

[54] STEAM INJECTION SYSTEM FOR USE IN A WELL

2,662,600 12/1953 Baker et al. .... 166/154  
3,349,849 10/1967 Closmann ..... 166/303  
3,530,939 9/1970 Turner ..... 166/303

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[73] Assignee: Chevron Research Company, San Francisco, Calif.

[57] ABSTRACT

[21] Appl. No.: 783,131

A steam injection system including a steam deflector connectable into a tubing string which steam deflector provides for selectively passing steam through the tubing string to the bottom thereof or diverting steam from inside the tubing string out into the wall liner-tubing annulus and in a direction concentric with and substantially parallel to the longitudinal axis of the tubing string and above the bottom end thereof utilizing a sliding-sleeve arrangement and packer cup means packing off the well liner-tubing annulus both above and below the steam deflector.

[22] Filed: Mar. 31, 1977

[51] Int. Cl.<sup>2</sup> ..... E21B 33/122; E21B 43/12

[52] U.S. Cl. .... 166/191; 166/202; 166/317; 166/318; 137/71; 137/874

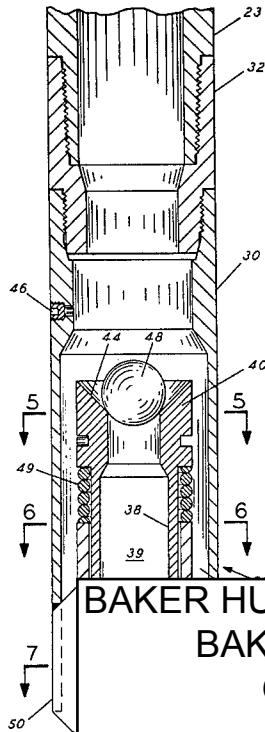
[58] Field of Search ..... 166/191, 186, 147, 202, 166/317, 318, 325, 306, 303, 269, 127, 194; 137/71, 625.48, 595, 610

[56] References Cited

U.S. PATENT DOCUMENTS

2,611,436 9/1952 Carr et al. .... 166/269

2 Claims, 11 Drawing Figures



BAKER HUGHES INCORPORATED AND  
BAKER HUGHES OILFIELD  
OPERATIONS, INC.  
Exhibit 1010  
BAKER HUGHES INCORPORATED AND  
BAKER HUGHES OILFIELD  
OPERATIONS, INC. v. PACKERS PLUS  
ENERGY SERVICES, INC.  
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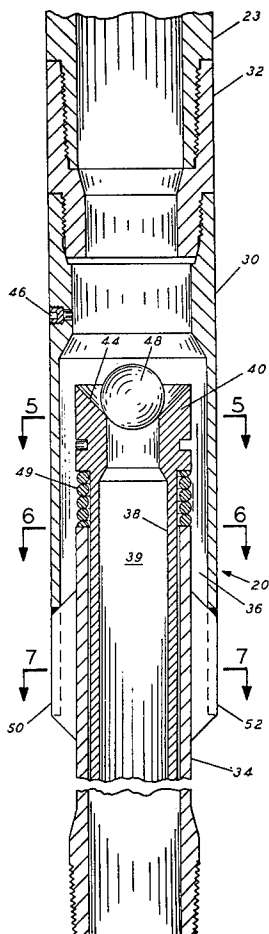
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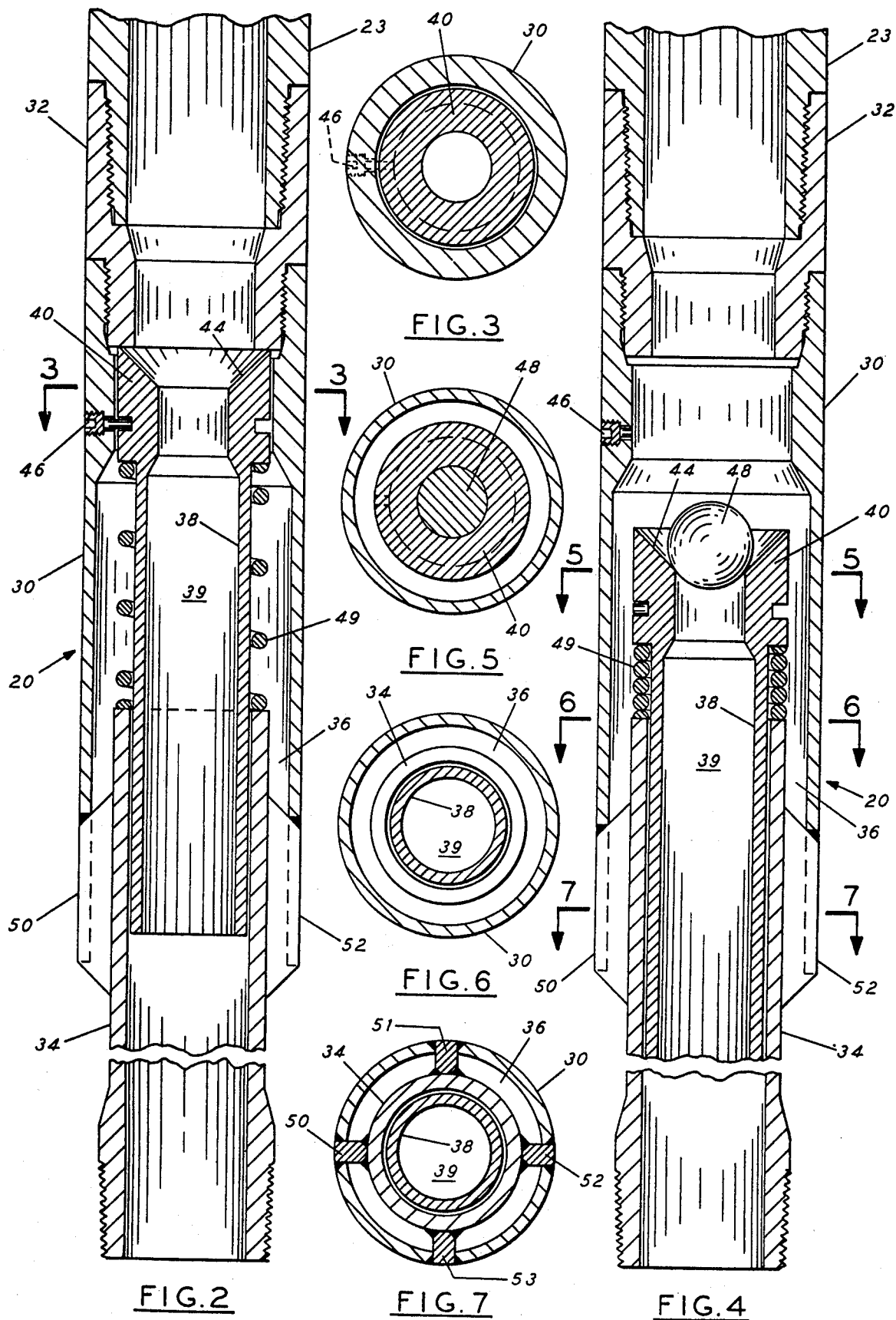
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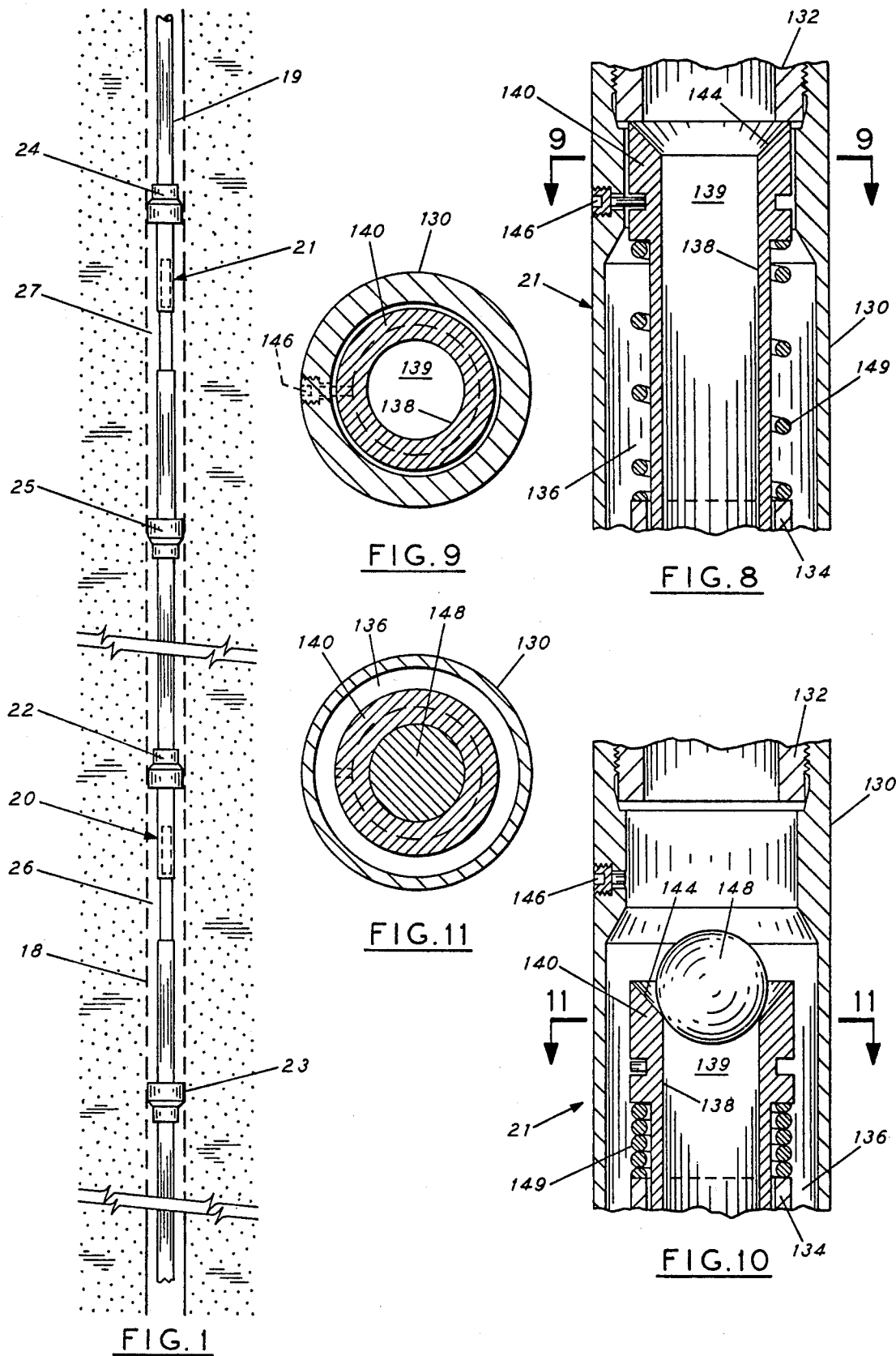
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## STEAM INJECTION SYSTEM FOR USE IN A WELL

### CROSS REFERENCE TO RELATED APPLICATIONS

This application is related to U.S. application Ser. No. 714,941, filed Aug. 16, 1976, by S. O. Hutchison now abandoned and to U.S. application Ser. No. 783,135, filed Mar. 31, 1977 by S. O. Hutchison and G. W. Anderson.

### FIELD OF THE INVENTION

The present invention relates to a steam injection system which includes a steam deflector connectable into a tubing string located in a well, and packer cups for packing off the tubing-well liner annulus both above and below the steam deflector. The steam deflector is adapted to selectively pass steam through the tubing string or to divert steam from the interior of the tubing string above the bottom thereof into the well liner-tubing annulus in a direction concentric with and substantially parallel to the longitudinal axis of the tubing string and the packer cups are adapted to pack off the well liner-tubing annulus both above and below the steam deflector.

### BACKGROUND OF THE INVENTION

Steam injection is a standard technique for improving oil recovery from a well. It is often desirable to inject steam into a well at a location other than the bottom of the tubing. This is particularly true in thick formations. Initially, the practice was to simply direct the steam into a well liner-tubing annulus in the form of a jet at right angles to the tubing string. This, however, caused damage to the liner. Later steam deflectors were used to deflect the steam into the well liner-tubing annulus in a downward direction above the outside of the tubing. However, uniform and certain placement of the steam was not certain utilizing the prior art placement methods. The present invention provides a steam injection system which overcomes these problems.

### BRIEF DESCRIPTION OF THE INVENTION

The present invention provides a steam injection system which includes a steam deflector connectable into a tubing string for selectively passing steam down the interior of the tubing string or for diverting the steam from the interior of the tubing string out into the well liner-tubing annulus in a direction concentric with and substantially parallel to the longitudinal axis of the tubing string and above the bottom thereof and at a velocity which does not substantially exceed the velocity of the steam formerly flowing inside of the deflector to prevent damage to the well liner and packer cup means packing off the tubing-liner annulus both above and below the steam deflector. A sliding sleeve and a ball are used to close off the interior of the steam deflector and to open a concentric annulus to steam flow to the outside of the steam deflector. The flow area of the concentric annulus is at least as great as the flow area through the interior of the deflector. A plurality of steam deflectors having different size of balls may be used to provide for a greater number of steam injection intervals.

### PRINCIPAL OBJECT OF THE INVENTION

The principal objection of the present invention is to provide a steam injection system for directing steam either down the tubing string or out of the tubing string in a direction concentric with and substantially parallel to the longitudinal axis of the tubing string and at an acceptable velocity into a packed-off portion of the well liner-tubing annulus. Other objects and advantages of the invention will be apparent from the following specification and drawings which are incorporated herein and made a part of this specification.

### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevation view partially in section and schematically illustrates apparatus assembled in accordance with the present invention positioned in a well adjacent a well liner.

FIG. 2 is a sectional view illustrating the preferred steam deflector assembled in accordance with the present invention in a position to inject steam through the lower end of the tubing string;

FIG. 3 is a sectional view taken at line 3—3 of FIG. 2;

FIG. 4 is a sectional view of the preferred steam deflector assembled in accordance with the present invention in position to divert steam into the well liner-tubing annulus;

FIG. 5 is a sectional view taken at line 5—5 of FIG. 4;

FIG. 6 is a sectional view taken at line 6—6 of FIG. 4;

FIG. 7 is a sectional view taken at line 7—7 of FIG. 4;

FIG. 8 is a sectional view illustrating an embodiment of apparatus assembled in accordance with the invention and useful in the tubing string above the FIG. 2—FIG. 7 embodiment to provide for a second level of steam injection, the apparatus being in position to direct steam down the tubing string;

FIG. 9 is a sectional view taken at line 9—9 of FIG. 8;

FIG. 10 is a sectional view of the FIG. 8 apparatus in position to divert steam into the well liner-tubing annulus; and

FIG. 11 is a sectional view taken at line 11—11 of FIG. 10.

### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 is an elevation view partially in section and illustrates steam deflector apparatus generally indicated by the numerals 20 and 21 connected on a tubing string 19 located in a well in accordance with the present invention. Steam is flowed into the tubing string from a steam generator (not shown) connected thereto. The steam deflector apparatus 20, 21 are shown between sets of packer cup assemblies 22—23 and 24—25 respectively. The preferred form of packer cups useful in accordance with the present invention are described and claimed in copending application U.S. Ser. No. 714,941, filed Aug. 16, 1976. The disclosure of said application is hereby incorporated by reference herein.

The preferred packer cup such as indicated by the numeral 24 for example comprises a mandrel section connectable into a tubing string 19. A sealing element 17 is provided with a central opening in snug engagement over the mandrel section. The sealing element includes



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