S-CAL RESEARCH CORPORATION

DOE/CE/15553--T2

SYSTEM TO INJECT STEAM AND PRODUCE OIL FROM THE SAME WELLBORE THROUGH DOWNHOLE VALVE SWITCHING

DOE/CE/15553--T2

DE93 007736

Contract DE-FG01-92 CE 15553

SECOND QUARTERLY REPORT

ABSTRACT:

A market analysis for the Downhole Valves and associated hardware in California has shown that the main effort should be concentrated on the second case studied in the First Quarter Report,namely that of re-entry into a thermal well equipped with a 7 in. casing.

An improved design,based on the use of a combination of a sliding sleeve valve with two plugs (all of them operated by wireline) is the most flexible and lowest cost configuration,for entering the largest market in California,that of existing vertical wells penetrating a relatively thin (=< 40 ft) reservoir.At present oil prices at the California refineries,these wells,operated under cyclic steam injection are barely economic.They could become much more productive with the addition of a pair of small-diameter horizontal drainholes.

A low-cost work-over program with all drilling and completion operations done through the 2 7/8 in. production tubing has been designed.

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MASTER

Laboratory tests have confirmed the operability of the modified sliding sleeve valve with steam at temperatures ranging up to 500 F. Calculations have also determined the steam quality improvements resulting from using a low-cost Silicate foam insulation on the 2 3/8 in. steam tubing,with the 7 in. casing/tubings annulus filled with low-pressure gas.

7.ADVANTAGES OF COMBINING A DUAL WHIPSTOCK WITH THE DOWNHOLE VALSE SYSTEM

There are presently in California more than 12,000 wells equipped for steam injection.Most of them have a 7" (OD) casing.All of them would see their productivity increased from the addition of multiple drainholes and from their operation in sequential cyclic steam injection under our patented process.This being a large ready market,the design of our Downhole Valves and associated hardware has been focused on this first application.The future availability of prototype equipment suitable for this type of well and casing size makes it easier to find an Oil Operator willing to demonstrate this new technology,as part of a work-over,especially if costs are kept to a minimum.

The limited space offered by a 7 in. casing (6.24 in.ID) is best utilized if the flow channels and Downhole Valve section are combined with a dual whipstock into a single element (30 ft long) which is run-in and anchored with the steam tubing.The production tubing is then stabbed into a PBR at the top of this combined element.

Each drainhole liner string is preferably a 1 3/4 in. coiled tubing which is inserted through the 2 7/8 in. production tubing (2 3/8 in.ID) and guided through one of the deviated outlets of the dual

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whipstock.The top of the liner string,after the drainhole has been drilled,is anchored and packed into the whipstock,after the horizontal portion of the hole has been gravel-packed and a cement slurry has been displaced behind the curved part of the liner.All the operations required for the addition of two drainholes: 1. cutting of elliptical windows into the casing,

2. drainhole drilling,

3. drainhole completion,

are done through the 2 7/8 in. production tubing.If the coiled tubing liner is also used for drainhole drilling (Ref.7),this work may be done without a derrick,using only a less expensive coiled tubing unit.

By incorporating into a single 30 ft.element all the required functions,the capital cost is also greatly reduced,primarily because of a reduction in rig time.A conceptual drawing of this "H joint" element is shown in cross section on Fig.1.A sliding sleeve three-way valve is shown on Fig.2 .It is derived from the assembly of commercially-available sliding valves (Fig.3)

To lift the produced fluids from the surface,a conventional beam pump will be used,so as to minimize costs and to maximize the re-use of existing facilities.

8. MODE OF OPERATION

To switch the left well of Fig.1 from production to injection,the only necessary wireline operations are the following:

- Pull out through the steam tubing to the surface the sliding sleeve of Fig.1

- Through the steam tubing,transfer the plug from the right lower

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branch of the "H joint to the left lower lower branch in Fig.1,using a modified kick-over tool (Fig.4),

- Replace the sliding sleeve in the steam tubing mandrel by another of the type shown on Fig.2.

Throughout these operations,the rod pump remains anchored in the production string so that it is unnecessary to bring-in a service unit rig to switch from "huff" to "puff" as in the case of conventional single cyclic steam injection wells.This substitution of a wireline unit for a service unit rig is more cost-effective.

9. VARIOUS APPROACHS TO THE CONSTRUCTION OF THE COMBINED ELEMENT

The deviated flow channels associated with the Downhole Valve are an integral part of the dual whipstock.As such,they must be made of a hard,non-drillable metal.This indicates that the combined element might be cast in one piece from molten metal.Subsequent machining of the mechanical features (threaded connections,landing nipples for plugs and choke mandrels,hydraulically actuated anchor slips,etc...) will then be more difficult and costly.It will require gun-drilling tools and technology.

Another approach is to build the combined elememt out of smaller metal pieces,pre-machined and assembled by welding.The main problem in that case is to design a welding procedure which does not significantly distort the machined parts.

Comparative costs of these two approaches are now being requested from various subcontractors.

The conceptual design of Fig.1 includes two conventional packers: a single-string packer on the right lower branch and a dual-string packer on the upper two branches of the "H joint".These are relatively

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costly items.Their replacement or potential elimination by other devices is presently under study to further reduce costs.

REFERENCES

7) "New Horizontal Drilling Techniques Using Coiled Tubing",by H.R.Wesson,Jr. SPE 23951,1992

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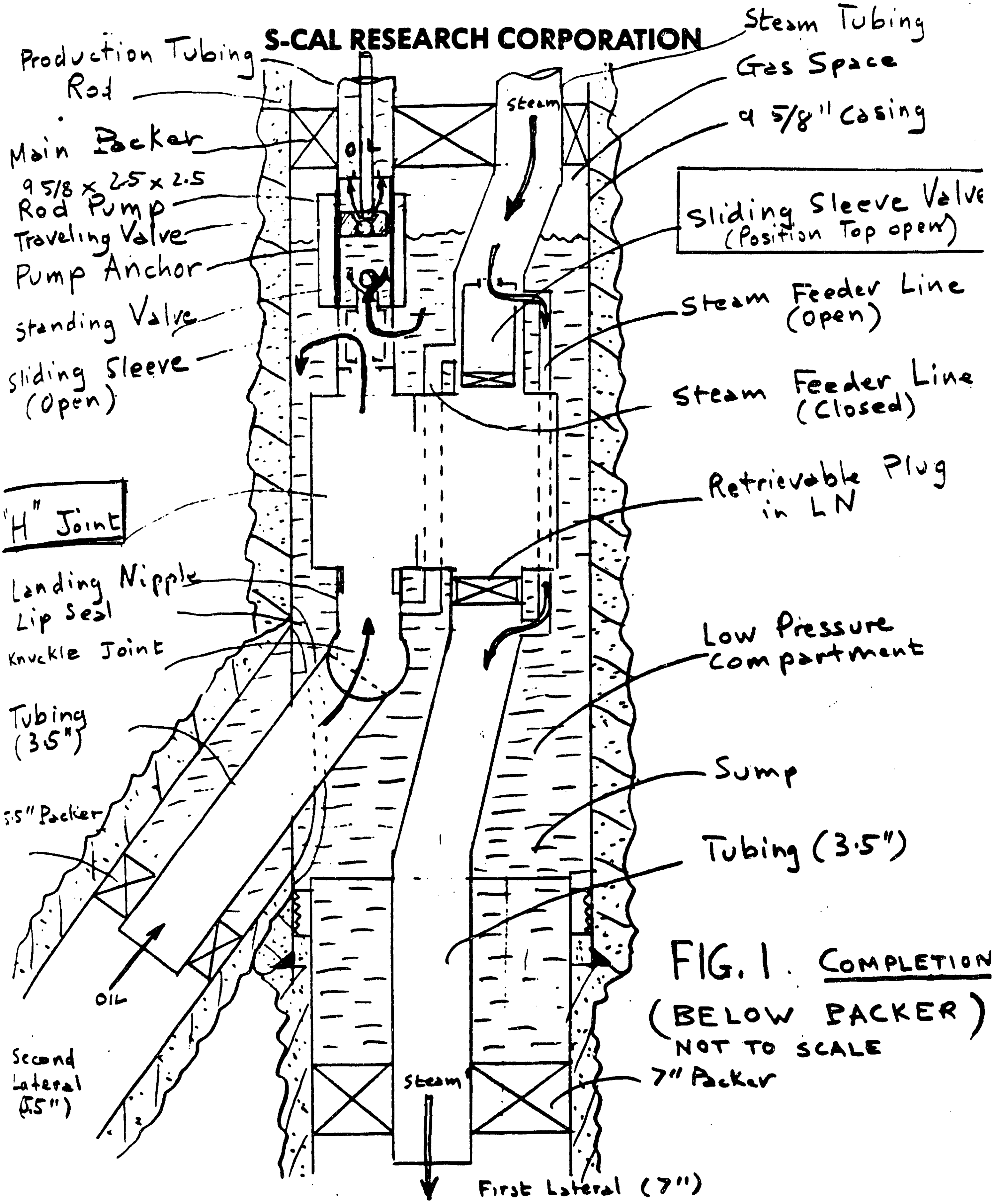

FIG. 1. COMPLETION (BELOW PACKER) NOT TO SCALE

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Item (2)

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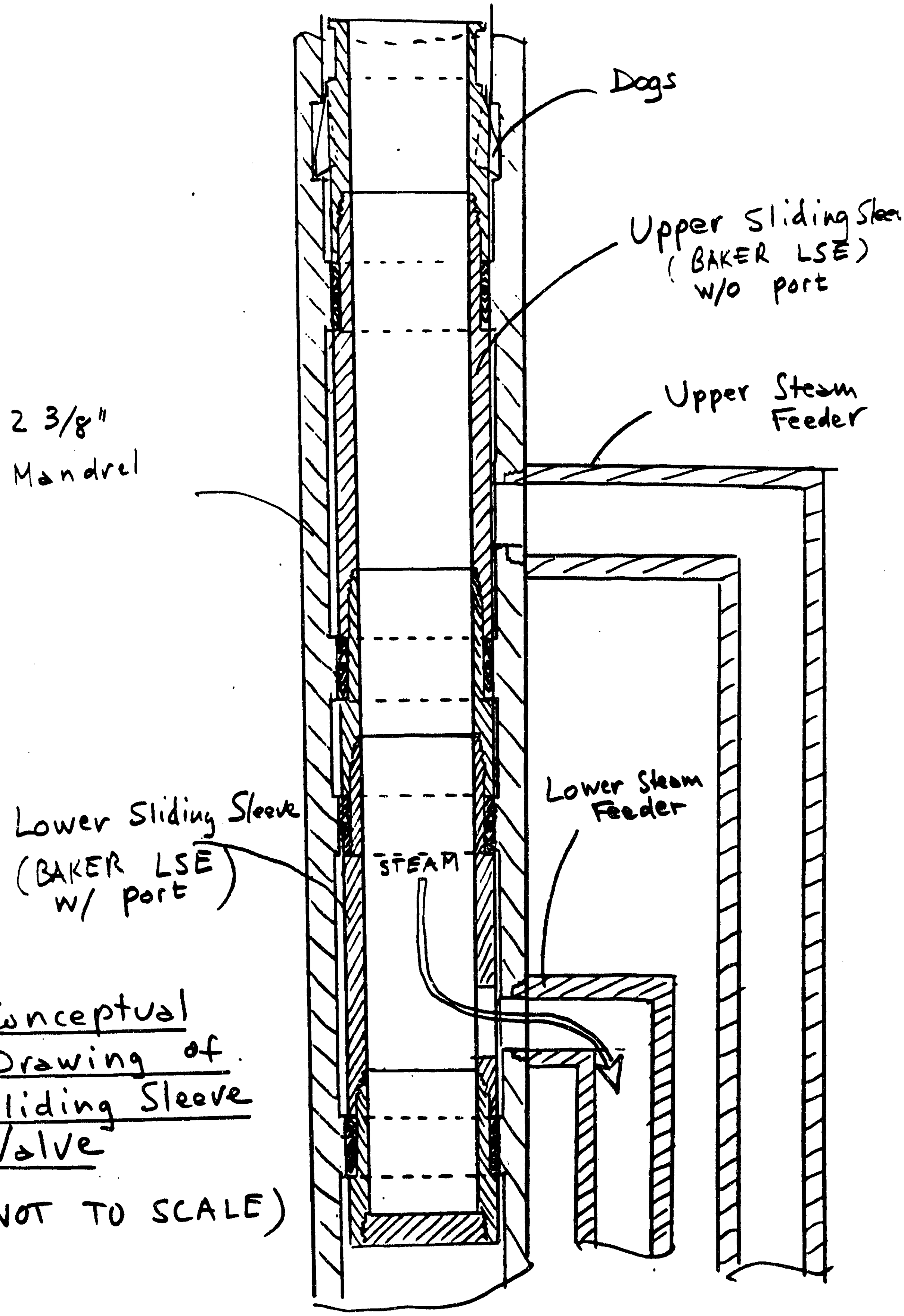

Fig. 2 – Conceptual Drawing of Sliding Sleeve Valve

(NOT TO SCALE)

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FIG. 3 _ SLIDING SLEEVES

BAKER PACKERS COMPLETION SYSTEMS FLOW CONTROL SYSTEMS

C

SEPARATION SLEEVES FOR MODEL "L" SLIDING SLEEVE

"LSE" Product No. 805-41 (Selective)
"LWE" Product No. 805-42 (Top NoGo)
"LGE" Product No. 805-50 (Top NoGo)
"LME" Product No. 805-45 (Top NoGo)

Model LSE

Model LWE

Model LGE

Model LME

The Baker Separation Sleeve used in the Model "L" Sliding Sleeve is designed to SHUT off tubing to annulus flow through the Sliding Sleeve should the Sliding Sleeve become inoperative. "Straight Through Flow" through the Separation Sleeve is accomplished by a chevron packing system that will seal off in the upper and lower seal bores, isolating the ports of the Sliding Sleeve.

The Separation Sleeve is also designed with an internal equalizing plug to equalize pressure before retrieving.

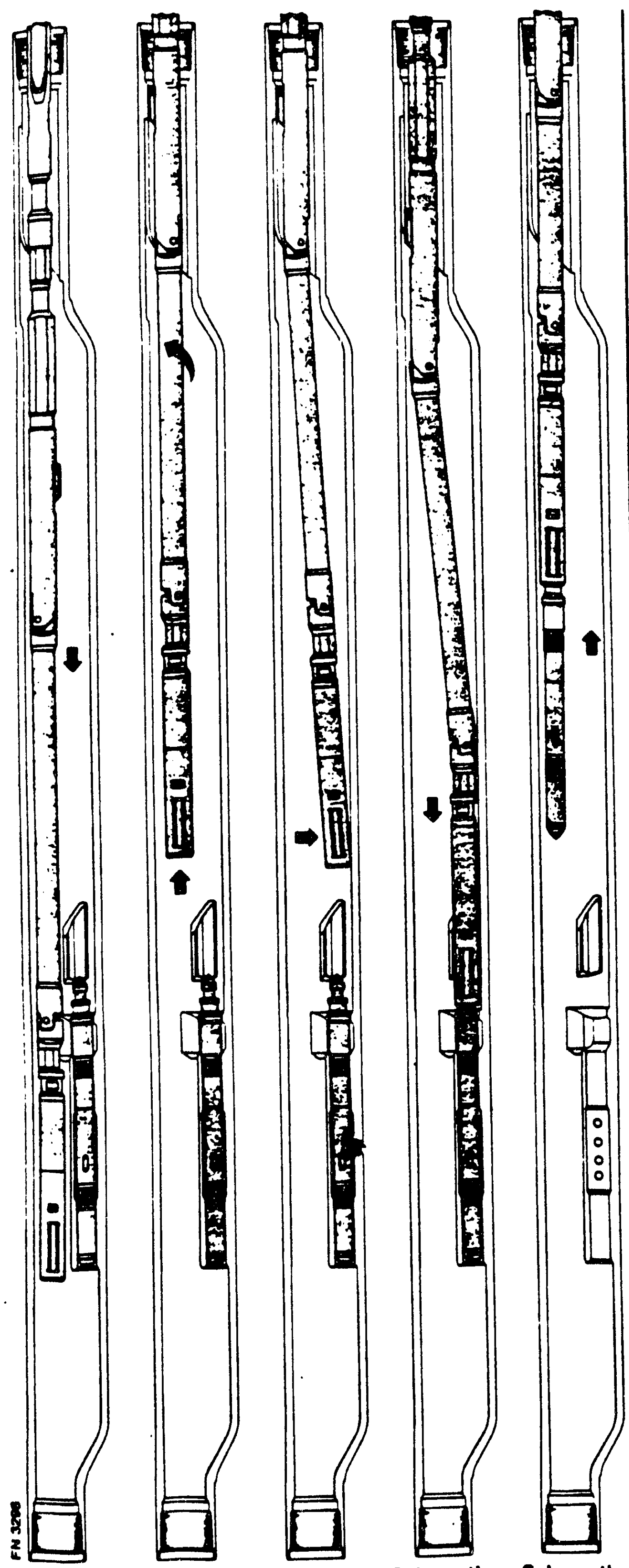
ORDERING EXAMPLE:
PRODUCT NO 805-45
SIZE 2.75 MODEL "LME" SEPARATION SLEEVE

MODEL "LME" SEPARATION SLEEVE SPECIFICATION GUIDE

Tubing OD in. mm	Seal Bore in. mm	Size	Max OD in. mm	To Run or Pull: Running & Pulling Tool •	To Run or Pull: "M-1" Probe Prod. No. 812-14	To Equalize: "A" Guide Prod. No. 811-71	To Equalize: "A" Prong" Prod. No. 811-70
3-1/2 88.9[illegible]	2.750 [illegible]	2.75	2.802 71.7	406S27500	812-14-2750	3-1/2	5/8" x 30
	2.812 [illegible]	2.81	2.875 73.02		812-14-2810		
4 101.60	3.125 [illegible]	3.12	3.175 [illegible]		812-14-3120	4	5/8" x 40
	3.250 82.5[illegible]	3.25	3.300 83.8[illegible]				
	3.312 84.12	3.31	3.403 86.44		812-14-3310		
4-1/2 114.3[illegible]	3.688 [illegible]	3.68	3.740 95.0[illegible]	406S36800	812-14-3680	4-1/2	
	3.812 [illegible]	3.81	3.835 [illegible]		812-14-3810		
5 127.0[illegible]	4.000 [illegible]	4.00	4.080 103.8[illegible]		812-14-4000	5	5/8" x 4[illegible]
	4.125 [illegible]	4.12	4.215 10[illegible]				
	4.312 [illegible]	4.31	4.385 [illegible]		812-14-4310		
5-1/2 [illegible]	4.562 115.8[illegible]	4.56	4.653 [illegible]			5-1/2	
6-5/8 168.28	5.500 [illegible]	5.50	5.600 142.24	Model "M" 811-50-5250	812-14-5500	6-5/8	

• See running and pulling tool specification guide for required OD's

FIG. 4 KICKOVER TOOLS FOR INSTALLING GAS LIFT VALVES IN SIDE POCKET MANDRELS



Schematic 1 Schematic 2 Schematic 3 Schematic 4 Schematic 5

To simplify the wireline work to install gas lift valves in Otis® Side Pocket Mandrels, a specially designed kickover tool can be used. This tool is a definite aid in deviated wells. It locates the mandrel (selectively when two or more mandrels are installed in one well), orients in the proper position, and offsets the valve (or pulling tool) into position over the pocket for setting or retrieving the valve.

Schematic 1—The kickover tool is run below the mandrel. Since the tool is locked in a rigid position, it is designed not to kick over accidentally.

Schematic 2—The kickover tool is raised until its key engages the kickover sleeve in the mandrel. Continued upward movement rotates the tool until its key enters a slot. When the key reaches the top of the slot, the operator is notified by a weight increase displayed on the weight indicator. The tool is now properly oriented.

Schematic 3—The pivot arm is designed to swing out and lock in position due to additional pull, (approximately 200 lbs. above the free weight of tool and line). This action locates the valve or pulling tool above the pocket or latch on the gas lift valve.

Schematic 4—The mandrel is designed to guide the valve or pulling tool to accurately land the valve or engage the latch on the valve.

Schematic 5—A straight, upward pull shears a pin when key reaches top of the slot. This action allows the trigger to guide freely out of the slot and through the tubing. When the pivot arm reaches the small upper section of the mandrel, it is designed to snap back and lock into its vertical running position, reducing drag on the tool and valve as it is removed.

HOW TO ORDER · KICKOVER TOOLS

SPECIFY

1. Tubing size and weight
2. Valve Size (1½", 1")

Part Number Prefix: 96MO

END

DATE
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