United States Patent [19]

Rundt

[11] **3,766,981**

[45] **Oct. 23, 1973**

[54] **SAND SCREEN SAND SAVER**

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[73] Assignee: **Amoco Production Company,** Tulsa, Okla.

[22] Filed: **Aug. 14, 1972**

[21] Appl. No.: **280,691**

[52] **U.S. Cl.** **166/202,** 166/224

[51] **Int. Cl.** **E21b 33/126**

[58] **Field of Search** 166/202-205, 224, 157, 162, 172, 173

[56] **References Cited**

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2,602,514	7/1952	Althouse	166/202
2,887,347	5/1959	Losey	166/202 X
2,935,132	5/1960	Arterburg et al.	166/202 X
3,119,451	1/1964	Hall	166/202
3,153,451	10/1964	Chancellor et al.	166/202 X
3,313,352	4/1967	Tennison et al.	166/202
3,316,971	5/1967	Brown	166/202 X
3,381,755	5/1968	Morrison	166/202 X
3,637,010	1/1972	Maly et al.	166/51

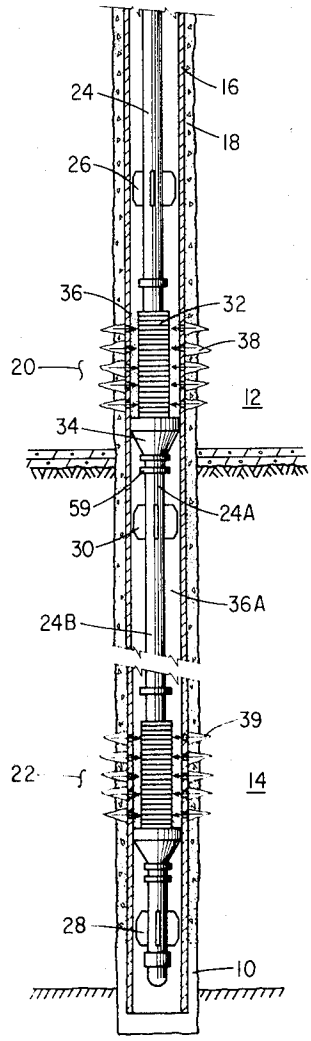
Primary Examiner—David H. Brown

Attorney—Paul F. Hawley et al.

[57] **ABSTRACT**

This is a special downhole sand screen assembly for oil and other fluids containing sand. This invention is called a sand screen sand saver and was developed especially for use with multi-layer concentric sand screens in which the outer screen has larger openings to retain the coarser sand particles and the openings in the inner screen are progressively smaller to retain the less coarse sand particles. The sand screen sand saver causes the sand to be retained so that it can form a sand pack between the outer screen and the well casing.

5 Claims, 4 Drawing Figures



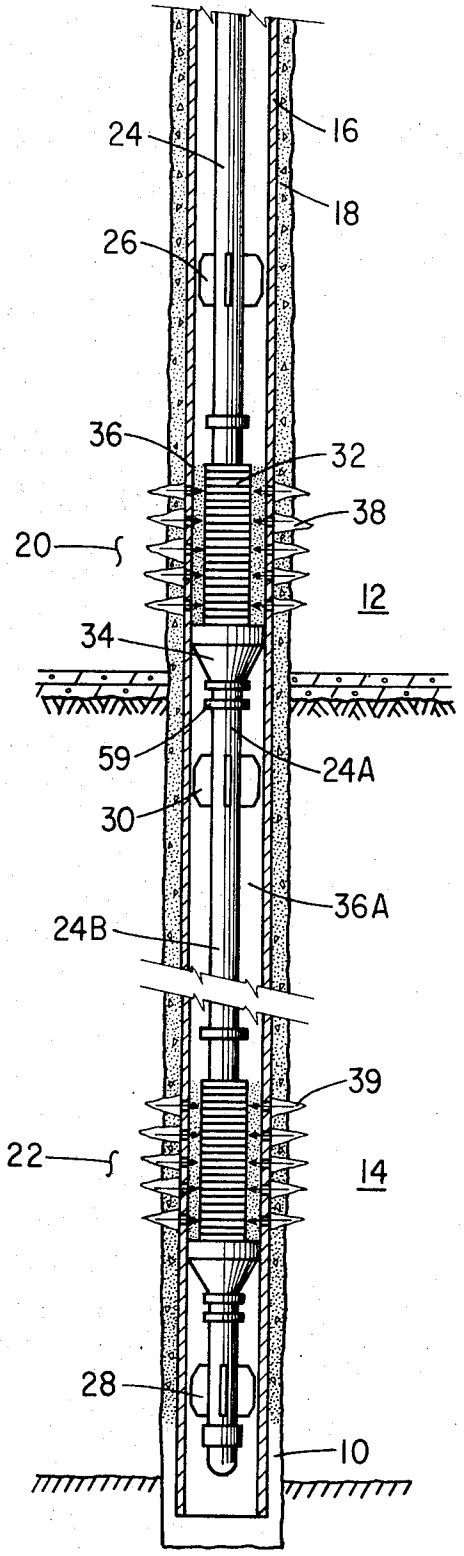


FIG. 1

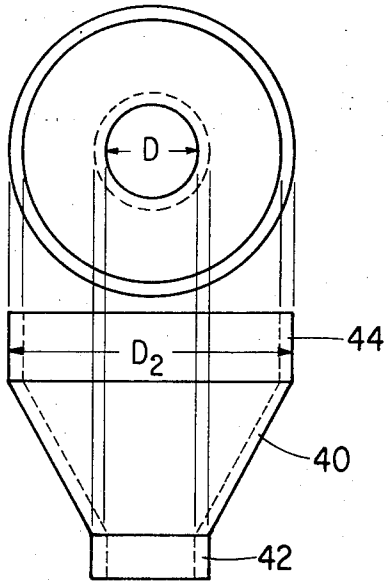


FIG. 2

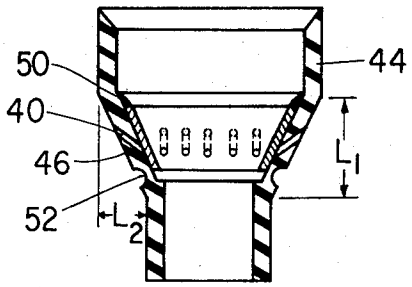


FIG. 3

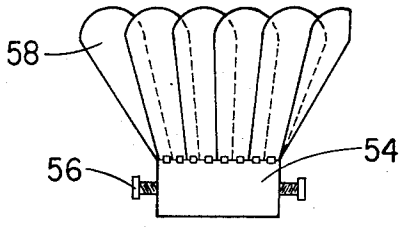


FIG. 4

SAND SCREEN SAND SAVER

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a sand filter for producing fluids through wellbores from subsurface formations. It relates especially to a multi-layer sand screen with special means to retain produced sand between the sand screen and the casing.

2. Setting of the Invention

Oil and gas are produced from underground formations through wellbores drilled from the surface to the formation. Some oil and gas is contained in the pores of consolidated rocks or sand. When this oil is produced through the wellbore, it is relatively free of any rock particles or sand. However, many oil and gas wells produce fluid from underground formations which are not consolidated. That is, the various sand particles are not strongly attached to each other and when the fluid is produced, it carries entrained sand with it which causes serious damage to well equipment. In producing oil and gas from such unconsolidated formations, some method must be provided to restrain the sand inflow into the well. There are numerous methods which have been used to combat this problem. They include (a) placing a screen in the well with sufficiently small openings to prevent inflow of all undesired materials; (b) use of a gravel pack placed in the annular area between the screen and the formations; the voids between the gravel grains being small enough to prevent inflow of sand; and (c) placing a screen in a well consisting of a mechanical screen and a pre-formed gravel pack attached to the screen.

One of the most promising methods of controlling sand in producing wells is the system using a multi-layer well screen described in U.S. Pat. application Ser. No. 77,492, now U.S. Pat No. 3,712,373, filed Oct. 2, 1970, William G. Bearden, et al.

The following U.S. Pats. relate to mechanical means of combating the sand production problem and although not at all exhaustive give a fair representation of the art in this area of which I am aware:

2,776,001 Clark
3,216,505 Johansson
3,262,499 Fleming
3,316,971 Brown
3, 81,755 Morrison

Some of these Patents show a packer set on a mandrel beneath a slotted liner to retain gravel so that a gravel pack may be formed in the wellbore at a specific location.

BRIEF DESCRIPTION OF THE INVENTION

A cup or other basket-like sand-retaining means is affixed to the lower end of a sand screen for use in a wellbore to obstruct the annular space between the sand screen filter at its lower end and the casing. As fluid containing sand is produced through the filter, the more coarse particles are blocked by the sand screen, the cup or sand screen saver (SSSS) will prevent the coarse particles from falling from the sand screen casing annulus to a void below the screen. The formation of this sand pack greatly increases the effectiveness of any sand control system using sand screens and also avoids the difficulties and expense of running gravel packs.

BRIEF DESCRIPTION OF THE DRAWINGS

Various objectives and a better understanding can be had of the invention by the following description taken in conjunction with the invention in which:

FIG. 1 illustrates downhole sand control assemblies utilizing my invention,

FIG. 2 illustrates one form of my sand screen sand saver,

FIG. 3 illustrates another form of my sand screen sand saver, and

FIG. 4 illustrates still another form of my sand screen sand saver.

DETAILED DESCRIPTION OF THE INVENTION

Attention is first directed to FIG. 1 which illustrates a borehole **10** drilled through a producing formation having upper zone **12** and a lower zone **14.** These formations will be assumed to produce a fluid such as oil which contains sand entrained therein in sufficient quantities to cause sand production problems. A casting **16** is mounted in hole **10** and cement **18** fills a portion of the void between the casing and the borehole wall. Casing **16** has perforations **38** and **39** adjacent zones **12** and **14.**

I show an upper sand control device **20** and a lower system **22.** These are connected into a tubing string **24** suspended in casing **16** and it is through this tubing that production is transported to the surface. For the purpose of this illustration, it will be assumed that zones **12** and **14** are part of the same underground reservoir or in any event can be produced through the same tubing string. It is important that screen assembly **20** and **22** be reasonably well centered in casing **16.** I obtain this by use of upper centralizer **26** above screen **20,** centralizer **28** below screen **22** and centralizer **30** which is immediately below **34.** Upper sand screen assembly **20** and lower assembly **22** are essentially identical. Thus, the discussion will center mainly on only one of these, namely, the upper assembly. Upper sand assembly **20** includes a sand screen filter **32** which for best results is a multi-layer sand screen filter as described in U.S. application Ser. No. 77,492, supra. I have added a sand screen sand saver **34** to sand screen **32.** Various configurations of sand screen sand saver **34** are shown in FIGS. **2, 3** and **4,** and will be described later. In order for sand screen **32** to operate at maximum efficiency, the annulus **36** between screen **32** and casing **16** should become filled with entrapped sand as the well is produced and the formation sand entrained in the fluid screens out on the outer layer of the sand screen. If the annulus space **36** is sufficiently small, a formation sand pack will form and will usually be maintained so long as production is maintained. However, it has been found that if either the annulus is too large or if production is stopped, the entrapped sand which forms a bridge frequently drops out to the annular void **36A** between casing **16** and tubing **24B** below the sand screen **34.** I eliminate these problems by the use of my sand screen sand saver **34** which is secured to tubing extension **24A** above the tubing collar **59** which extends beneath the sand screen **32.** The portion of the tubular member within sand screen **32** between the main tubing string and tubing extension **24A** is ordinarily a section of slotted or perforated pipe (not shown in the drawing) connected directly into the tubing string **24.**

Fluid is produced from zone 12 through perforations 38 through the openings in the sand screen 32 and eventually through the slotted pipe and up the tubing. The lower end of the tubing is closed. The outer layer of screen 32 has perforations which are sufficiently small so as to stop the larger sand particles being produced with the fluid through perforations 38. These sand particles drop out into annulus 36. Any tendency for the sand particles to fall to below screen 32 is prevented by my sand screen sand saver 34 and assures the retention of a "sand pack" between the screen and the casing. I can thus have reasonably large clearance between sand screen 32 and casing 16, for example, from about 1.25 inches to as large as convenient. Further, if I should have to stop production to make repairs at the surface for some reason, then with my invention there is no danger of the sand, which has formed a very efficient filter in annulus 36, falling out, which might occur if my sand screen sand saver were not used. Thus, when I resume production, my sand system filter 20 is operating at maximum efficiency. There is no low efficiency period.

Attention is directed to FIG. 2 for a simple form of my sand screen sand saver. Shown there is a cup 40 having a lower portion 42 which has an internal diameter "D", which is essentially the same as the external diameter of tubing extension 24A. It has an intermediate section which tapers upwardly and has an upper section 44 which has an outside diameter "D_2" which is essentially the same as the inside diameter of casing 16. This hollow member may be clamped or otherwise secured to tubing extension 24 immediately below sand screen 32. This sand screen sand saver can be made of molded rubber or it can be made of metal.

Attention is now directed to FIG. 3 which illustrates some preferred features of my sand screen sand saver. This one embodiment is shown having a plurality of ports sloping inwardly and downwardly through section 40. A flexible slotted annular member 48 inside section 40 is secured at its upper edge 50 to section 40. This serves as a check or flapper valve for ease in running the device in fluid-filled wells to reduce pressure surges against the perforated or exposed formation. However, once the device is in position, sand will be retained on top of annular valve 48.

From time to time, most wells are subject to workover problems in which case the tubing 24 must be pulled from the well. This also will pull the sand screen. If my sand screen sand saver 34 is made of metal of too high strength, then it would become nearly impossible to pull the tubing string. I relieve this problem by several methods. I can simply make the material sufficiently strong to retain sand for the length of the sand screen but sufficiently weak so that I start to pull it, it will collapse. Preferably, I can aid this by forming a circumferential groove 52 in section 40 to weaken the sand saver.

As shown in FIG. 3, L_1 is the vertical component and L_2 is the horizontal component of the dimensions of section 40. It is a fact that sometimes centralizers 26 and 30 have sufficient clearance so that tubing 24 is not completely centered. Even though sand screen 32 is not absolutely centered, my invention will still function. One precaution I can take to help insure this is to make $L_1/L_2 \geq 2$. This gives me flexibility so that if D_2 is approximately the same as that of the inside of the casing, then the upper section 44 will contact the inside of casing 16 and form a sand-retaining seal therewith.

Attention is now directed to FIG. 4 for another embodiment of my sand screen sand saver. I show there a base collar 54 with screws 56 so that collar 54 can be firmly attached to tubing extension 24A immediately below sand screen 32. I make my cup portion from a plurality of upwardly extending flexible petal-like elements 58 which can be made from sheet steel. The spring-like elements 58 expand or fall outwardly against the inside of the casing and form an upwardly facing bucket to catch the sand. When it is required to pull the sand screen 32, these resilient petal elements will be easily inverted so that the entrapped sand can fall down and not stick the sand screen in the casing.

I have shown two spaced-apart sand screen assemblies 20 and 22. However, my invention works equally well for one assembly or for any reasonable number.

While the above invention has been described in detail, it is to be understood that various modifications can be made thereto without departing from the spirit or scope of the invention.

I claim:

1. A sand screen sand saver for use with a sand screen supported by a tubing string suspended in a casing lining a wellbore which has perforations opposite an underground producing formation which comprises a hollow cup-like member having
   a lower cylindrical portion,
   an upper cylindrical portion of larger diameter than said lower portion,
   an intermediate truncated cone portion connecting said lower section and said upper section, said intermediate section having a plurality of ports therethrough sloping inwardly and downwardly.

2. An apparatus as defined in claim 1 including check valve means closing said ports.

3. An apparatus as defined in claim 2 in which $L_1/L_2 \geq 2$ where L_2 is the longitudinal distance between said lower section and said upper section and L_2 is the difference between the radius of said lower portion and the radius of said upper portion.

4. An apparatus as defined in claim 3 including a circumferential groove in the lower exterior portion of said intermediate section.

5. A sand screen saver for use with a sand screen supported by a tubing string suspended in a casing lining a wellbore which has perforations opposite an underground producing formation which comprises a hollow cup-like member having
   a lower cylindrical portion,
   an upper cylindrical portion of larger diameter than said lower portion,
   an intermediate truncated conical portion connecting said lower section and said upper section, said intermediate section including a circumferential groove in the lower part of said intermediate section.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,766,981 Dated October 23, 1973

Inventor(s) Ronald J. Rundt

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 44, "2,776,001 Clark" should read --2,776,011 Clark--; line 48, "3, 81,755 Morrison" should read --3,381,755 Morrison--; line 61, "sand screen saver (SSSS)" should read --sand screen sand saver (SSSS)--.

Column 3, line 38, "ports sloping" should read --ports 46 sloping--; line 54, "that I start to pull" should read --that when I start to pull--.

Column 4, line 41, "claim 2" should read --claim 1--.

Signed and sealed this 6th day of August 1974.

(SEAL)
Attest:

McCOY M. GIBSON, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents