluids from the well flush said selected volume of fluid to the bottom of the well.
6. Apparatus for injecting fluid from a source into a

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- well having a production conduit, said apparatus including in combination
- pneumatic pressure means coupled to the well to receive actuating pressure therefrom,
- chamber member means coupled in fluid communication to said pneumatic pressure means, to said source, and to said well,
- control means including first, second, and third valves, said first valve being a normally-open valve coupled to the production conduit of the well, said second valve being a normally closed valve coupled between the production conduit of the well and said chamber member means, said third valve being a normally-open valve coupled to said chamber member means and to the source of fluid to be injected into the well, and
- timing means coupled to said pneumatic pressure means for periodically actuating the same to allow a selected volume of fluid to flow into said chamber member means from said source, said control means providing injection of the selected volume of fluid in said chamber member means into the well as produced fluids from the well flush said selected volume of fluid to the bottom of the well.

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