

[54] **METHODS FOR CLEANING AND FORMING SAND FILTERS AND A SELF-CLEANING STRAIGHT SPRING FILTER**

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E21B 37/02

[58] Field of Search 166/311, 315, 234, 231;
175/314; 210/497, 497.1, 411, 408; 209/393,
395; 161/57; 29/457

[56] **References Cited**

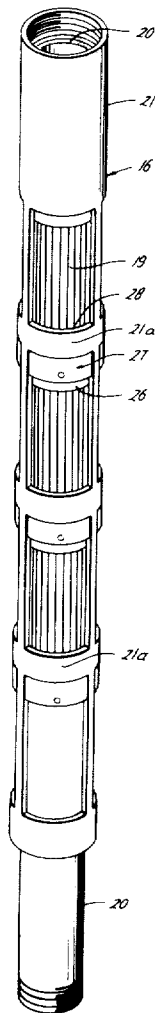
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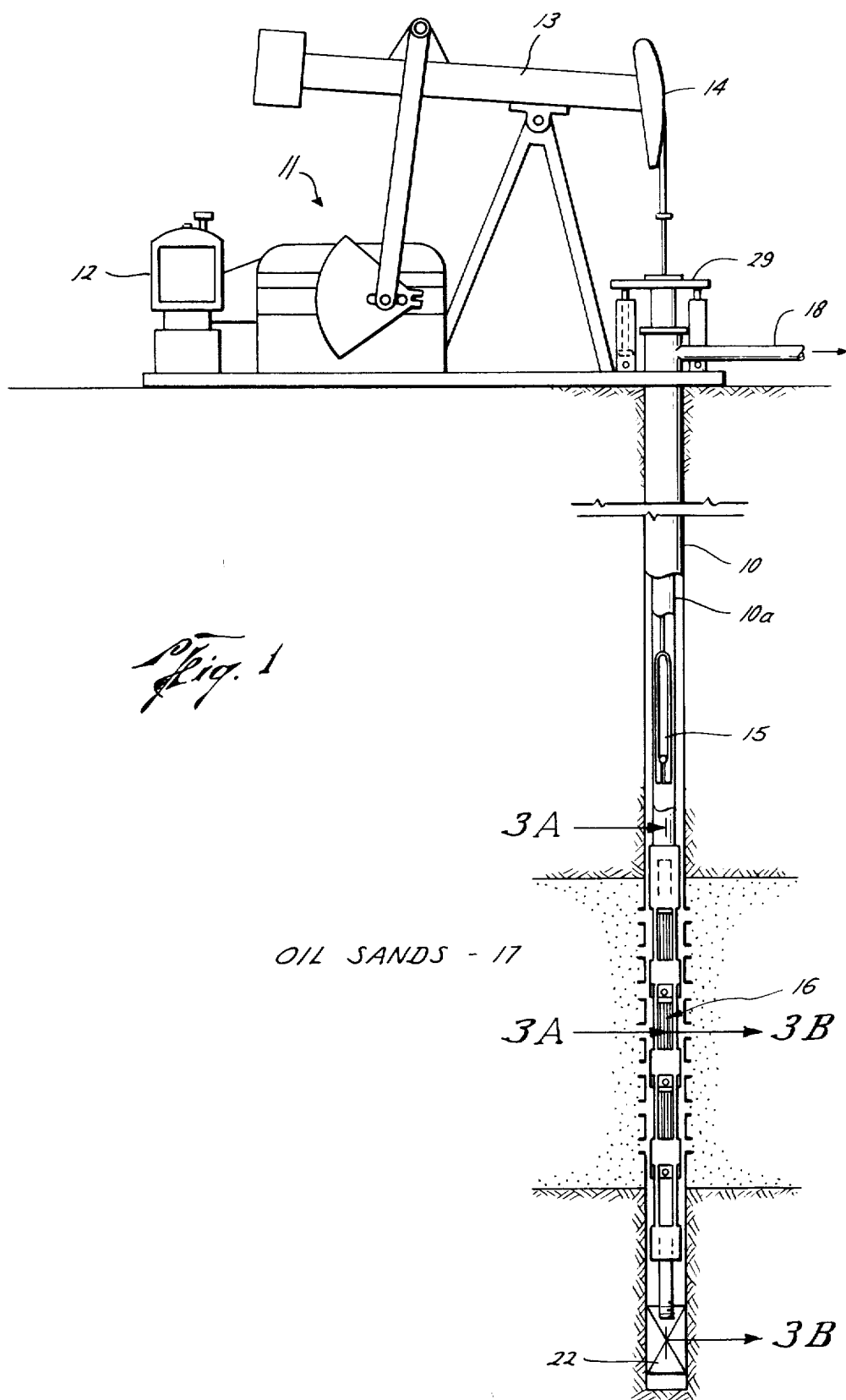
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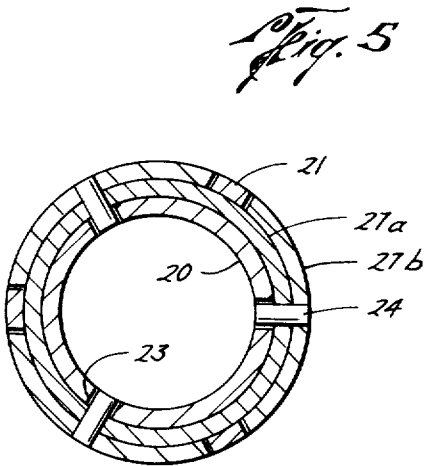
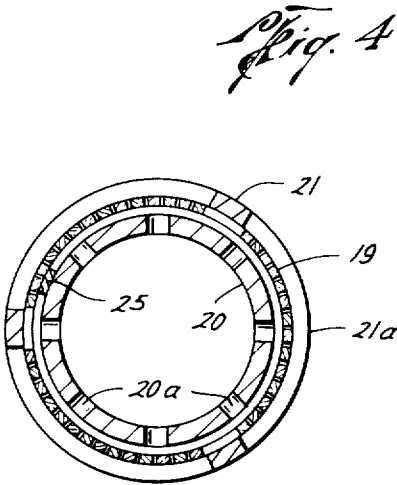
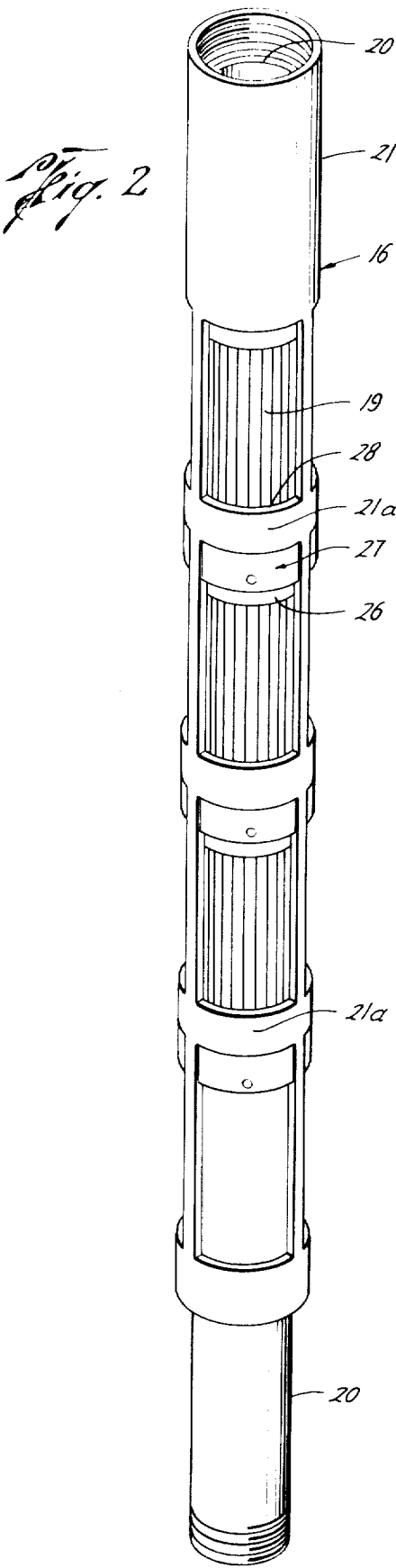
[57] **ABSTRACT**

Methods for cleaning and manufacturing straight spring and filters for use at the petroliferous unconsolidated sand strata of an oil well, and a self-cleaning straight spring filter are disclosed. The filter comprises one or more sets of contiguous straight parallel closely spaced apart springs mounted around a perforated tube. With the spring upper ends fixedly secured around the periphery of the tube and the lower ends fixed to a ring encircling the tube and slideable in a longitudinal slot in the tube, the contiguous springs are closely spaced apart at a precise distance for filtering sand from sandbearing oil. A sleeve is slideable over one or more sets of springs to contact the ringed ends of the next adjacent spring set for scraping the calcification from the exterior surface of the springs, then the sleeves are moveable further to buckle and spread the springs apart for flushing and cleaning therebetween.

16 Claims, 8 Drawing Figures







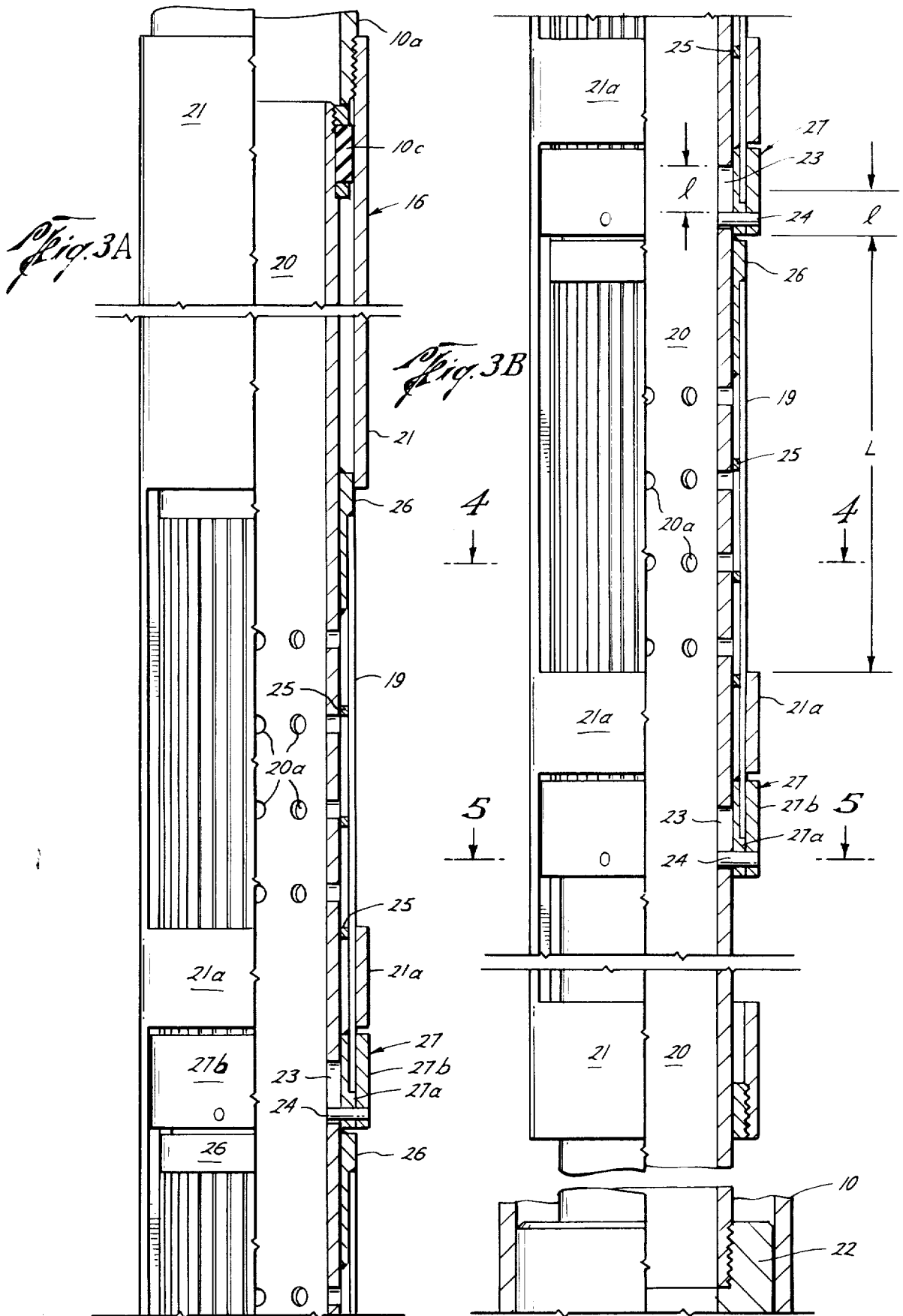


Fig. 6

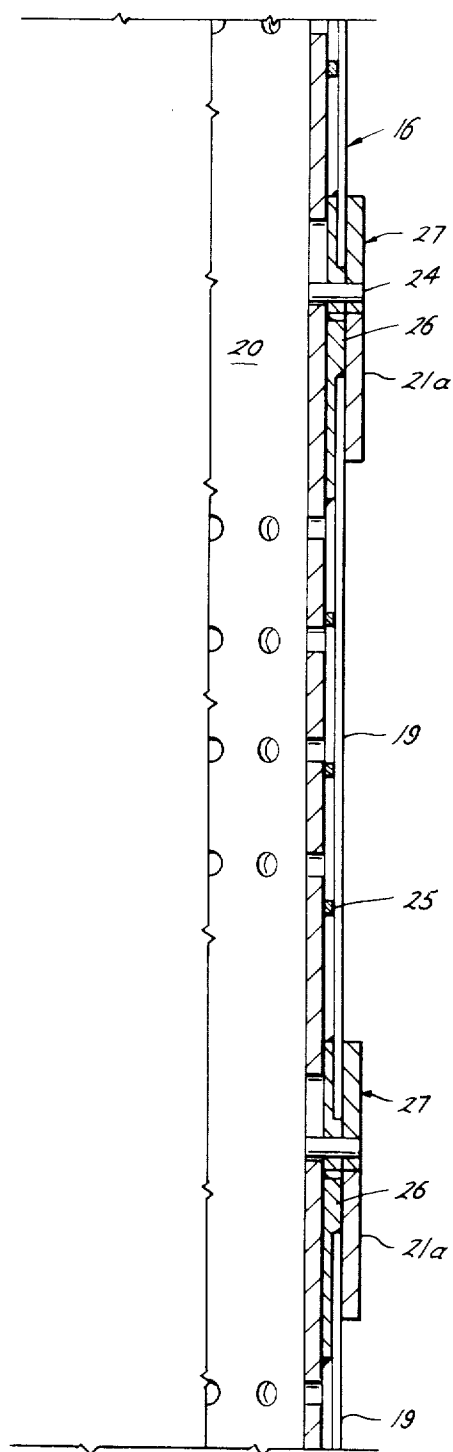
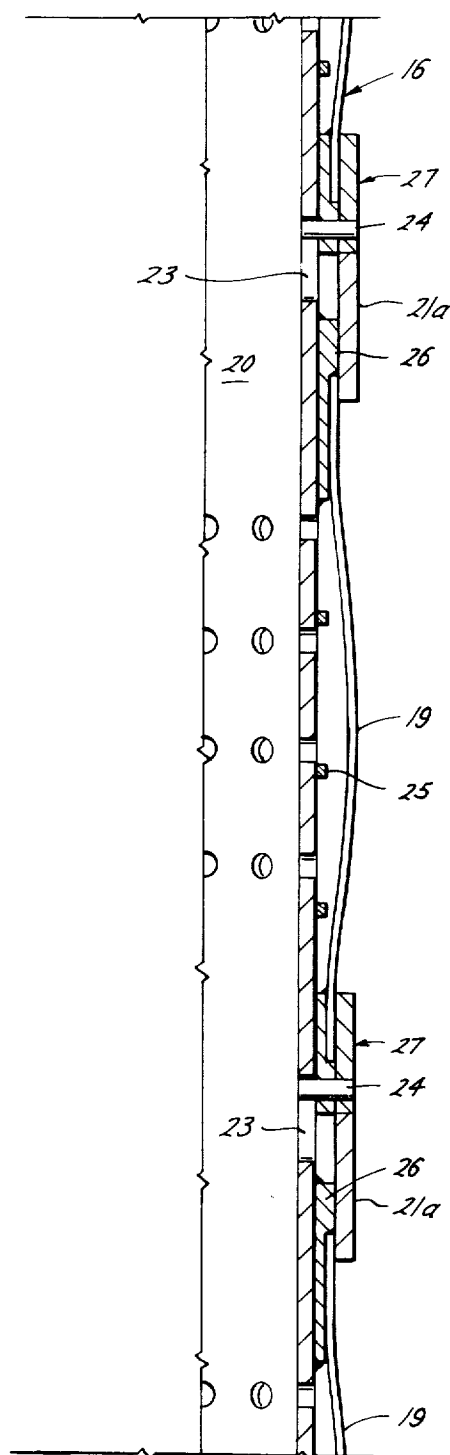


Fig. 7



METHODS FOR CLEANING AND FORMING SAND FILTERS AND A SELF-CLEANING STRAIGHT SPRING FILTER

BACKGROUND OF THE INVENTION

There are many thousands of oil wells over the surface of the earth and particularly in the United States that are drilled and completed in unconsolidated sand, i.e. crumbly sandstone. In such wells, sand does not necessarily precipitate to the bottom of the well, but instead may remain in suspension and is pumped up, if not free flowing, with the oil. As a result, most mechanical parts as valves, bearings, pistons, cylinders, etc. wear out prematurely under such conditions. Accordingly, the sand must be filtered out from the oil, preferably in the well. Petroleum companies have spent large sums of money in trying to find a suitable solution to the sand problem, but heretofore there has been no completely satisfactory method or long lasting device for preventing the entry of sand into the tube string and eventually into the suction pipe of the pump, or other works.

One oil well combination foam and wire coil filter is disclosed in U.S. Pat. No. 2,837,032, but that filter is quite sophisticated and expensive to manufacture, and is not adjustable to be opened for backwashing a cleaning liquid, as water, to clean the clogged filter. Another attempted solution was a spring filter as disclosed in U.S. Pat. No. 3,754,651, but because no spacers are apparent between the helical filter elements, the elements would have to be held in slight tension to separate the helical filter elements during filtering. Thus that filter could not be used as an oil well filter on which high compressive loads may be placed. Likewise no guide tube or mandrel can be utilized to strengthen the compressive capabilities for converting the filter to one for use in wells. Also, the spring filter of U.S. Pat. No. 3,179,116 is incapable of being strengthened to use in wells. Any compressive force on the triangular spring elements would cause them to collapse, and further the coined depressions for separating the spring elements would cause the spring elements to flex with a load thereon causing displacement of the adjacent coils and variation of the gauge therebetween.

The principal feature lacking in all of the above prior patents is the utilization of vertical, straight contiguous, closely, and precisely spaced apart springs for forming the sand filter.

Accordingly, a new and better method for manufacturing a self-cleaning straight spring filter for mounting on the lower end of a tubing string extending down into a well to an oil containing sand strata, a method for cleaning a straight spring filter, and at least one new and better self-cleaning straight spring filter for use in a well are greatly desired and in demand.

OBJECTS OF THE INVENTION

Accordingly, a primary object of this invention is to provide a method for forming a straight spring filter for mounting on the lower end of a tubing string extending down into a well to a liquid containing sand strata that has high production of clean filtered liquids and yet is self-cleaning.

A further primary object of this invention is to provide a method for cleaning a straight spring filter that is clogged with sand when connected at the lower end

of a production tubing string deep in a producing oil well.

Another primary object of this invention is to provide at least one high strength, self-cleaning straight spring filter that can be easily cleaned at sub-surface levels, and has inner spacers for resisting high differential pressures for producing a large amount of oil, and for maintaining uniform diameter of the rings of contiguous straight springs around their perforated tube.

Yet another object of this invention is to provide a high strength self-cleaning straight spring filter having straight springs fixedly secured at one end to a perforated pipe and moveably secured at their other ends for being buckled and separated for providing increased back wash flow and increased cleaning action in the filter.

A further object of this invention is to provide a self-cleaning, straight spring filter having spacers between the straight springs and a perforated tube for preventing any lateral displacement during normal or high pressure operation.

A still further object of this invention is to provide a method for cleaning a filter, a method for forming a filter, and a spring filter that is self-cleanable when filtering crude oil, that is easy to operate, is of simple configuration, is economical to build and assemble, and is of greater efficiency for the filtering of sand from a petro-
liferous unconsolidated sand strata of an oil well.

Other objects and various advantages of the disclosed methods and self-cleaning straight spring filter will be apparent from the following detailed description, together with the accompanying drawings, submitted for purposes of illustration only and not intended to define the scope of the invention, reference being had for that purpose to the subjoined claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The drawings diagrammatically illustrate by way of example, not by way of limitation, one form or mechanism for carrying out the methods of the invention wherein like reference numerals have been employed to indicate similar parts in the several views in which:

FIG. 1 is a schematic diagrammatic view with parts in section of the new sand filter as mounted in a typical oil well;

FIG. 2 is a schematic diagrammatic perspective view of the self-cleaning straight spring filter in filtering position;

FIG. 3A, taken at 3A—3A on FIG. 1, is a schematic diagrammatic longitudinal cross-sectional view of the upper portion of the self-cleaning straight spring filter in filtering position for use in a well casing;

FIG. 3B, taken at 3B—3B on FIG. 1, is a schematic diagrammatic longitudinal cross-sectional view of the lower portion of the filter of FIG. 2;

FIG. 4 is a sectional view at 4—4 on FIG. 3B;

FIG. 5 is a sectional view at 5—5 on FIG. 3B;

FIG. 6 is a cross-sectional view of a portion of the filter of FIG. 2 illustrated in a second position after the springs have been scraped clean by upward movement of the outer sleeve; and

FIG. 7 is a cross-sectional view similar to FIG. 6, but with the filter illustrated in a third position after the springs have been buckled and spread apart for the backwash cleaning step.

DESCRIPTION OF THE INVENTION

The invention disclosed herein, the scope of which being defined in the appended claims, is not limited in its application to the details of construction and arrangement of parts shown and described for carrying out the disclosed methods, since the invention is capable of other embodiments for carrying out other methods and of being practiced or carried out in various other ways. Also, it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation. Further, many modifications and variations of the invention as hereinbefore set forth will occur to those skilled in the art. Therefore, all such modifications and variations which are within the spirit and scope of the invention herein are included and only such limitations should be imposed as are indicated in the appended claims.

DESCRIPTION OF THE METHODS

This invention comprises a few methods for cleaning a sand filter and for filtering sand from oil in an oil well and at least one mechanism for filtering sand from oil in the well.

Primarily, the method for cleaning a sand filter comprising a flexible screen formed of square straight springs around a perforated tube extending down into a petroliferous unconsolidated sand strata of an oil well comprising the steps of,

1. scraping an outer ring over substantially the full length of the flexible screen for removing calcification from the exterior surface of the square springs for creating an area of unconsolidated formation around the screen.

2. buckling the square springs outwardly by moving one end of the springs toward the other end with the outer ring for altering the gaps between the springs and breaking up the unconsolidated sand mass in the gaps,

3. flushing the consolidated sand mass from between the springs, and

4. reversing the scraping movement of the outer ring over the screen for restoring the square springs to their original contiguous position for filtering sand as sand-bearing oil passes through the screen, through the perforated tube, and up out of the well.

A method for forming a self-cleaning straight spring filter for mounting on the lower end of a tubing string extending down into a petroliferous unconsolidated sand strata of an oil well comprising the steps of,

1. forming a screen of contiguous straight springs around a perforated tube,

2. fixedly attaching a first end of two ends of the straight springs to the peripheral surface of the perforated tube in a precisely spaced relationship to each other for preventing the flow of sand therebetween,

3. connecting a ring means to a vertical motion actuator means in the well for sliding over the springs for scraping the calcification from the external surface of the screen for cleaning thereof, and

4. forming the second end of the straight springs moveable toward the first end of the springs for buckling the springs outwardly for removal of sand therebetween.

Basically, the method for forming a self-cleaning straight spring filter for mounting on the lower end of a tubing string extending down into a petroliferous un-

consolidated sand strata of an oil well, for example, comprises the steps of,

1. forming a cylindrical screen of vertical, straight contiguous springs around a perforated tube,

2. mounting the springs at a precise distance apart around the periphery of the perforated tube for preventing the flow of sand therebetween,

3. slideably mounting a ring over the screen for removing calcification from substantially the full length of the springs, and

4. slideably mounting the ring on the screen for additional movement for buckling the springs outwardly for spreading them apart for further cleaning thereof.

In greater detail, the latter method may be expanded to the following steps:

1. forming an outer tube concentric with an inner perforated tube,

2. mounting a plurality of vertical, straight, contiguous springs around the inner perforated tube and spaced from the inner tube with spacers,

3. fixing the upper end of each of the straight vertical springs to the inner perforated tube for spacing the springs at a precise distance apart for preventing the flow of sand therebetween,

4. fixing the lower end of each of the straight vertical springs to a ring slideable on the inner tube toward the lower ends for buckling the springs outwardly,

5. forming a second ring integral with the outer tube for sliding over substantially the full length of the vertical straight springs for cleaning calcification from the external surface of the springs, and

6. forming the ring slideable a second distance for contacting the lower ends of the springs for buckling and separating the springs for additional cleaning thereof.

While these methods are illustrated as being practiced or operated by a piston and bylinder motor applying the required reciprocal movement to the scraping ring, obviously this scraping ring may be operated by hand. Likewise, while the above disclosed methods are described principally for filtering sand from petroliferous unconsolidated sand strata of an oil well, obviously other liquids may be cleaned of sand, as water from a water well, for example.

APPARATUS OF THE INVENTION

A self-cleaning straight spring filter is disclosed hereinafter that may be cleaned by other methods than those described above and may be formed by other methods than those previously set forth, as by hand. Further, while the disclosed apparatus was designed primarily for use in oil wells, clearly it may be used for removing foreign material from other liquids as for removing sand from water, for example.

FIG. 1 is a schematic diagrammatic view of a typical producing oil well 10 having pumping equipment 11 comprising motor means 12 for actuating walking beam 13 with horse head 14 for operating pump 15 in the well. A crude oil pump is utilized after free flow has ceased for raising the oil that has passed through the filter 16 from the petroliferous unconsolidated sand strata 17 up to the surface to exit from discharge pipe 18. Except for the filter 16, all of the above parts may be conventional elements.

FIG. 2 illustrates a schematic enlarged perspective view of the preferred embodiment of the new self-cleaning straight spring filter 16. The self-cleaning filter

16 comprises a flexible screen formed of a plurality of square cross-sectional straight springs 19 mounted contiguous or very close to each other but spaced a precise distance from each other and arranged substantially completely around a perforated tube 20, FIG. 2, and particularly as shown in FIGS. 3A and 3B. The square springs 19, FIG. 2, are shown behind the cutouts 21a in an outer sleeve 21 as disclosed in greater detail in FIGS. 3A and 3B.

As illustrated in FIG. 3A, the upper end of the outer sleeve 21 of the filter 16 is attached, as with screw threads, to the production tubing string 10a, FIG. 1, above, leading upwardly to the discharge pipe 18. A suitable seal 10c, FIG. 3A, may be utilized in the threaded joint described above.

PERFORATED TUBE 20

The perforated tube 20, FIGS. 3A and 3B having perforations 20a, forms the internal portion of the sand filter. Its lower end is secured to the walls of the well 10, FIG. 3B, just under or in the bottom portion of the petroliferous unconsolidated sand strata 17 in a suitable manner, as with screw threads in a packer 22, FIGS. 1 and 3B. The perforated tube 20 having longitudinal slots 23 is pinned to an outer arcuate lower spring retainer segment 27 with pins 24 operable in the slots.

STRAIGHT SPRINGS 16

The long, vertical, straight, square springs 16, FIGS. 2, 3A, 3B, particularly, extend longitudinally of the perforated tube 20 to form a flexible screen therearound it and are spaced from the perforated tube 20 with a spiral ring spacer 25. The screen is illustrated, FIG. 2, as comprising basically three sleeves mounted in tandem on the perforated tube with the springs 16 of each sleeve being collinear with the springs of the other sleeves. As illustrated in FIG. 3A, the spring upper ends of one typical sleeve of springs, for example, are secured to the perforated tube 20 with spring upper retainer 26.

SPRING UPPER RETAINER 26

Spring upper retainer 26 of each of the three sleeves of springs comprises a ring circumscribing the perforated tube 20 and secured thereto, as by welding. The upper ends of the springs, in turn are fixedly secured, as by welding, to a recessed area on the spring upper retainer ring 26 to fixedly position the springs 16 at a precise distance apart for filtering the foreign material from the liquid, as in our preferred case, sand from crude oil. A pinned spring lower retainer 27 moveably fastens the spring lower ends to the perforated tube 20.

PINNED SPRING LOWER RETAINER 27

Pinned spring lower retainer 27, FIG. 3B, comprises the three following elements, an inner ring 27a similar to, but actually the allochiral projection of the spring upper retainer ring 26, FIG. 3B, the pin 24 described previously, and an arcuate segment 27b slideable in a window in outer sleeve 21. The pinned spring lower retainer 27 is longitudinally slideably retained on the perforated tube 20 by the pin 24 operable in longitudinal slot 23 in the tube. The lower ends of the springs 16 are fixed, as by welding, to ring 27a and spaced apart from each other by the same precise distance as the spring upper ends are separated. Arcuate segment 27b fits closely over ring 27a and, if desired but not necessary,

the springs may be welded thereto. Thus pin 24 locks the springs in the spring lower retainer 27. With the springs 19 lying flat upon their spacer 25, fastening pin 24 is positioned at the lower end of slot 23 whereby upward sliding movement of the pin 24 of the pinned spring lower retainer 27 to the upper end of the slot 23 will buckle the springs outwardly.

SLEEVE 21

Sleeve 21, FIG. 2, has ring portions 21a formed integrally therewith for forming windows 28. As viewed in FIGS. 3A and 3B, with upward movement of the outer sleeve 21 relative to inner perforated tube 20, ring portions 21a scrape off all calcification on the external surface of springs 19 until the ring portions contact the next spring lower retainer 27 above. Thus, ring portion 21, FIG. 3B, moves upwardly through the distance L. A conventional hydraulic piston and cylinder lifting jack 29, FIG. 1, is connected to the upper end of the production tube 10a for raising the outer sleeve 21, FIG. 3B, with its scraper ring 21a, relative to the springs fixed to the perforated tube 20 which is fastened to the well bottom. Thus, this raising of scraper ring 21a this much through the distance L results in cleaning of the outer surface of the springs. Further upward movement through the distance L by the motor 29 of the scraper ring 21a against the spring lower retainer 27 buckles and spreads apart the springs for cleaning therebetween.

FIG. 4, a sectional view at 4—4 on FIG. 3B, illustrates the straight square springs 19 in filtering position around the perforated tube 20 and spaced therefrom with spiral square ring spacer 25.

FIG. 5, a sectional view at 5—5 on FIG. 3B, illustrates the pin and slot connection of the spring 1 lower retainer 27 comprising pin 24 for locking inner ring 27a and arcuate segment 27b to the perforated tube 20 through its slot 23.

FIG. 6 is a sectional view of a portion of the straight spring filter 16 in sand filtering position after the outer sleeve 21 has been moved upwardly and the outer sleeve ring portions 21a have scraped over the springs to abut up against the lower retainers of the springs above. Thus the outer sleeve ring portions 21a have just completed the cleaning of the outer surfaces of the springs.

FIG. 7, similar to FIG. 6, illustrates the position of the spring filter after the outer sleeve ring portions 21a have been moved upwardly further for the length of the slot 23 to buckle and spread apart the springs 19 for backwash cleaning of the surfaces between the springs.

OPERATION

In operation of the self-cleaning straight spring filter 16, FIGS. 1-7, after the filter is lowered to its producing level in the petroliferous unconsolidated sand strata, the perforated tube 20 of the lower end of the filter is secured in packer 22 so that downward movement, pressure, and force from the vertical motion actuator 29 and from the weight of the drill string contracting the spring filter is obviated. After a great amount of crude oil production and the filter begins to sand up, the vertical motion actuator 29 is operated from the ground level control to raise the outer sleeve 21 and its integral ring 21a to accordingly scrape the calcification from the external surface of the straight springs 19. This cleaning action ends after outer sleeve

ring 21a completes the sweeping of the entire spring length and contacts the lower retainer of the next set of springs above, as illustrated in FIG. 6. Then the outer sleeve 21 is pulled upwardly an additional distance equal to the length of the slots which accordingly causes the springs to buckle and spread outwardly to the position illustrated in FIG. 7. A cleaning fluid, as water, is then backwashed through the springs for a predetermined length of time to clean the surfaces between the springs, the outer sleeve is lowered back to the initial position of FIGS. 3A, 3B, and production of sand-free crude oil is restored.

Accordingly, a very efficient self-cleaning straight spring filter is disclosed that is operable under heavy loads for crude oil production, for example, at the bottom of a long heavy drill string and which the straight springs of square material are supported by the spacers and end supporting retainers for maintaining uniform spacing therebetween, for preventing distortion under heavy loads, for providing increased flow of liquids through the filter springs due to the elongated slots formed by the precisely spaced apart springs, and for increased cleaning action in the filter as the outer sleeve scrapes the springs and they are separated for further cleaning, and for resisting high transverse loads, lateral displacement, and differential pressures.

Accordingly, a high strength, high load light self-cleaning straight spring filter is provided that resists differential pressures, maintains uniform spacing between the springs, and has increased flow therethrough and increased cleaning action with the buckling and spreading of the springs. Further, lateral displacement or twisting of the straight springs is prevented and any variation of spring gauge is prevented when operating under high loads.

Obviously other methods may be utilized with the disclosed sand filters for filtering sand from crude oil in an oil well protruding into a petroliferous unconsolidated sand strata.

Accordingly, it will be seen that the above methods for filtering sand from oil and of making selfcleaning straight spring filters and the disclosed self-cleaning straight spring filter will operate in a manner which meets each of the objects set forth hereinbefore.

While only one mechanism has been disclosed, it will be evident that various other modifications are possible in the arrangement and construction of the disclosed self-cleaning straight spring filter without departing from the scope of the invention and it is accordingly desired to comprehend within the purview of this invention such modifications as may be considered to fall within the scope of the appended claims.

We claim:

1. A method for cleaning a sand filter comprising a flexible screen formed of square straight springs around a perforated tube extending down into a petroliferous unconsolidated sand strata of an oil well comprising the steps of,

- a. scraping an outer ring over substantially the full length of the flexible screen for removing calcification from the exterior surface of the square springs for creating an area of unconsolidated formation around the screen,
- b. buckling the square springs outwardly by moving one end of the springs toward the other end with the outer ring for altering the gaps between the

springs and breaking up the consolidated sand mass in the gaps,

c. flushing the consolidated sand mass from between the springs, and

d. reversing the scraping movement of the outer ring over the screen for restoring the square springs to their original contiguous position for filtering sand as sand-bearing oil passes through the screen through the perforated tube, and up out of the well.

2. A method as recited in claim 1 wherein the second method step comprises,

a. moving the scraping ring beyond its spring to contact an end of an adjacent spring, and

b. moving the end of the adjacent spring toward its other end to buckle the spring radially outwardly from the perforated tube for cleaning of the sand from between the springs.

3. A method for forming a self-cleaning straight spring filter for mounting on the lower end of a tubing string extending down into a petroliferous unconsolidated sand strata of an oil well comprising the steps of,

a. forming a screen of contiguous straight springs around a perforated tube,

b. fixedly attaching a first end of two ends of the straight springs to the peripheral surface of the perforated tube in a precisely spaced relationship to each other for preventing the flow of sand therebetween,

c. connecting a ring means to a vertical motion actuator means in the well for sliding over the springs for scraping the calcification from the external surface of the screen for cleaning thereof, and

d. forming the second end of the straight springs moveable toward the first end of the springs for buckling the springs outwardly for removal of sand therebetween.

4. A method for forming a self-cleaning spring sand screen for mounting on the lower end of a tubing string extending down into a well to a liquid-containing sand strata comprising the steps of,

a. forming a cylindrical screen of vertical, straight contiguous springs around a perforated tube,

b. mounting the springs at a precise distance apart around the periphery of the perforated tube for preventing the flow of sand therebetween,

c. slideably mounting a ring over the screen for removing calcification from substantially the full length of the springs, and

d. slideably mounting the ring on the screen for additional movement for buckling the springs outwardly for spreading them apart for further cleaning thereof.

5. A method for forming a spring sand screen for mounting on that portion of a tubing string extending into a well to a liquid-containing sand strata comprising the steps of,

a. forming an outer tube concentric with an inner perforated tube,

b. mounting a plurality of vertical, straight, contiguous springs around the inner perforated tube and spaced from the inner tube with spacers,

c. fixing a first end of each of the springs to the inner perforated tube for spacing the springs at a precise distance apart for preventing the flow of sand therebetween,

- d. fixing a second end of each of the springs to a ring slideable on the inner tube toward the first ends for buckling the springs outwardly,
- e. forming a second ring integral with the outer tube for sliding over substantially the full length of the vertical straight springs for cleaning calcification from the external surface of the springs, and
- f. forming the ring slideable a second distance for contacting the second ends of the springs for buckling and separating the springs for additional cleaning thereof.
- 6. A method as recited in claim 5 wherein the third and fourth steps comprise,
 - a. fixing the upper end of each of the straight vertical springs to the inner perforated tube for spacing the springs at a precise distance apart for preventing the flow of sand therebetween, and
 - b. fixing the lower end of each of the straight vertical springs to a ring slideable on the inner tube toward the lower ends for buckling the springs outwardly.
- 7. A self-cleaning straight spring filter for mounting on the lower end of a production tubing string for extending down into a petroliferous unconsolidated sand strata of an oil well comprising,
 - a. a plurality of vertical, straight, contiguous springs having upper and lower ends mounted around a perforated tube means and extending down adjacent to the petroliferous sand strata,
 - b. ring means for fixedly connecting said upper ends of said vertical straight springs to said perforated tube in a precisely spaced relationship to each other sufficient to prevent the flow of sand therebetween,
 - c. spring lower retainer means for slideably securing the spring lower ends to said perforated tube,
 - d. sleeve means connected to a vertical motion actuator means on the well for sliding over said springs for cleaning thereof, and
 - e. said sleeve means being responsive to further movement of said actuator means for raising said spring lower ends toward said spring upper ends for raising said spring lower retainer means for buckling and spreading said springs for additional cleaning thereof.
- 8. A self-cleaning filter as recited in claim 7 wherein,
 - a. said sleeve means comprises a sleeve ring portion slideably encircling said springs and connected to said vertical motion actuator for sliding over substantially the full length of said springs to contact said spring lower retainer means for removing calcification from the exterior surface of the springs.
- 9. A self-cleaning filter as recited in claim 7 wherein,
 - a. said spring lower retainer means has a pin slideable in a slot in said perforated tube, and movement of said ring means by said sleeve means buckles and spreads said springs for additional cleaning thereof, and
 - b. said spring lower retainer means being responsive to said actuator means for raising said spring lower ends toward said spring upper ends for raising said spring lower retainer means for buckling and spreading said springs for additional cleaning thereof.
- 10. A self-cleaning spring sand screen for mounting on the lower end of a tubing string extending down into a well to a liquid-containing sand strata comprising,

- a. two concentric inner and outer tube means, said inner tube means being perforated,
- b. a screen comprising a plurality of vertical, straight, contiguous spring means mounted around said perforated inner tube means,
- c. said spring means being spaced from each other sufficient to prevent the flow of sand therebetween,
- d. ring means for sliding over said spring means for cleaning thereof, and
- e. said spring means being responsive to further movement of said ring means for being spread apart from each other for additional cleaning thereof.
- 11. A self-cleaning spring sand screen for mounting on the lower end of a tubing string extending down into a well to a liquid-containing sand strata comprising,
 - a. two concentric inner and outer tubes, said inner tube being perforated,
 - b. a screen of vertical, straight, contiguous springs mounted around said perforated inner tube and spaced from said inner tube with spacers,
 - c. a first end of each of said springs being fixed to said inner tube for spacing said springs at a precise distance apart for stopping the flow of sand therebetween as the sand containing liquid passes through the screen, into the perforated inner tube, and up to the tubing string above,
 - d. a second end of each of said springs being fixed to a ring at said same precise distance apart relative to each other as said first ends, said ring being slideable on said inner tube toward said first ends for buckling the springs outwardly,
 - e. said outer tube having ring means for sliding a first distance over substantially the full length of the vertical straight springs for cleaning thereof, and
 - f. said ring means being slideable a second distance for contacting said second ends of said springs for separating the springs for additional cleaning thereof.
- 12. A self-cleaning spring sand screen as recited in claim 11 wherein,
 - a. said first end of each of said springs fixed to said inner tube is the upper end of each of said springs, and
 - b. said second end of each of said springs fixed to said slideable ring is the lower end of each of said springs whereby said upper end is forced up toward said upper end to buckle the springs for cleaning.
- 13. A self-cleaning straight spring filter for mounting on the lower end of a tubing string for extending down into a petroliferous unconsolidated sand strata of an oil well comprising,
 - a. a plurality of straight, contiguous springs having upper and lower ends mounted lengthwise around a perforated tube in a precisely spaced relationship to each other sufficient to filter the sand from sand-bearing oil passing between the springs and into the perforated tube,
 - b. sleeve means connected to a reciprocal motion actuator means in the well for sliding over said springs for cleaning thereof, and
 - c. said sleeve means being responsive to further movement of said reciprocal motion actuator means for contacting said spring lower ends for buckling and spreading said springs apart for additional cleaning thereof.

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14. A self-cleaning straight spring filter as recited in claim 13 wherein,

- a. said plurality of straight springs comprises at least two tandem groups of straight parallel springs mounted lengthwise around said perforated tube, and
- b. said sleeve means comprises a separate sleeve encircling each separate group of straight parallel springs, all sleeves being connected to said reciprocal motion actuator means for sliding over its respective group of springs.

15. A self-cleaning straight spring filter as recited in claim 14 wherein,

- a. said upper ends of said springs of each group being fixedly mounted on said perforated tube,
- b. pin means for slideably connecting said lower ends of said springs of each group with slots in said perforated tube, whereby movement of the lower ends of the springs of each group in their respective slots toward their respective upper ends causes said buckling and spreading of said springs as each of said separate sleeves passes over its group of springs and contacts said pin means of the next upper group of springs, and
- c. said pin means of each tandem group of springs being responsive to contact with said sleeve means of the next upper group of springs after said sleeve

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means has passed over its group of springs for sliding in its slot and buckling and spreading said springs for the additional cleaning.

16. A self-cleaning straight spring filter for mounting on the lower end of a production tubing string extending down into a well to a liquid-containing sand strata comprising,

- a. two sets of contiguous straight vertical parallel spring means positioned lengthwise in tandem around a perforated tube,
- b. a first end of each of said vertical straight spring means of each set being fixedly secured around the periphery of said perforated tube,
- c. a second end of each of said spring means of each set being fixed to a ring having a portion slideable in a longitudinal slot so that each of said spring means moveable second ends is moveable toward its first end,
- d. a sleeve slideable over the length of each set of spring means to contact said moveable second ends of each set, and
- e. each of said spring means being responsive to further movement of said sleeve means for buckling and spreading apart said spring means for additional cleaning thereof.

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