June 19, 1962 L. B. SCOTT 3,039,531

INJECTOR MECHANISM FOR CASING PERFORATION PLUGGING ELEMENTS

Filed April 11, 1958 4 Sheets-Sheet 1

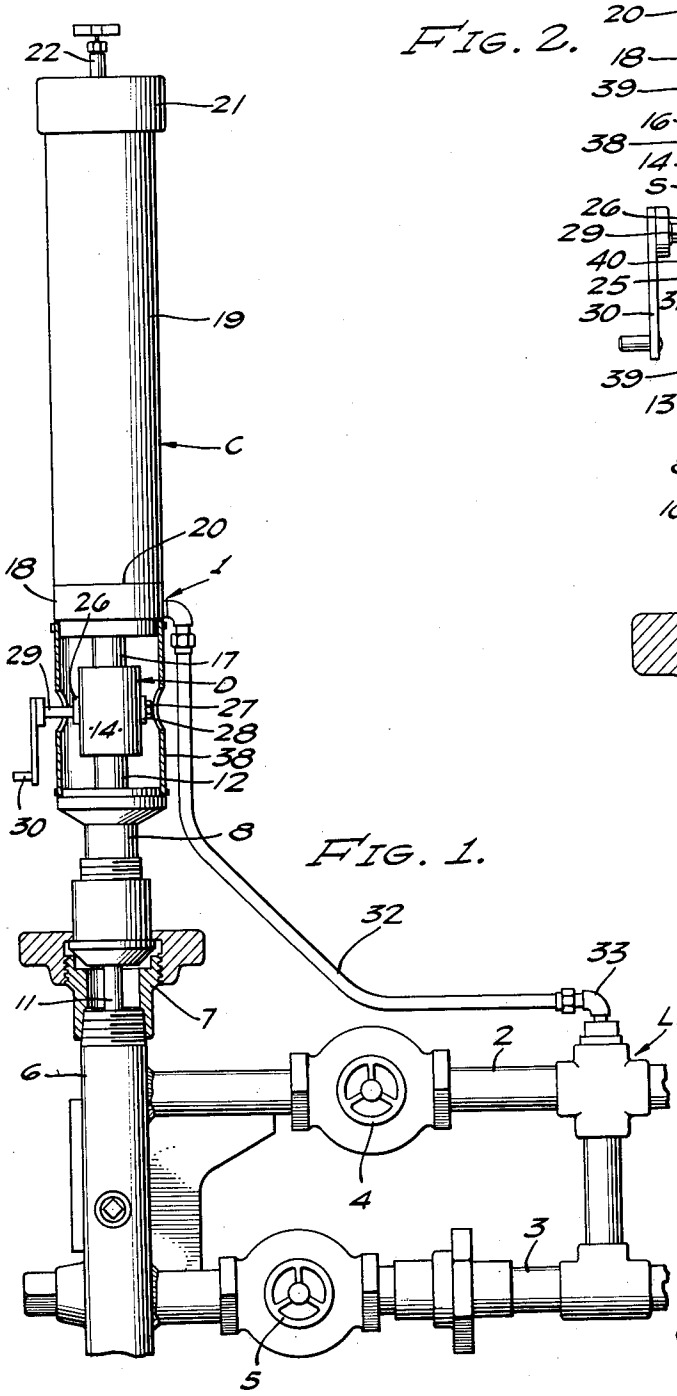

FIG. 1.

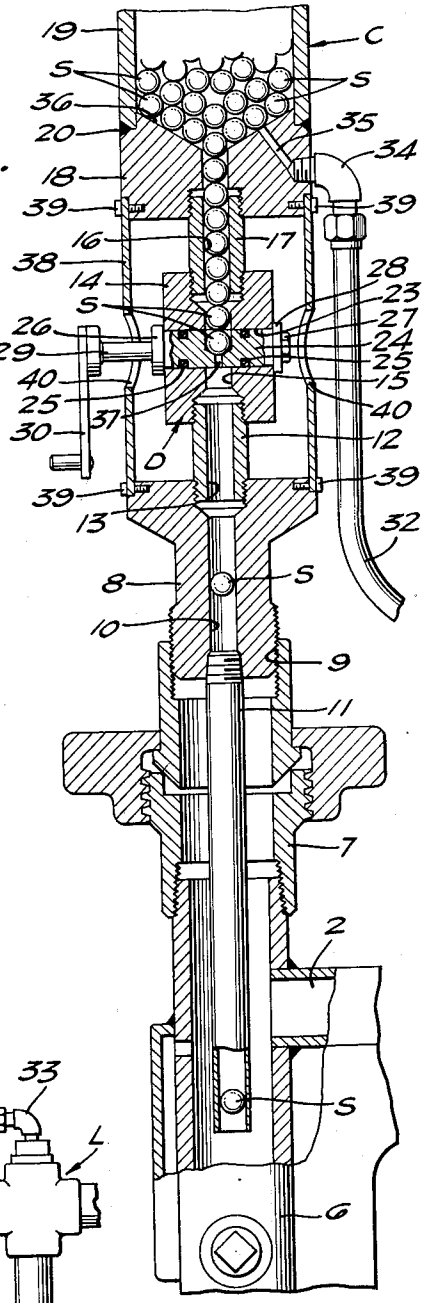

FIG. 2.

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INJECTOR MECHANISM FOR CASING PERFORATION PLUGGING ELEMENTS

Filed April 11, 1958 4 Sheets-Sheet 2

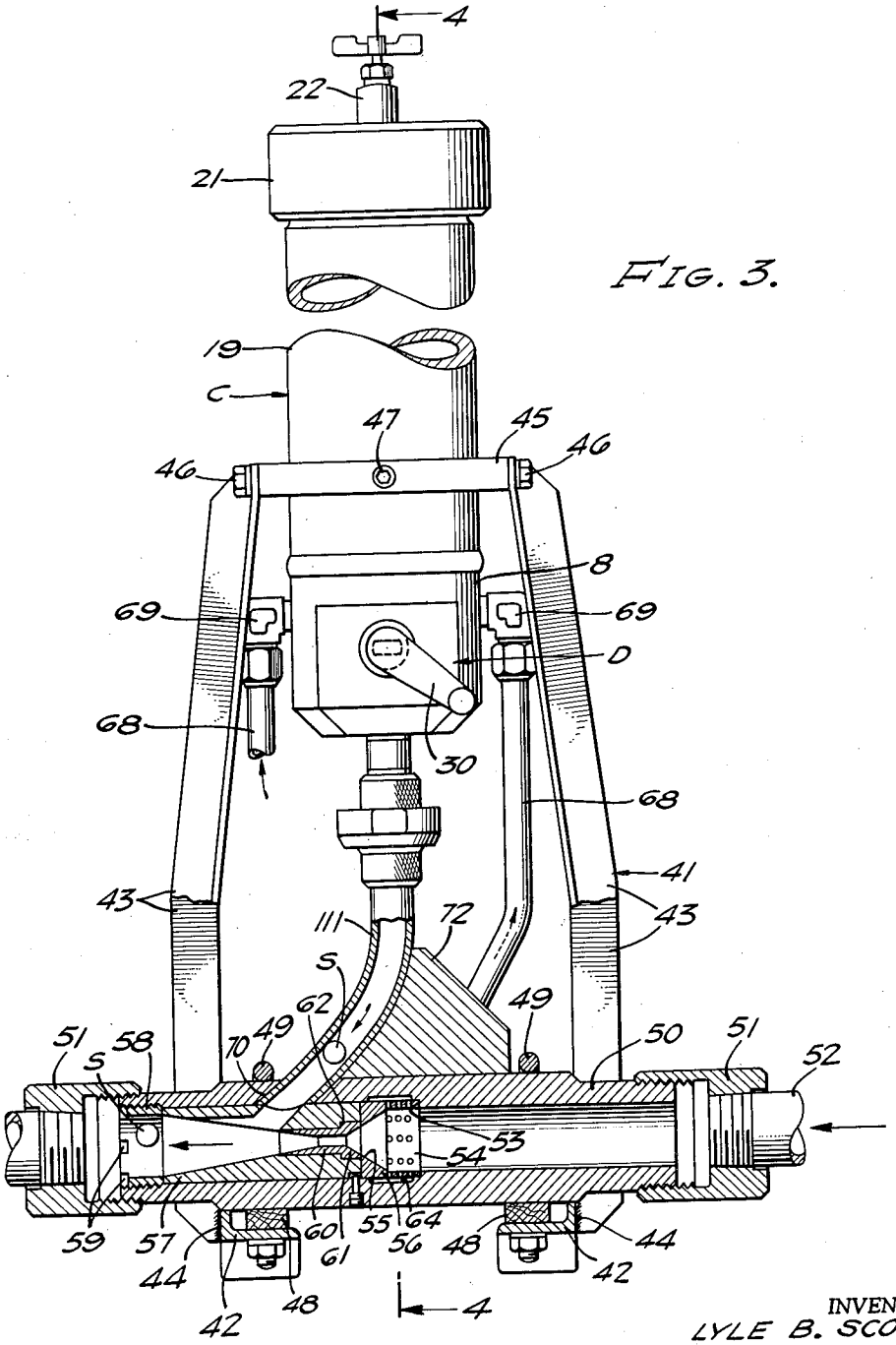

FIG. 3.

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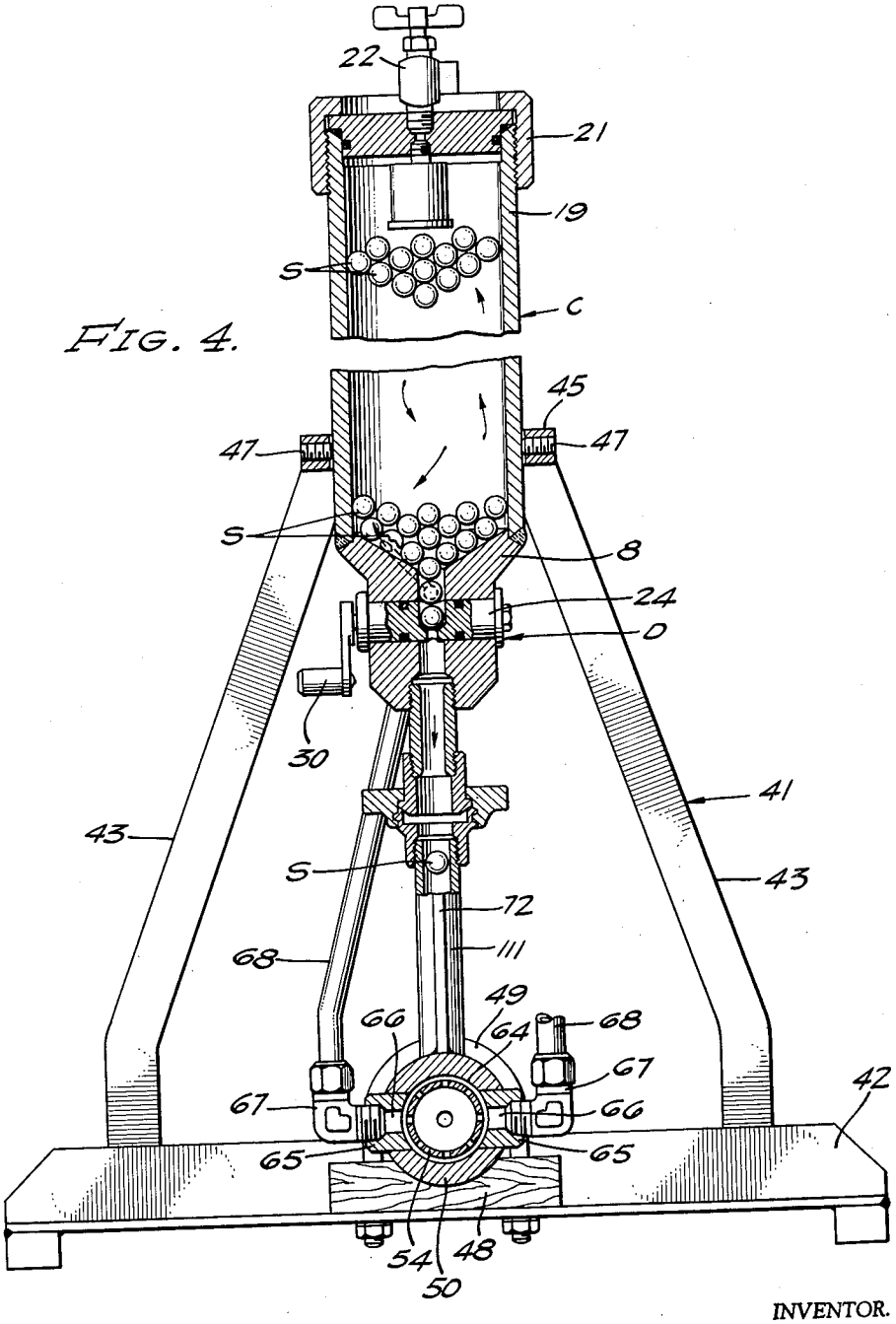
June 19, 1962 L. B. SCOTT 3,039,531

INJECTOR MECHANISM FOR CASING PERFORATION PLUGGING ELEMENTS

Filed April 11, 1958 4 Sheets-Sheet 3

FIG. 4.



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Filed April 11, 1958 4 Sheets-Sheet 4

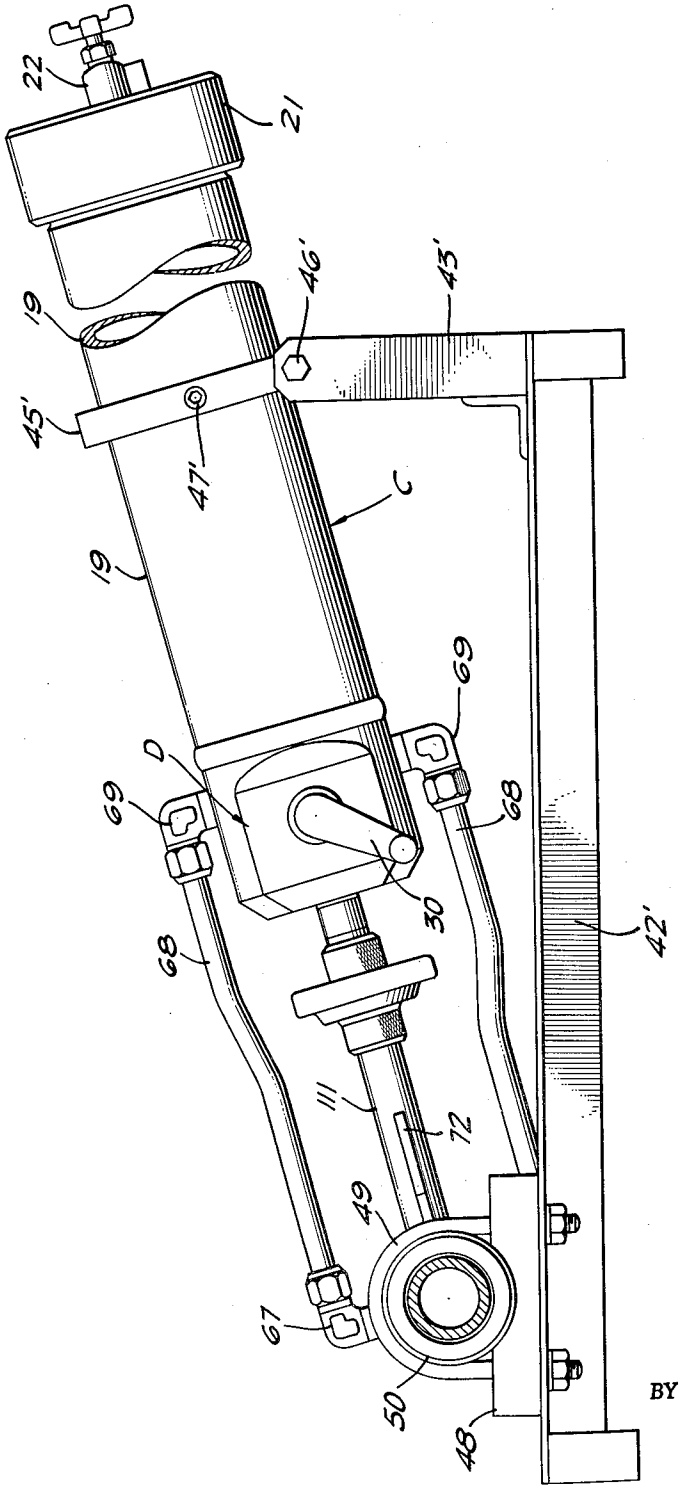

FIG. 5.

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INJECTOR MECHANISM FOR CASING PERFORATION PLUGGING ELEMENTS

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5 Claims. (Cl. 166—70)

The present invention relates to a mechanism for selectively dispensing or injecting plugging elements into a fluid stream, and more particularly to an injector mechanism which is particularly adapted for use in the performance of the method disclosed in U.S. Patent No. 2,754,910 dated July 19, 1956, to James V. Derrick et al.

In this prior patent there is disclosed a method for temporarily plugging perforations in well casing during well treating operations involving the injection of fluid under pressure into the well through the casing perforations.

The present invention contemplates improved mechanism for selectively dispensing or injecting perforation sealing balls or other plugging elements into the fluid stream as it is being pumped into the well.

It is highly desirable that during certain well treating operations, such as hydraulic formation fracturing, acidizing, or other operations where fluid is pumped down into the well and forced off into the formation, that continuity of injection be maintained. Accordingly, in order for a perforation sealer injector mechanism to be fully effective it should provide means for dispensing or injecting the perforation sealer elements into the fluid stream without requiring interruption of the fluid injection operation. One of the primary objects of the present invention is to provide such an injector mechanism, which enables uninterrupted fluid injection and which in addition employs to advantage in the operation of the sealer injector, fluid being pumped into the well.

Another object is to provide a mechanism for injecting perforation sealer elements into a fluid stream being pumped into the well, which requires that no special equipment be installed in the fluid conducting lines leading to the well. In accordance with one embodiment of the invention, the injector mechanism may be readily installed upon a conventional lubricator at the well head, while in accordance with another embodiment of the invention the injector mechanism may be conveniently installed in a fluid conducting conduit leading from the injection pump, or pumps, to the well.

A further object of the invention is to provide a perforation sealer injector mechanism including means for producing a pressure drop across the injector, and means for employing this pressure drop to provide an agitating flow of injection fluid through the sealer injector mechanism for agitating a supply of sealer elements in a container carried by the mechanism, such agitating fluid also being employed to facilitate the passage of perforation sealing elements from the mechanism into the injection fluid stream.

Still a further object of the invention is to provide perforation sealer injector mechanism in accordance with the foregoing, wherein an extremely simple form of dispenser mechanism may be availed of for selectively discharging individual perforation sealing elements from the container aforementioned, and wherein the agitating fluid flows from the container through the dispenser mechanism, so as to facilitate unfailing discharge of a perforation sealing element from the dispensing mechanism upon operation of the latter. This dispenser mechanism is preferably of the rotating trap chamber type and may be manually cycled so as to dispense individual perforation sealing elements at will or, if desired, suitable mechanized means may be employed for operating the dispenser mechanism.

Other objects and advantages of the invention will hereinafter be described or will become apparent to those skilled in the art, and the novel features thereof will be defined in the appended claims.

In the accompanying drawings:

FIGURE 1 is an elevational view, with certain of the parts broken away and shown in section, depicting a perforation sealer injector apparatus made in accordance with the invention and adapted to be associated with a conventional lubricator at the well head;

FIGURE 2 is an enlarged fragmentary view in vertical section through the injector mechanism of FIG. 1;

FIGURE 3 is an elevational view, with certain of the parts broken away and shown in section, of a modified ball injector mechanism made in accordance with the invention and adapted to be installed in a fluid conduit leading to the well head;

FIGURE 4 is a view in vertical section as taken on the line 4—4 of FIG. 3, and

FIGURE 5 is an elevational view depicting a modification of the perforation sealer injector mechanism of FIG. 3.

Like reference characters in the several figures of the drawings and in the following description designate corresponding parts.

Referring particularly to FIGS. 1 and 2, perforation sealer injector mechanism in accordance with the invention is generally designated at **1**, and in this embodiment, the injector is shown as operatively supported upon a known type of lubricator L, including a pair of vertically spaced flow lines **2** and **3**, respectively, having therein control valves **4** and **5** for selectively controlling the flow of fluid into a vertical pipe or manifold **6**, which is adapted to conduct injection fluid to tubing, not shown, extending downwardly into a well into which it is desired to inject treating fluid as, for example, formation fracturing fluid, acidizing fluid, washing fluid, or the like.

Removably secured to the upper extremity of the manifold or vertical pipe **6**, as by means of a coupling **7**, is a supporting base **8** vertically mounted in the coupling **7** as at **9**, and having therethrough a central passageway **10**. Depending from the support **8** and threadedly or otherwise secured thereto, is a discharge conduit **11** which extends downwardly in the manifold **6** to a point below the junction of flow line **2** with the vertical pipe or manifold **6**.

An appropriate type of dispenser generally designated D, is supported at the upper end of the base support **8**, and in the illustrative embodiment a rotating trap chamber dispenser is disclosed, the dispenser D being connected at its base to a nipple **12** which in turn is threadedly mounted in the base support **8**, with an opening **13** through the nipple communicating with the passageway **10** from the base **8**.

The body of the dispenser D is designated at **14**, and is provided with a vertical passageway **15** therethrough which is in alignment with the opening **13** through nipple **12**, and with an opening **16** through an upper nipple **17** which is connected to the dispenser body **14** and has supported upon its upper extremity a base **18** of a perforation sealer container C. The container C in the illustrative embodiment includes a cylindrical housing **19**, which is welded or otherwise suitably secured as at **20**, to the base **18**. At its upper extremity, the housing **19** is provided with a closure **21**, which is preferably provided with a vent valve **22**.

In the performance of the perforation sealing method of the aforementioned patent, perforation sealing elements in the form of balls may be employed, although other shaped perforation sealing elements may also be

employed. In order to facilitate the disclosure of the present invention, balls are disclosed as the perforation sealing elements to be dispensed by the dispenser D into the stream of well treating fluid; such sealing elements are designated at S and, in practice, may be on the order of ½" diameter, more or less.

The container C, and particularly the housing 19 thereof, is preferably of such a size as to readily accommodate upwards of 750 or more of such sealing elements as may be required in a specific perforation sealing operation.

In order to dispense the sealing elements S selectively and individually from the container C to enable their entrainment in the flow of treating fluid, the body 14 of the dispenser D is provided with a transverse bore 23 intersecting the passage 15 therethrough, and having disposed therein a rotatable dispenser barrel 24. Suitable sealing means 25, 25 are disposed about the barrel 24 at opposite sides of the passage 15.

In order to secure the barrel 24 in the bore 23, the barrel is preferably provided with an enlarged shoulder 26 at one end engageable with the body 14, and at its other end the barrel 24 has secured thereto by a screw 27 a washer 28. In the illustrative embodiment the barrel 24 is also provided with an axially extended stem 29 having thereon a hand-crank 30 for effecting rotation of the barrel. However, as pointed out hereinabove, any appropriate means may be employed for intermittently rotating the barrel. At its mid-point the barrel 24 is provided with a receiver chamber 31 which extends radially inwardly to approximately the axis of the barrel so as to receive therein a single perforation sealing element S when the receiver chamber 31 is vertically disposed and opens upwardly into the passageway 15 through the body 14. Upon rotation of the barrel through 180° the perforation sealer element S will be trapped within the chamber 31 until the chamber opens downwardly into the passageway 15 through the body 14, at which time it will be dispensed for movement into the stream of treating fluid.

In accordance with one of the salient features of the invention, means are provided whereby the treating fluid is employed to agitate the perforation sealer elements S in the container C. In this connection, a conduit or tube 32 is connected to the flow line 2, as at 33, the tube 32 being connected at its other end as by a fitting 34 to the base 18 of container C. A port 35 extends through the base 18 and communicates with the fitting 34, thus establishing a fluid passage extending from the flow line 2 through the tube 32 into the container housing 19.

The flow of treating fluid through the tube 32 will effect agitation of the sealer elements S in the housing 19, whereby, particularly when a large number of sealing elements is disposed in the housing 19, the sealing elements will not become compacted against the base 18 and thus prevent them from freely passing into the dispenser barrel 24. For further facilitating the movement of the sealer elements into the dispenser D, the inner surface 36 of the base 18 of the container is preferably convergent upon the center of the base as shown in FIG. 2.

In the operation of the mechanism, in order to effect an agitating flow of fluid through the tube 32, the valve 4 in flow line 2 will be partially closed so as to effect a pressure drop across the injector mechanism, thus resulting in the flow of fluid through the tube 32 into the housing 19 and thence downwardly through the assembly, discharging at the lower extremity of discharge conduit 11.

Dispenser barrel 24 is provided with a small passageway 37 for maintaining fluid communication between the housing container C and the lubricator L when the barrel 24 has been rotated to discharge a sealer S therefrom. Accordingly, the fluid passing through tube 32 and container C will also serve to facilitate movement of sealing elements S downwardly through the passageway 10 and through the discharge conduit 11. Further pressure drop and consequent suction on the fluid in the container C is effected by reason of the lower extremity of discharge conduit 11 opening in the direction of the flow of treating fluid through manifold pipe 6, so that the sealing elements S will consistently be discharged from the dispenser D and fed into the stream of treating fluid upon each cycle of the dispenser barrel 24.

Preferably a cylindrical case 38 is extended between the lower extremity of base 18 and support 8 and secured thereto at its opposite ends in a suitable manner, as by screws 39. At diametrically opposed points the case 38 is provided with openings through one of which the stem 29 of dispenser barrel 24 projects, and through the other of which the screw 27 is accessible for engagement by a wrench or the like to enable the removal of the dispenser barrel 24 from the dispenser D for service or replacement as may be necessary or desirable.

Referring to FIGS. 3 and 4, a modified construction is shown wherein the injector mechanism is adapted to be disposed in a conduit or line leading from a pumping unit to the well in lieu of being mounted upon a lubricator as in the embodiment of FIGS. 1 and 2. In this modified construction, a support is provided, as generally indicated at 41, this support being adapted to be disposed, for example, on the ground, at a point between the well head and the pumping unit. The support is preferably fabricated of angle irons or the like, and includes a pair of horizontally extended parallel rails 42, having longitudinally spaced upstanding support arms 43 welded or otherwise secured thereto as at 44. The respective support arms 43 converge upwardly upon one another and at their upper extremities have connected thereto, as by means of screws 46 or the like, a ring 45. The ring 45 is disposed about the container C with the container secured in the ring as by means of set screws 47 or other appropriate means.

Disposed upon each of the rails 42 is a cradle 48 in which is secured, as by U-clamps 49, a conduit 50 adapted to be connected at its opposite ends as by unions 51, 51 in a flow line 52 leading from the well head to the pumping mechanism for injecting fluid into a well. Interiorly of the conduit 50 it is provided with a radial shoulder 53 against which abuts one end of a cylindrical screen or filter 54.

In this embodiment venturi means is provided for effecting a pressure drop across the injector mechanism. In this connection, a ring 55 having a tapered opening 56 therethrough abuts at the other end of the screen 54, and an elongated venturi sleeve 57 is disposed in the conduit 50 for engagement with the ring 55 and pressed thereagainst, as by a threaded sleeve 58 adjustably mounted in the conduit 50 and provided with notches 59 for engagement by a wrench, whereby the screen 54, the ring 55 and the venturi sleeve 57 may be pressed in the direction of the shoulder 53 so as to securely retain these parts in the conduit 50.

A venturi throat insert 60, having an enlarged end flange 61, is disposed in the inner end of the venturi sleeve 57, with the enlarged end 61 disposed between a shoulder 62 in the sleeve 57 and the opposing end of ring 56. It will be noted that the venturi sleeve 57 and throat insert 60, together with the ring 56, constitue a venturi passage through the conduit 50, but other specific assemblies may be availed of for providing the venturi means in the conduit.

As in the embodiment of the invention first described, means are provided for circulating agitating fluid through the container C as a function of the pressure drop in the flow line. In the embodiment of FIGS. 3 and 4 the pressure drop is provided by the venturi means.

Fluid flows through the conduit 50 in the direction of the arrows and at the upstream side of the venturi means, and surrounding the screen 54 the conduit 50 is provided with an internal annular flow space 64. A pair of diametrically opposed fittings 65, 65 extend into the

conduit **50** and are provided with flow passages **66** communicating with the annular space **64**. L fittings **67** are connected to the fittings **65** and tubes **68**, **68** are connected to the fittings **67** at one end, the tubes **68** being connected at their other ends by fittings **69** to the base **8** of the container C. At the downstream side of the venturi means the discharge conduit **111** leading from the container C and into the conduit **50**, as at **70**, is subjected to the low pressure side of the venturi means whereby a circulation of fluid through tubes **68** into the container C and back into the conduit **50** will be effected.

The discharge conduit **111** is arched in the direction of fluid flow through the conduit **50** and preferably a reinforcing gusset **72** is welded or otherwise suitably secured between the discharge conduit **111** and the conduit **50**. The gusset **72** protects the discharge conduit **111** against excessive strains as the dispenser mechanism is operated to dispense perforation sealing elements S and causes pressure pulses in fluid flowing through the mechanism.

The structure comprising the container C and the dispenser D in this modified construction is the same as that previously described in connection with the embodiment of FIGS. 1 and 2; therefore, further description of these features need not be resorted to for an understanding of the invention, and the same reference numerals are applied.

Referring to FIG. 5, an embodiment generally corresponding to that shown in FIGS. 3 and 4 is disclosed. However, supporting rails **42'** are employed in the construction of FIG. 5 which extend transversely of the conduit **50** to a substantial extent to one side of the latter. Relatively short vertical support arms **43'** are interconnected as by screws **46'** to ring **45'**, this ring being secured to the housing **19** of container C as by set screws **47'**.

In this construction it will be noted that the mechanism is disposed at an angle, as distinguished from previously described embodiments wherein the container is disposed substantially on a vertical axis. In practice, the container C, dispenser mechanism D, discharge conduit **111** and conduit **50**, together with all of the appertenances thereto, may be interchangeably mounted upon the supporting base construction of FIGS. 3 and 4 on the one hand, or of FIG. 5 on the other hand, by simply removing the U-bolts **49**.

Preferably the container C in the embodiment of FIG. 5 is disposed at an angle of approximately 15° to the horizontal. The result of such angular disposition being that in those cases where a large number of perforation sealer elements, say, on the order of up to 750 or more of such elements, are disposed in the container C, there is little or no tendency for the perforation sealer elements in the zone of the dispenser mechanism, by reason of the weight of the overlying perforation sealer elements, to become compacted and bound so as not to be freely dispensed.

While the specific details of several embodiments of the invention have been herein shown and described, changes and alterations may be resorted to without departing from the spirit of the invention as defined in the appended claims.

I claim:

1. In apparatus for feeding elements into well treating fluid being pumped into a well, a conduit through which said fluid passes, a container for said elements, means for intermittently dispensing said elements from said container into said conduit, means providing a passageway leading from said conduit in spaced relation to said dispensing means to said container, and means in said conduit between said passageway and said dispensing means for restricting the flow of treating fluid through said conduit to cause circulation of treating fluid through said passageway, said container and said dispensing means, said dispensing means including a body having a passage therethrough communicating with said container, a cylindrical member intersecting said passage and having a chamber for receiving an element from said container and discharging said element upon rotation of said cylindrical member, and said cylindrical member having a port therethrough for enabling continuous flow of fluid from said container to said conduit.

2. Apparatus as defined in claim 1, wherein dispensing means includes a discharge tube leading from the dispensing means into said conduit and opening in the direction of flow of treating fluid in said conduit downstream with respect to said flow restricting means.

3. In apparatus for feeding elements into well treating fluid being pumped into a well, a conduit for conducting fluid into the well, injector means including a container for said elements, discharge means beneath said container having a discharge passageway leading from said container to said conduit, dispenser means carried by said discharge means and disposed across said discharge passageway for intermittently permitting the transfer of said elements through said discharge passageway from said container, means providing a passage communicating between said conduit upstream of said discharge means and said container, and means for providing a restriction in said conduit downstream from the connection of said last-mentioned passage to said conduit for causing fluid to flow from said conduit through said last-mentioned passage into said container, said dispenser means having an opening therethrough for enabling the flow of fluid from said container into said discharge passageway.

4. Apparatus as defined in claim 3, wherein said discharge passageway opens into said conduit in the direction of flow of fluid through said conduit so as to provide a suction on said discharge passageway.

5. Apparatus as defined in claim 3, wherein said discharge means includes a tubular member connected to said dispenser means at one end and extending into said conduit at the other end in concentric relation to said conduit, and said discharge passageway extending through said tubular member, whereby the flow of fluid through said conduit around said tubular member provides a suction on said discharge passageway.

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