March 4, 1958 A. L. KELTNER 2,825,411

CIRCULATING SWABS FOR WELLS

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Fig. 1.

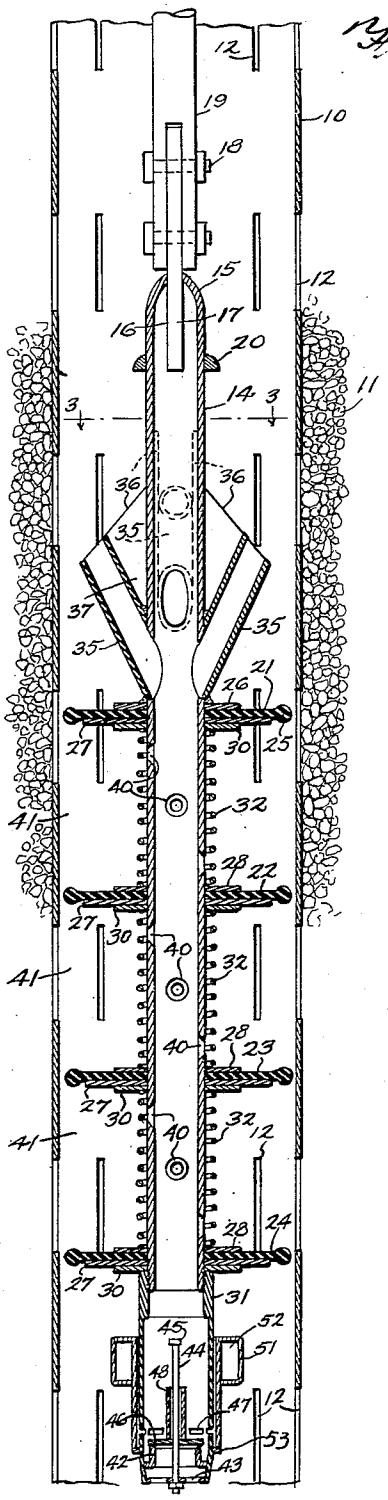


Fig. 3.

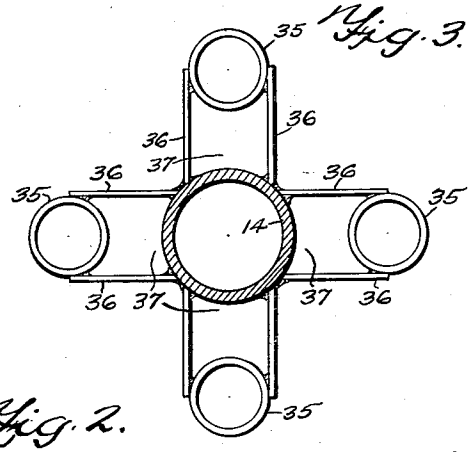
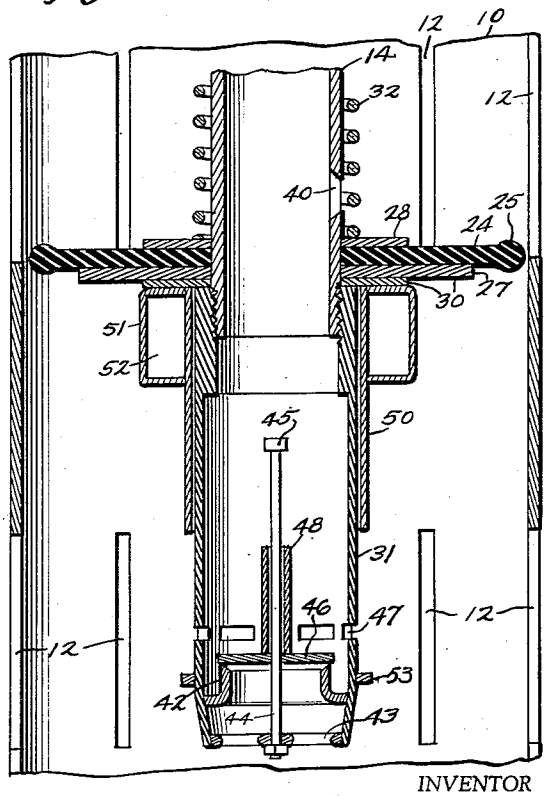


Fig. 2.



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Fig. 4.

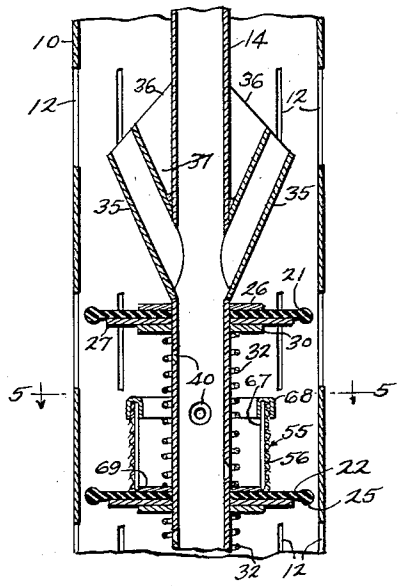


Fig. 8.

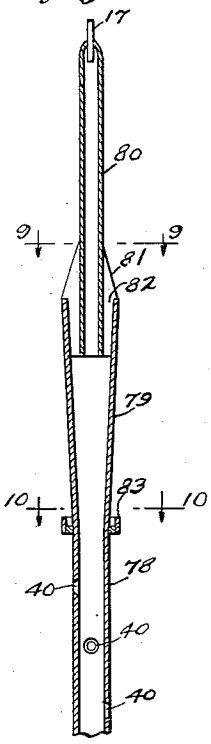


Fig. 5.

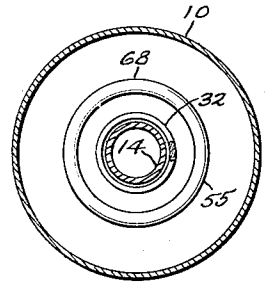


Fig. 7.

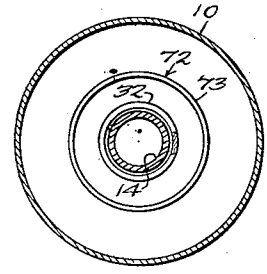


Fig. 6.

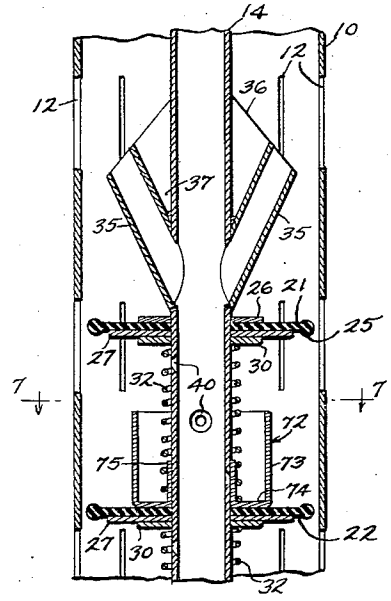


Fig. 9.

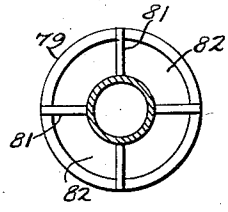
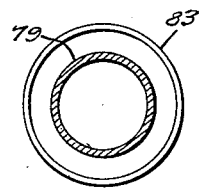


Fig. 10.



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CIRCULATING SWABS FOR WELLS

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Application October 29, 1953, Serial No. 389,072

11 Claims. (Cl. 166—177)

This invention relates to a circulating swab for wells, and more particularly water wells, for example those used as sources for irrigating water, although the invention is also applicable to oil wells, as further referred to below.

As is well known, water wells frequently become clogged adjacent the well casings, for example through the packing of sand and the like, thus materially reducing the flow of water into the casing and reducing the total supply of water available. Many methods have been proposed and devised to take care of this situation for the purpose of loosening or removing the packed material which interferes with the flow of water. Such prior methods and apparatus, however, have not been particularly effective, and certainly not as effective as is desirable.

An important object of the present invention is to provide a novel type of swab through the operation of which sands and other fine materials tending to choke the supply of water into the well casing can be broken loose and removed, thus conditioning the well by cleaning the bodies of coarser materials around the well casing, such as gravel and the like, through which the water readily may flow into the well casing.

A further object is to provide a novel type of circulating swab through the use of which water inwardly and outwardly of the casing is circulated to cause a more effective opening of the perforations in the well casing and the flowing of sand into the bottom of the well casing from which it may be more readily removed, thus leaving the well in improved condition for the substantially uninterrupted flow of water into the well casing.

A further object is to provide a well swab wherein novel elements carried by the swab itself cooperate with the well casing to cause a more effective circulation of the water through the perforations in the well casing and through the materials surrounding the well casing to cause an opening of the pores in the surrounding material by the removal of fine packing materials such as sand and the like.

A further object is to provide such a swab of novel construction employing resilient means operating in combination with the well casing itself to effect a transmission of water pressure to the well casing perforations to clean the latter and to effect a circulation of the water around and through materials surrounding the well casing for a far greater radius than has been possible with prior constructions, thus materially increasing the flow of water into the well casing.

Other objects and advantages of the invention will become apparent during the course of the following description.

In the drawing I have shown several embodiments of the invention. In this showing:

Figure 1 is a vertical sectional view through a portion of a well casing showing some of the surrounding formations, with the operative portions of the well swab within the casing, parts being shown in elevation,

Figure 2 is an enlarged fragmentary sectional view of

the same, showing the lowermost resilient swab element and the valve at the bottom of the swab structure,

Figure 3 is a detailed sectional view on line 3—3 of Figure 1,

Figure 4 is a fragmentary sectional view showing a portion of the swab structure with a dry chemical container in position relative to one of the swab elements,

Figure 5 is a detailed section on line 5—5 of Figure 4,

Figure 6 is a view similar to Figure 4 showing a wet chemical container in the same relationship,

Figure 7 is a detailed sectional view on line 7—7 of Figure 6;

Figure 8 is a detailed vertical sectional view through a modified type of swab supporting means shown particularly for use with small bore wells,

Figure 9 is a detailed sectional view on line 9—9 of Figure 8, and

Figure 10 is a similar view on line 10—10 of Figure 8.

Referring to Figures 1, 2 and 3, the numeral 10 designates a conventional well casing in position in the surrounding formations of sand, gravel, etc., indicated by the numeral 11. The well casing 10 is perforated at longitudinally and circumferentially spaced points as at 12 for the flow of water from the surrounding formations into the well casing, which water is removed with any desired type of pumping apparatus.

The device forming the subject-matter of the present invention comprises a swab body 14 in the form of a tube, the upper end of which is curved inwardly as at 15 and is slotted as at 16 to receive and fit a welded shank 17 the upper end of which is bolted as at 18 to a pull rod 19. The rod 19 is adapted for suitable connection with conventional jars and wire line as will become apparent. Near its upper end, the tubular body 14 is provided with a fishing tool lug 20 of any desired type.

At spaced points therealong, the tubular body 14 is provided with a plurality of longitudinally spaced resilient swabs 21, 22, 23 and 24 each of which is thickened at its peripheral edge portion as at 25, and such portion of the swab is slightly spaced from the well casing as shown in Figure 1. Above the swab 21 is arranged a positioning disc 26 welded to the tubular body 14 and against the bottom of which the swab element 21 seats. A relatively large washer 27 seats against the bottom of each of the swabs 21, 22, 23 and 24, and plates or discs 28 similar to the disc 26 are seated above the swabs 22, 23 and 24, and these plates may be somewhat thinner than the plate 26 since the latter forms a postive stop welded to the tube 14. Beneath each plate 27 is arranged a lower disc 30 and such disc of the lowermost swab element 24 seats against the upper end of the sleeve 31 threaded on the lower end of the tubular body 14 for a purpose to be described. Between adjacent pairs of the swab elements are arranged compression springs 32 which exert their force throughout the distance between the uppermost swab 21 and lowermost swab 24. The spring maintains the plate 30 of the lowermost swab engaged with the top of the sleeve 31, while the uppermost swab 21 is prevented from moving upwardly by the plate 26 welded to the body 14.

It will be apparent from the foregoing that the intermediate swabs 22 and 23 may move vertically in either direction under the influence of pressures to which they are subjected, while the lowermost swab 24 may move upwardly from the position shown in Figure 1. It also will be apparent that the peripheral portions of the swab elements may flex upwardly more readily than downwardly because of the larger plates 27 arranged therebeneath. Above the uppermost swab element 21, diverging tubes 35 are welded or otherwise secured to and communicate with the interior of the tubular body 14 for

the downward flow of water from the upper part of the well casing into the tubular body **14**. To opposite sides of each tubular member **35** are welded retaining plates **36**, these plates also being welded to the tubular body **14**. The plates **36** not only serve rigidly to fix the tubular members **35** in position but each pair of plates **36** cooperates with the body **14** and associated tubular member **35** to form a pocket **37** in which can settle samples of materials from the well.

The tubular body **14** is provided with circumferentially and longitudinally spaced openings **40** which extend throughout the portion of the tubular body between the uppermost and lowermost swab elements **21** and **24** respectively. The openings **40** preferably decrease in diameter radially outwardly to act in the nature of jets for the projection of water at relatively high velocity outwardly from the tubular body **14** into the pockets **41** between adjacent pairs of swab elements, the purpose of which will become more apparent below.

As more clearly shown in Figure 2, the sleeve **31** is provided therein with an annular valve seat **42** the upper extremity of which tapers upwardly substantially to a knife edge. The interior of the valve seat **42** communicates with the interior of the well casing through the open lower end of the sleeve **31**, through the legs of a spider **43** carried by the casing **31**. A guide rod **44** projects through the center of the spider **43** and is provided at its upper end with a head **45**. A vertically slidable valve **46** surrounds the stem **44** and is adapted to engage the valve seat **42** as shown in Figure 2. Above the valve **46**, when this element is in closed position, the sleeve **31** is provided with circumferentially spaced and elongated unloading openings **47** for a purpose to be described. A weight sleeve or hammer **48** slidably surrounds the stem **44** above the valve **46**.

For the purpose of controlling the openings **47**, as will become apparent, a vertically slidable sleeve **50** surrounds the sleeve **31** and is provided at its upper end with a surrounding member **51** forming an air chamber **52**. It will become apparent below that upon downward movement of the swab the sleeve **50** moves upwardly. When the swab is pulled upwardly, the sleeve **50** moves downwardly and closes the openings **47**. Downward movement of the member **50** is limited by a stop ring **53** (Figures 1 and 2) carried by the sleeve **31**.

In Figures 4 and 5 there is illustrated a container for dry chemicals adapted to be used in conjunction with the operation of the swab. In the embodiment shown in Figure 4, the chemical container has been shown in conjunction with the swab element **22**, but it will become apparent that it may be used with this or any lower swab element or any combination of such elements. The container is indicated as a whole by the numeral **55** and comprises a wire cylinder **56** forming a container for the dry chemicals and stiffened by vertical rib members **67** and by an annular top cap member **68** surrounding the upper edge of the basket and confining the stiffening members **67** in close proximity thereto. The basket further comprises a solid bottom member or disc **69** which seats on the adjacent swab element, and may be substituted for the associated disc **28**.

In Figures 6 and 7 there is shown a modified type of chemical holder, particularly for use with wet chemicals. In this form of the invention, the chemical holder, indicated as a whole by the numeral **72**, comprises an imperforate surrounding container wall **73**, a solid bottom wall **74**, and an inner annular sleeve **75** which snugly surrounds the tubular body **14** within the associated spring **32**. The bottom **74** will be substituted for the associated top disc **28**, described in connection with Figure 1. The container **72** is adapted to contain a wet chemical to be gradually "sloshed" out of the container in the operation of the device as will become apparent.

A slightly modified type of construction is shown in Figure 8 for use with wells of smaller bores. In this case, a tubular body **78** is employed in place of the previously described body **14**. The diverging tubular members **35** cannot be used in the smaller well, and accordingly a modified type of water inlet for the upper end of the swab body is provided. The body **78** has its upper portion **79** increasing in diameter upwardly so as to provide an open inverted frusto-conical construction above which is arranged the tube **80** adapted for connection with the jars and line wire in any suitable manner, for example as fully disclosed in conjunction with the form of the form of the invention in Figure 1. The tubular member **80** is substantially smaller in diameter than the upper end of the body portion **79** and projects downwardly into the latter. Tube **80** is fixed with respect to the body portion **79** by radial connecting plates **81** welded in position and defining with the members **79** and **80** a plurality of liquid inlet openings **82** (Figure 9).

Whereas the pockets **37** in Figure 1 form means for collecting formation samples from the well, this is not possible with the type of upper swab body construction shown in Figure 8. As a substitute formation collecting means, the upper extremity of the cylindrical portion **78** of the swab body is provided with an annular cup **83** for receiving formation samples which can be examined when the swab is pulled from the well.

Operation

It will be noted that the swab construction is self-contained without the provision of any surrounding casing elements. Therefore, the swab operates directly in conjunction with the well casing itself, by which greatly improved results can be obtained.

When a well is to be conditioned, sand present in the bottom of the well may be pumped out with any conventional type of sand pump. The present swab is then lowered into the well and sinks into the water therein. As the swab sinks, the sleeve **50** will be moved upwardly due partly to the buoyancy of the air chamber **52** and partly to resistance encountered by water engaging the bottom of the surrounding chamber structure **51**. The openings **47** are then uncovered for the scavenging of any solid material from within the sleeve **31** which might otherwise prevent the seating of the valve **46** when the swab is ascending. Substantial quantities of water of course will move upwardly through sleeve **31** and through the interior of the tubular body **14** to a substantial extent above the swab structure, depending upon the depth of the water.

The swab is now pulled upwardly at a relatively high speed to a point substantially above the static water level in the well, and is then suddenly stopped. The heavy column of water being pushed ahead of the swab is allowed to drop, thus "pounding" the well to assist in loosening encrusted formations in the well casing perforations **12**.

The operations referred to above are continuously repeated over a substantial length of time, and particular attention is invited to the functioning of the apparatus during upward movement of the swab. With a substantial body of water trapped between the swab elements and to a substantial depth thereabove, it will be apparent that when the swab is pulled upwardly, water will rush downwardly through the tubular members **35** into the swab body **14**, thence out through the jet openings **40** and into the chambers **41**. Agitation and pressure of the liquid occurs in the chambers **41**, which results quite effectively in breaking incrustations which have formed in the perforations of the well casing, thus loosening this material. The water will be forced under pressure radially outwardly through the well casing openings **12**, and due to the fact that the peripheral edges of the swab elements are only slightly spaced from the well casing, rapid upward movement of the swab creates subatmospheric pressure beneath the lowermost swab element **24**. Therefore, water forced radially outwardly through the

openings 12 will tend to circulate downwardly and back into the well casing beneath the swab, carrying with it fine materials which have tended to clog the surrounding well formation. Any tendency for encrusted openings 12 to resist radially outward flow of water, or any such resistance occurring through the packing of fine sands outwardly of any of the chambers 41, will greatly increase the pressure in such chamber, causing the expansion thereof due to movement of at least one adjacent swab element against the tension of at least one of the springs 32. The swab element tends to return to its normal position, thus maintaining a flushing pressure in the chamber to tend to loosen the material which is resisting circulation of the water through the well casing openings 12.

Attention also is invited to the fact that during such rapid upward movement of the swab, the valve 46 closes while the sleeve 50 will be in its lowermost position closing the openings 47. Thus the water rushing downwardly into the interior of the swab body 14 is prevented from flowing from the bottom of such body, and the water pressure is thus utilized to the maximum extent to break through resisting formations which have prevented a free flow of water into the well.

To explain somewhat more fully the operation of the springs 32 and the slidable swab elements, attention is invited to the fact that the springs serve as jars in the event a large slug of sand or the like comes into the well casing, tending to cause the swab to become stuck. In such case, upon upward movement of the swab, the jamming of one of the swab elements 22 would tend to prevent such element from moving upwardly. The spring beneath such swab element thus will be compressed and loaded and the force thus generated in the spring, when the loading thereof is sufficient for such purpose, moves the jammed swab element 22 upwardly to dislodge the slug of mud or sand which has caused the jamming action. In the second place, assuming for example that upon the rapid upward movement of the swab, passage of water from the uppermost chamber 41 is resisted by incrustations in the openings 12 which it is passing, such chamber will expand causing downward movement of the next lower swab element. This increases the pressure of the water in the next lower chamber 41, rendering this water more effective as the swab moves upwardly to dislodge incrustations or the like which have previously caused the upper chamber 41 to expand.

The rapid lifting of the swab, the sudden stopping and then dropping of the swab, in the continuous repetition of such steps, provides a highly effective cleaning action. During rapid lifting of the swab, the water, due to its inertia, moves downwardly relative to the swab at relatively high speed, through tubes 35 and outwardly through openings 40 into the chambers 41 thence through the casing openings 12 into the surrounding formation. Then, as the lowermost swab element 24 passes successive casing openings 12, the partial vacuum existing below the swab element 24 "jerks" into the well casing any incrustation that may have been partially loosened in the openings 12. This results in what may be termed a "high frequency respiratory action," and by virtue of extreme pressures applied to the well casing perforations and to the well formations, the action breaks loose any incrusted formations or the packing of fine sand which has interfered with the flowing of the water into the well. The circulatory action is assisted by the partial vacuum beneath the lowermost swab element, whereby water forced outwardly between the swab elements flows downwardly into the bottom of the well, causing fine sands and the like to flow into the bottom of the well to collect therein. This action opens the interstices of the surrounding well formations to facilitate the flow of water into the well. The collected sands can be removed periodically or after the operation of the swab by the use of a conventional sand pump.

The basket devices in Figures 4 to 7 inclusive, can be provided for the use of any chemicals or other materials for chemically or mechanically assisting the operation of the swab. For example, Dry Ice may be used in one or more baskets 55 in the operation of the device. The carbon dioxide gas and surrounding water will form carbonic acid sufficiently strong to dissolve, loosen and remove various types of incrustations, facilitated by the normal circulatory and water pressure operation which occurs through the use of the apparatus as described above.

Regardless of the use of chemicals or other materials, it has been found that the repetitious up and down movement of the apparatus and the functioning following its operation affords no opportunity for any relodging of sand or sediment in the surrounding formation or in the well casing openings. Large volumes of water will be propelled at high velocity through the well casing perforations to accomplish the results stated, and the device is strictly a wire line tool. The swab has no surrounding casing except the well casing itself which is utilized in the operation of the swab combination and the only valve employed in the swab is the lower valve 46 which automatically closes when the swab is elevated and opens when the swab is lowered for the relatively free flow of water upwardly through the swab body.

The operation of the form of the device shown in Figure 8 will be identical with that described above. The tubular body 78 will be provided beneath the cup 83 with the series of swab elements as described above, these elements being identical with the elements 21 to 24 inclusive, except that they are of such size as to render them practicable for use in a smaller well. Instead of the tubular water inlets 35, the form of the invention shown in Figure 8 minimizes the overall diameter of the swab by providing the water inlet openings 82. Therefore, the device is highly practicable for use in wells of various well casing diameters. The valve 46 of course, also will be used with the modified type of swab body, and in both cases, the hammer member 48 will insure the seating of the valve 46.

While the invention has been particularly described in its use in connection with water wells, it is also highly useful in the development of oil wells. Experimentation has indicated its usefulness in cleaning oil wells in connection with the practice of applying a special sand to the well bore and formation and then forcing the sand back into crevices by extremely high pressure. This process is completed by recleaning the well and removing all surplus sand.

The construction illustrated embodies the invention in a preferred form, but it is intended that the disclosure be illustrative rather than definitive. The invention is defined in the appended claims.

I claim:

1. A well swab structure comprising a tubular stem, a plurality of resilient disc-like swab elements surrounding said stem and axially slidable with respect thereto, and resilient means supporting said elements in normally predetermined spaced relation along said stem, said stem having an opening for the introduction of liquid thereinto and provided with openings for the passage of such liquid into the spaces between said elements.

2. A well swab structure comprising a tubular stem, a plurality of pairs of resilient disc-like swab elements surrounding said stem and spaced therealong, a rigid disc above the uppermost element fixed to said stem to limit upward movement thereof, means carried by said stem beneath the lowermost element to limit downward movement thereof, the remaining swab elements being axially slidable along said stem, and springs arranged between adjacent pairs of swab elements to resiliently maintain them in predetermined normal spaced relationship to each other, said stem having an opening for the introduction of liquid into the upper end thereof and being provided

with openings for the flow of such liquid into the spaces between said elements.

3. A well swab structure comprising a tubular body, a plurality of resilient disc-like swab elements surrounding said body in axially spaced relation therealong, a chemical container having a bottom seated on one of said elements and open at its top, and a spring arranged between the elements of each adjacent pair to tend to maintain them in predetermined spaced relation, one of said springs seating against said bottom of said chemical container.

4. A well swab structure comprising a tubular body, connecting means at the upper end of said body for connecting it to a mechanism to raise and lower said body within a well casing, a plurality of pairs of resilient disc-like swab elements surrounding and axially slidable along said body and arranged in normal positions spaced from each other, said body being provided above the uppermost disc-like element and below said connecting means with liquid inlet ports through which liquid may flow downwardly into said tubular body, said body being further provided with lateral outlet openings between elements of adjacent pairs of said swab elements, and springs surrounding said body between adjacent swab elements to bias them to said normal positions from which they are movable axially along said body under the influence of liquid pressures in the spaces between said swab elements.

5. A well swab structure comprising a tubular body, connecting means at the upper end of said body for connecting it to a mechanism to raise and lower said body within a well casing, a plurality of pairs of resilient disc-like swab elements, and means supporting said elements with respect to said body at predetermined spaced points therealong, said body being provided above the uppermost swab element and below said connecting means with liquid inlet ports through which liquid may flow downwardly into said tubular body, said body being further provided with lateral outlet openings between adjacent pairs of said elements, said supporting means comprising rigid discs arranged above and below each of said resilient swab elements, the upper of such rigid discs being of smaller diameter than the lower of such discs whereby each resilient element at its periphery is deformable to a greater extent upwardly than downwardly.

6. A well swab structure comprising a tubular body adapted for insertion in a well casing and having means at its upper end for connecting it to a vertical reciprocating means for moving said body upwardly and downwardly in the well casing, a plurality of resilient disc-like swab elements surrounding and axially movable along said body and normally spaced from each other, said body above the uppermost resilient element having liquid inlet passages for the flow of liquid from the interior of the well casing into said body, said body having lateral outlet openings for the flow of liquid from the interior of said body to the spaces between said swab elements, resilient means tending to maintain said resilient elements in predetermined spaced relation along said body, and an upwardly opening check valve carried by said body below the lowermost element for allowing the flow of liquid upwardly through said body when the latter is lowered into the well.

7. A well swab structure comprising a tubular body adapted for insertion in a well casing and having means at its upper end for connecting it to a vertical reciprocating means for moving said body upwardly and downwardly in the well casing, a plurality of disc-like swab elements, means supporting said elements on said body at spaced points therealong, said body above the uppermost element having water inlet passages for the flow of water from the interior of the well casing into said body, and said body having lateral outlet openings for the flow of liquid from the interior of said body to the spaces between said elements, a tubular valve housing carried by said body below said elements and provided with a valve seat, and an upwardly opening check valve carried by said valve housing below the lowermost swab element for the flow of liquid upwardly through said body when the latter is lowered into the well, said valve housing having an upper end limiting downward movement of the lowermost swab element.

8. A device in accordance with claim 7 wherein said valve housing above said valve seat is provided with radial openings communicating between the interior of said valve housing and the interior of the well casing, and a float controlled sleeve valve surrounding said valve housing and movable downwardly to close such openings when said housing is moved upwardly, and movable upwardly to uncover such openings when said housing moves downwardly.

9. In combination with a well casing in operative position in the ground and provided with liquid influx openings for the flow of liquid from the surrounding formation into the well casing, a swab structure comprising a tubular body having means at its upper end for connecting it to a raising and lowering mechanism, a plurality of swab elements carried by said body in spaced relation with each other to define with said body and said well casing a plurality of chambers, said swab elements having clearance with respect to the well casing said body being provided above the uppermost swab element with inlet means for the flow of liquid into said tubular body and said body having lateral discharge openings for the flow of liquid from said body into said chambers, said swab elements being axially movable along said body, a spring surrounding said body in each chamber to bias said swab elements to normal positions along said body, from which positions they are axially movable in accordance with variations in pressures in said chambers, and a check valve below the lowermost swab element opening upwardly for allowing the flow of liquid from the well into said body when the latter moves downwardly.

10. In combination with a well casing in operative position in the ground and provided with liquid influx openings for the flow of liquid from the surrounding formation into the well casing, a swab structure comprising a tubular body having means at its upper end for connecting it to a raising and lowering mechanism, a plurality of swab elements carried by said body in spaced relation with each other to define with said body and said well casing a plurality of chambers, said swab elements having clearance with respect to the well casing said body being provided above the uppermost swab element with inlet means for the flow of liquid into said tubular body and said body having lateral discharge openings for the flow of liquid from said body into said chambers, each of said swab elements being of resilient disc-like structure and provided above its upper face and below its lower face with rigid washers, and a coil spring in each chamber surrounding said body and biasing said swab elements to predetermined positions from which they are axially movable against the compression of said springs.

11. In combination with a well casing in operative position in the ground and provided with liquid influx openings for the flow of liquid from the surrounding formation into the well casing, a swab structure comprising a tubular body having means at its upper end for connecting it to a raising and lowering mechanism, a plurality of swab elements carried by said body in spaced relation with each other to define with said body and said well casing a plurality of chambers, said swab elements having clearance with respect to the well casing said body being provided above the uppermost swab element with inlet means for the flow of liquid into said tubular body and said body having lateral discharge openings for the flow of liquid from said body into said

chambers, a tubular valve housing carried by said body beneath the lowermost swab element and provided with an upwardly opening seat, an upwardly opening check valve engageable with said seat, said valve housing having lateral openings therethrough above said valve seat, and a tubular sleeve surrounding said valve housing operable to open and close said lateral openings and having a float at its upper end.

References Cited in the file of this patent

UNITED STATES PATENTS

2,221,775	Boynton	Nov. 19, 1940
2,250,775	Rice	July 29, 1941
2,392,144	Hall	Jan. 1, 1946
2,601,614	Johnson	June 24, 1952