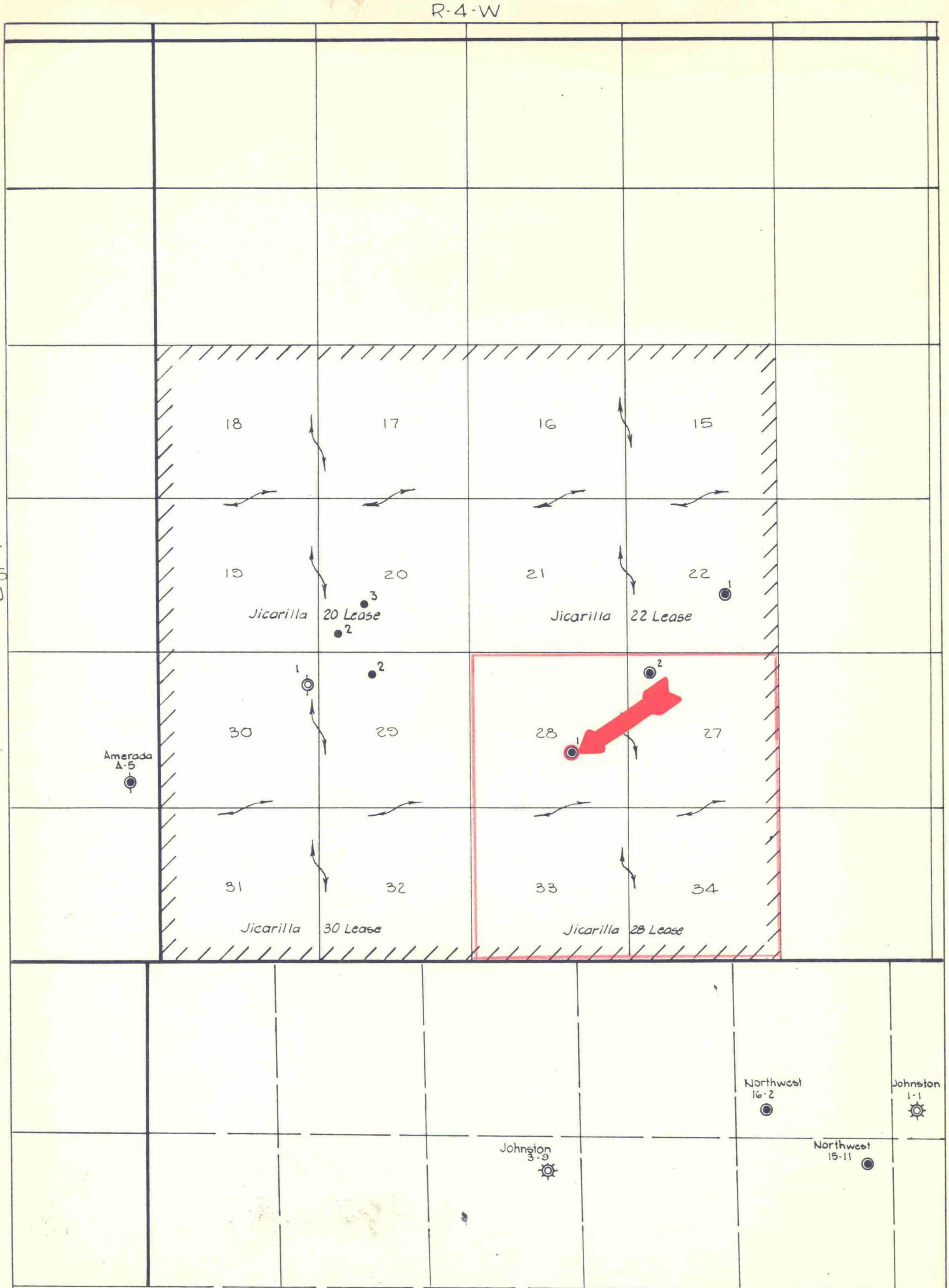

LEGEND

- GALLUP OIL WELL
- DAKOTA - GALLUP DUAL COMPLETION

CONOCO

CONTINENTAL OIL COMPANY
PRODUCTION DEPARTMENT

CONOCO

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APPROVED	SHEET OF	

WEST LINDRITH BLOCK
Rio Arriba Co., New Mexico

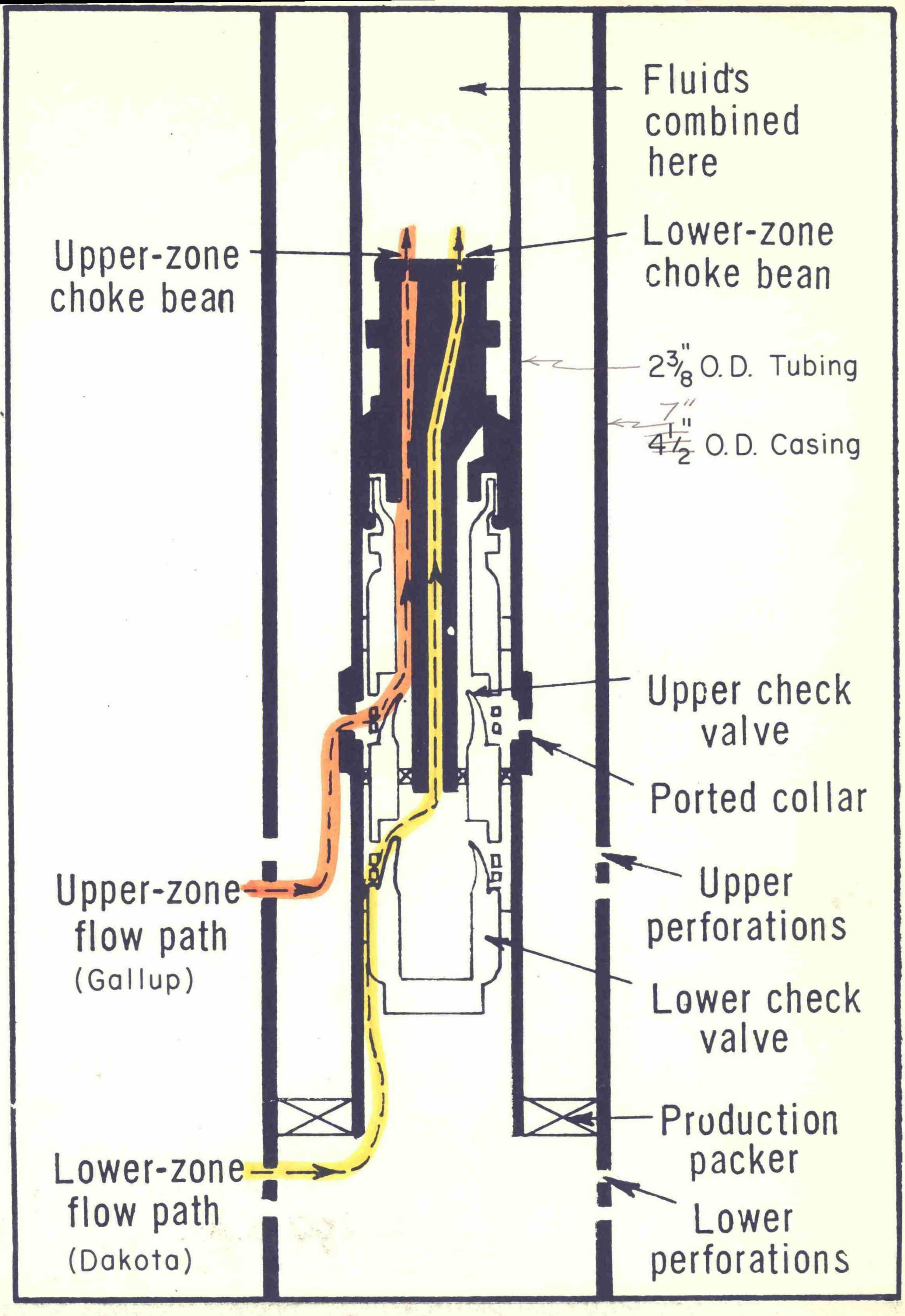
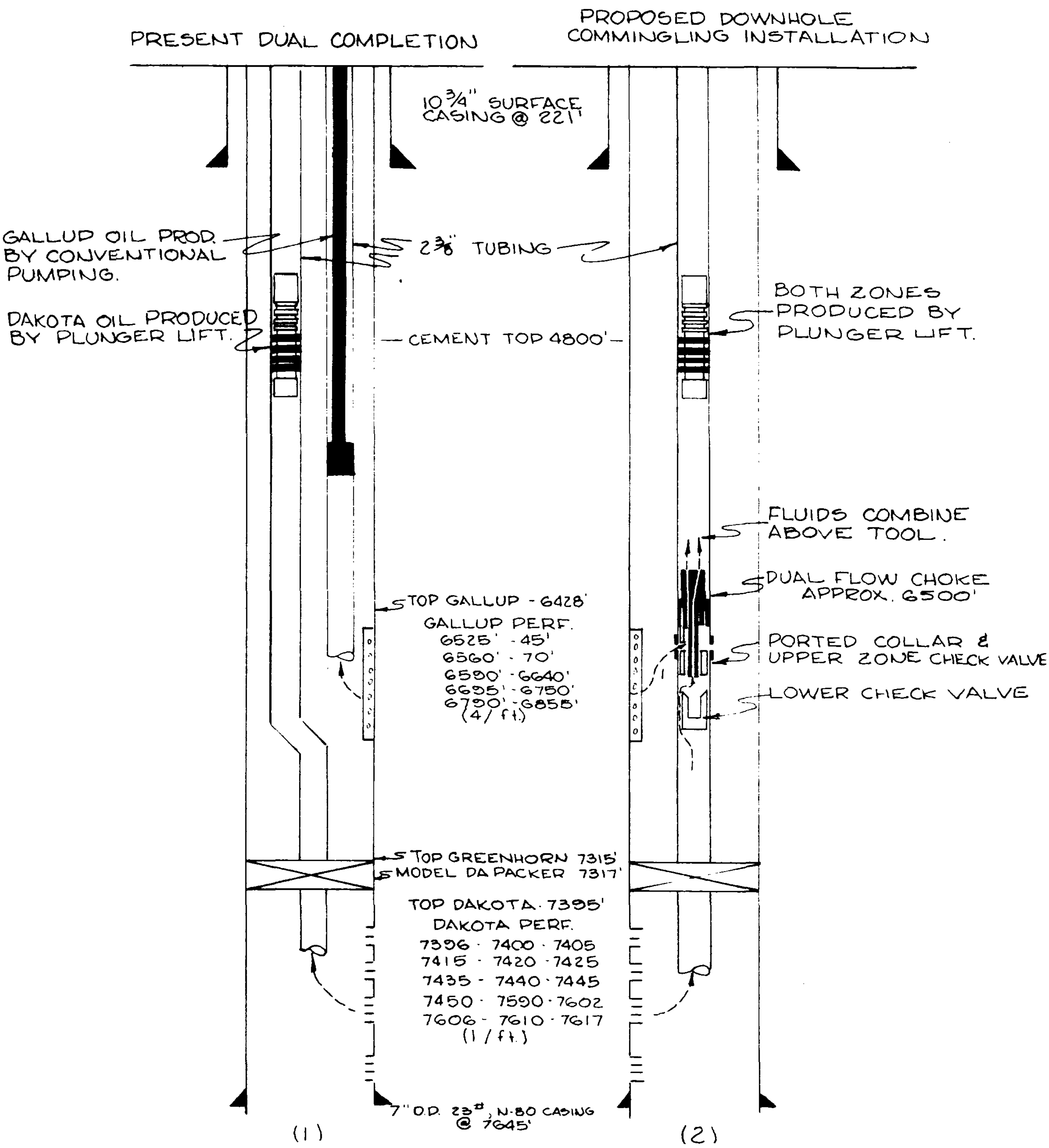


FIGURE NO. 7

Schematic diagram showing installation of Otis "Dual flow choke assembly" for dual zone downhole commingling.

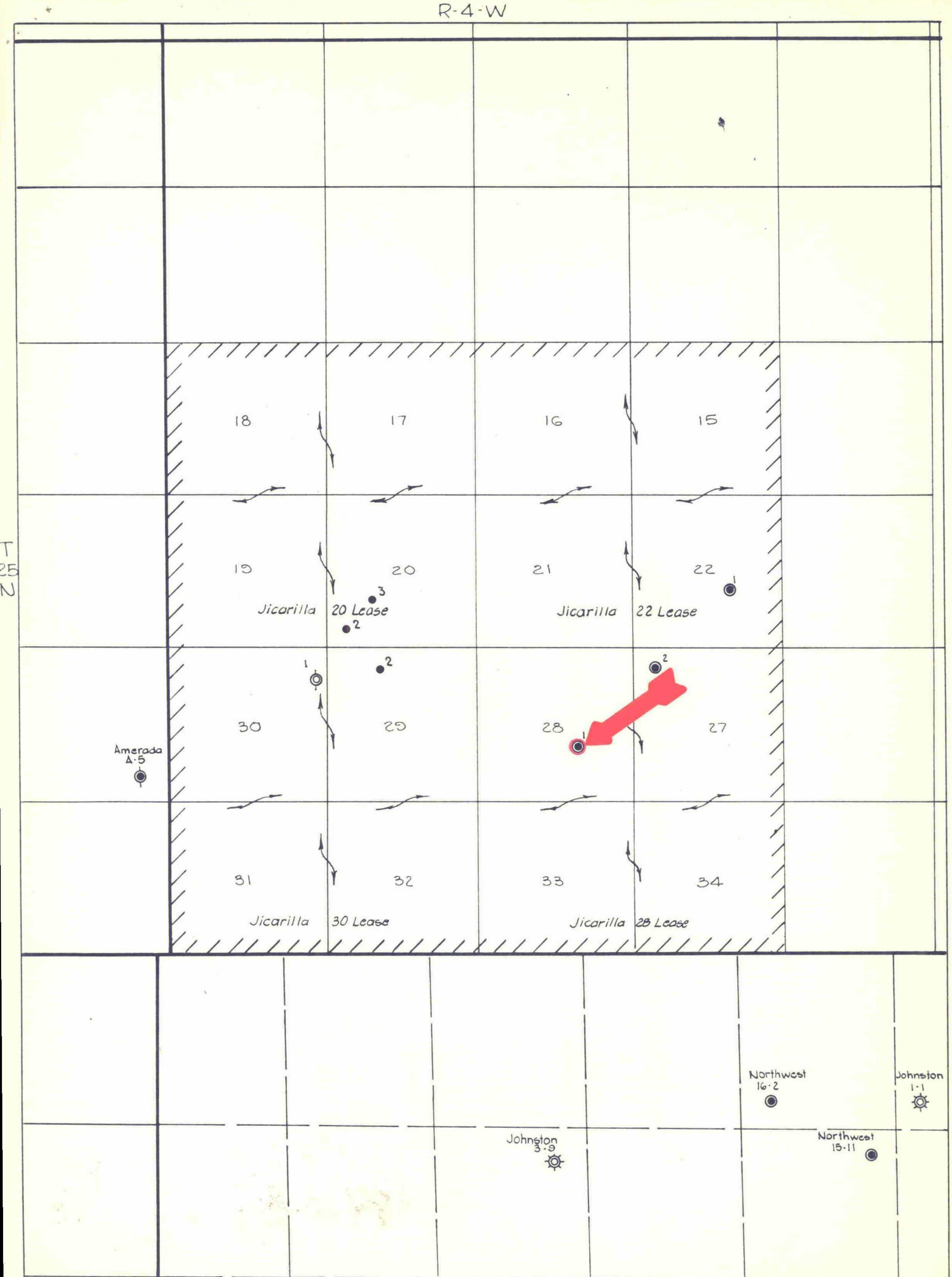
Case 3112



JICARILLA 28 WELL No. 1

SCHEMATIC DIAGRAM SHOWING PRESENT CONVENTIONAL DUAL GALLUP DAKOTA COMPLETION(1) AND PROPOSED INSTALLATION OF "DUAL FLOW CHOKE ASSEMBLY" DUAL ZONE DOWNHOLE COMMINGLING(2).

Case 3172



LEGEND

- GALLUP OIL WELL
- DAKOTA - GALLUP DUAL COMPLETION

CONOCO **CONTINENTAL OIL COMPANY** **CONOCO**

PRODUCTION DEPARTMENT

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WEST LINDRITH BLOCK
Rio Arriba Co., New Mexico

Case 3112

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OCTOBER 1961

This new type dual completion reduces costs, boosts recovery

Unique wireline retrievable tool permits commingling of production downhole, accurate determination of contribution from each zone

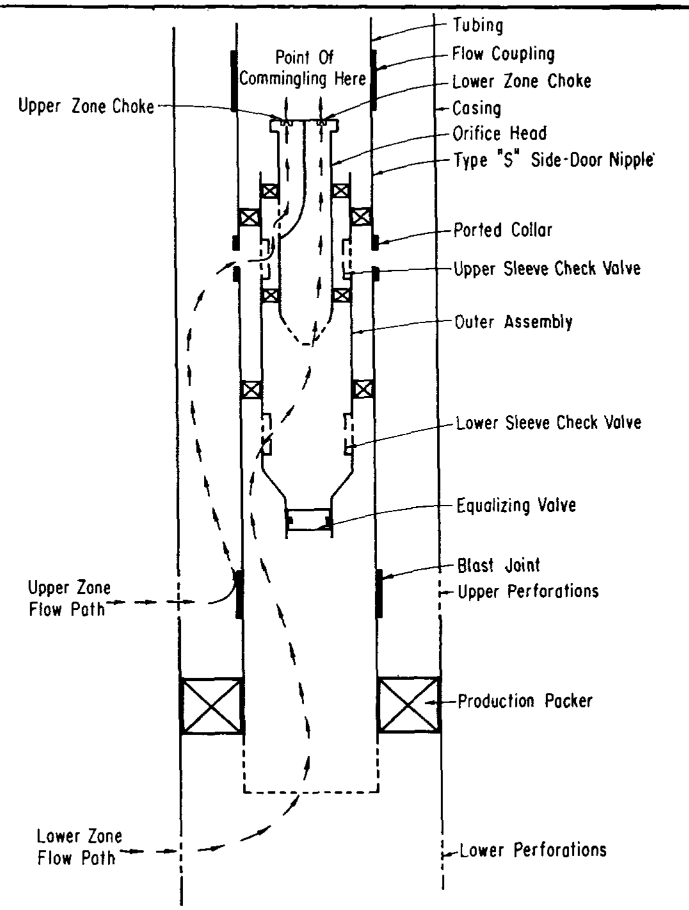


FIGURE 1—Schematic drawing shows how new multiple completion wireline tool works. Note that production is effectively separated until commingled above chokes.

By J. W. Hodges, Administrative Engineer, Sun Oil Company, Beaumont, Texas

Sun Oil Company has developed and is currently using a new wireline multiple completion tool to produce two separate reservoirs simultaneously through a single tubing string. The multiple completion tool has been successfully installed in a well in Allen Parish, Louisiana since March 1960. Annual gross income from the well has increased $48,400.00, with a net reduction in operating costs. Another tool was set recently in a well in St. Mary Parish. Five additional Sun installations in Louisiana are in progress.

Major advantages in using this tool to commingle production from separate reservoirs in one string of tubing are:

- Excess energy from one zone can be used to lift production from a weaker well.
- Current income can be increased and well costs reduced sharply.
- Completions can be made economically in doubtful looking zones apparently not worth the additional investment required for a twin string dual.
- When completed and commingled with a good well, weak zones can be produced to depletion without artificial lift.

All these factors contribute to an increase in ultimate recovery.

Operation of the downhole commingling tool is shown schematically in Figure 1. The lower zone flows up the tubing, enters the tool through a slotted section in the outer assembly, flows around a resilient check valve and enters the tube of the orifice head assembly where it is choked. Lower zone production then is commingled with upper zone fluid in the tubing above the tool.

The upper zone flows up the casing and into the tubing through a ported collar. It then enters the tool through another slotted section in the outer assembly, flows around the upper resilient check valve into the annulus around the tube, is choked and then commingled with the lower zone.

Pack-off elements maintain separation of the two zones up to the point of regulation. The system thus becomes analagous to surface commingling, as shown in Figure 2, except that the point of pressure reduction is located in the logical place—at the bottom of the well where energy in the released gas can be utilized. This energy is wasted when surface chokes are used.

The multiple completion choke assembly is shown in Figure 3. The outer assembly, shown on the left, is run with wireline tools and is located and locked in a type S side-door choke landing nipple. The resilient check valves, shown opposite the relative positions they occupy within the tool, prevent flow from one zone to the other. The orifice head, shown on

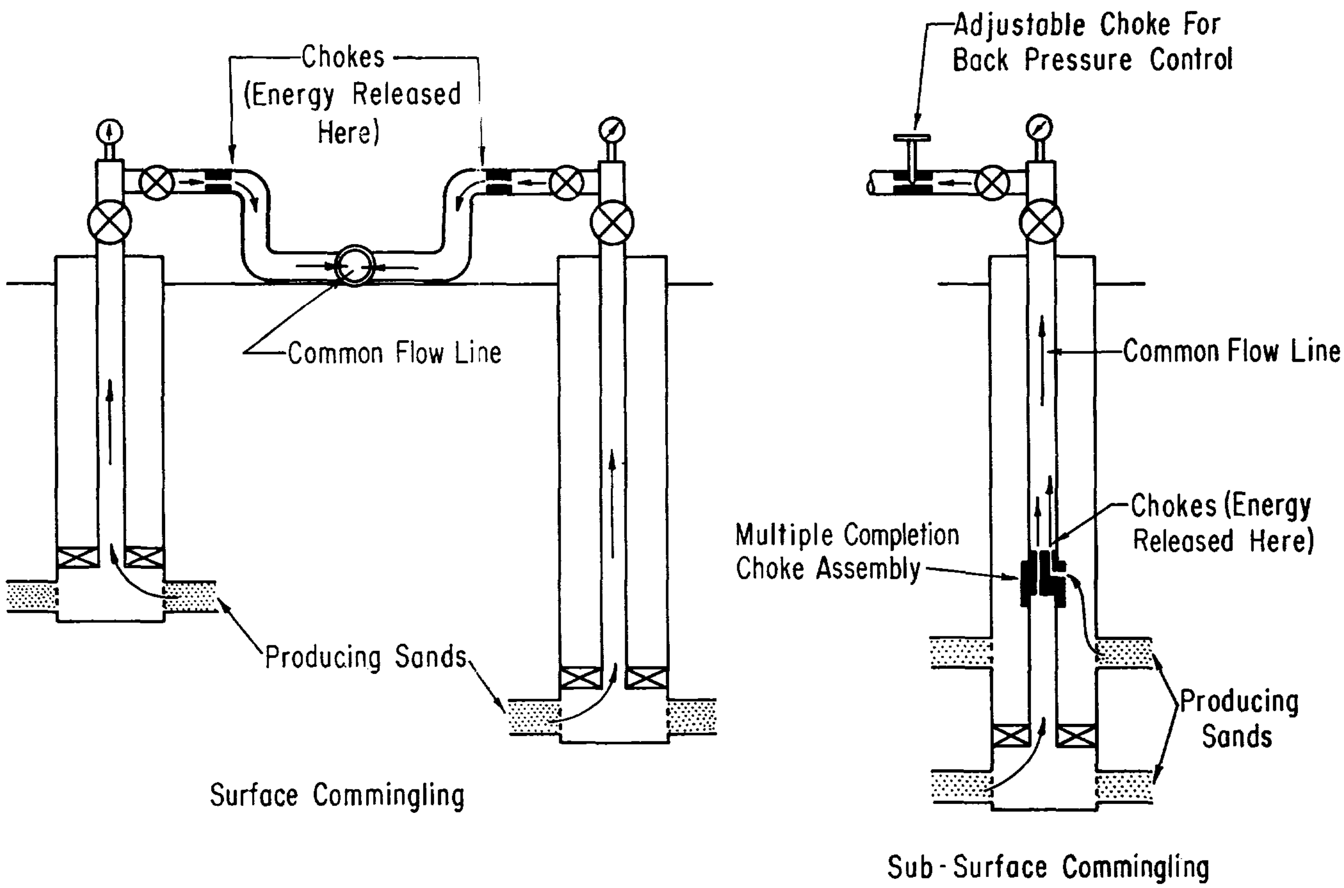


FIGURE 2—Downhole commingling is analoguous to surface commingling except that the pressure reduction is accomplished at the bottom of the hole where energy in released gas can be used.

the right with the two tungsten carbide choke beans, is run separately and is locked in the outer assembly.

Steps involved in installation of the assembly are illustrated in Figure 4. When a choke change is required, the orifice head is pulled leaving the outer assembly in place. The check valves in the outer assembly prevent flow from one zone to the other even with the orifice head removed from the well. Required wireline operations are relatively simple and have become routine.

The well in Allen Parish, prior to installation of the multiple completion choke assembly, was producing as a concentric dual completion with the upper zone flowing in the annulus between the 2⅜-inch tubing and 5½-inch casing and the lower zone flowing through the tubing. The upper zone, a high ratio oil well, is completed through perforations 8,067-70 feet. The lower zone, a gas well, is completed through perforations 8,448-52 feet. The conversion to commingled flow was made with wireline tools by pulling the side-door choke located at 8,000 feet and replacing it with the multiple completion choke assembly.

The subsequent increase in production resulted from decreased gas-liquid ratios and an increase in lower zone productivity. Operating costs were reduced through elimination of the surface heater (by the bottom hole choke effect) and because gas from the lower zone no longer requires compression to enter the sales line. Periodic production and packer leakage tests required by the Louisiana Department of Conservation have been performed on a routine basis. *There has been no evidence of communication between the two reservoirs.*

Hardness of the choke material and location of chokes below paraffin deposition depth have eliminated choke erosion and plugging. This has resulted in accurate determination of the contribution from each zone. Table 1 reflects the consistency of production rates through the $^5/_{64}$-inch choke serving the upper zone well. The same $^5/_{64}$-inch choke was used in each test and operated in the well from April 1, 1960 until replaced with a different size choke in January 1961. The choke was not cut when replaced.

The tests were used as a basis for allocating production to each zone, and were obtained by inserting a blank choke bean in the orifice head opening communicated to the lower zone. (This again is analagous to the conventional surface commingling system shown in Figure 2 and is the same thing as closing the wing valve on one of the wells while producing the other on test.) When a stabilized upper zone rate had been established, the orifice head was round tripped and a stabilized test made with both zones producing. The predetermined rate of gas and liquid production from the upper zone was subtracted from the total. The remainder was allocated to the lower zone.

The rate of production from the upper zone is not affected by commingling as flow through the choke is not in the critical range. Flow from the lower zone is in the critical range and can be regulated with a surface choke. Producing characteristics of the two zones determine method of control and test procedures.

Conditions imposed by use of the multiple completion choke assembly afford maximum opportunity for accurate flow rate control. In any system involving commingled production, the accuracy of determining the contribution from each zone depends on accurate flow rate control. The chokes in the multiple completion tool —more resistant to erosion and unaffected by paraffin deposition—will perform more efficiently than surface chokes. The multiple completion tool dual, therefore, will provide for more accurate allocation than can be obtained with conventional surface commingling.

Multiple completion choke beans are undergoing a severe abrasion test in one of Sun's wells in Chambers County, Texas. In an attempt to solve acute problems associated with high pressure well completions, the multiple completion tool has been modified to single zone flow and is being used as a bottom hole choke. Surface tubing pressure of this well has been reduced from 7,300 psi to 4,100 psi.

A high differential type leak, probably a tubing thread leak, which had existed before the installation was made, has been stopped. Production through the choke to date has been 492,000 Mcf of gas and 2,400 barrels of condensate, a total effluent in excess of 24 million pounds. There has been no discernible cutting of the choke.

If this experiment proves the feasibility of pressure reduction as a solution to the problems associated with producing abnormally high pressure wells, hazards to personnel will be reduced and the terrific costs incurred in working over such wells can be avoided.

The dual oil well in St. Mary Parish, an inland water location, is completed 14,236-39-feet and 14,025-33-feet. A drill stem test of the upper sand completion indicated productivity too low to justify the additional cost of a twin string dual. Production tubing was run with a single packer, a side-door choke landing nipple, and a side-door choke.

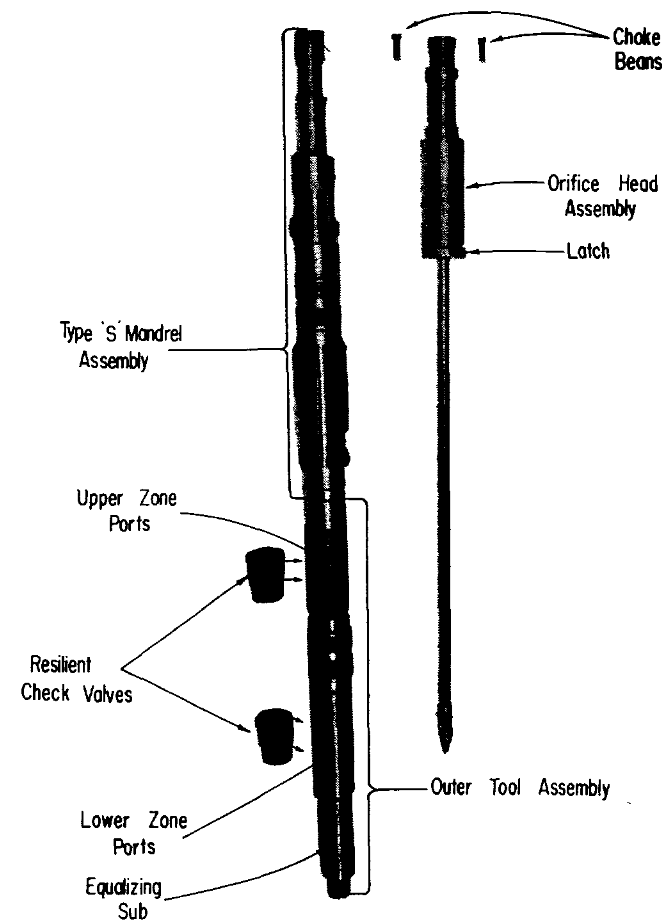


FIGURE 3—Elements of multiple completion tool are shown here. Orifice head assembly can be retrieved separately to blank off one choke for well test purposes or to change production chokes.

The side-door choke was removed after displacing drilling mud, and the multiple completion choke assembly was installed in its place. Testing now is in progress to establish potential of the two zones.

The flowing bottom hole pressure of the lower zone is reduced from 6,500 psi to 1,350 psi across the tool. Surface pressure is regulated at 150 psi and can be increased with an adjustable choke, if necessary, to control upper zone production. Tubing pressure immediately above the multiple completion tool can be elevated to approximately 3,250 psi without changing the lower zone rate.

The necessary wire line operations in this deep, high pressure, high temperature, directional well have been performed with relative ease; however, a word of caution is directed to anyone planning to use this tool for the first time: someone with previous experience should be on the job. Dressing and running the assembly would not be a routine operation to an inexperienced person and could jeopardize success of the installation.

The multiple completion tool can be used in a wide range of wells: dual oil; dual oil and gas; dual gas (the tool is ideally adapted to dual gas wells and is being used in that capacity in Mexico); permanent completions; and gas lift installations.

To determine whether the tool has application in any particular well, one must first determine the pressure that will exist at the point of commingling. This will be the controlled surface pressure plus the pressure required to lift the combined fluids to the surface, the latter being essentially a function of gas-liquid ratio,

TABLE 1—Test Results of Upper Well With Lower Well Blanked Off

TEST DATE	Choke Size	Oil-BPD	Gas-Mcfd	GOR
7-24-60	5/64"	7.23	248	34,200
10- 5-60	5/64"	7.80	227	29,100
10-18-60	5/64"	7.80	227	29,100
12- 4-60	5/64"	7.23	209	28,900
1-27-61	2-5/64"	6.38	175	27,500

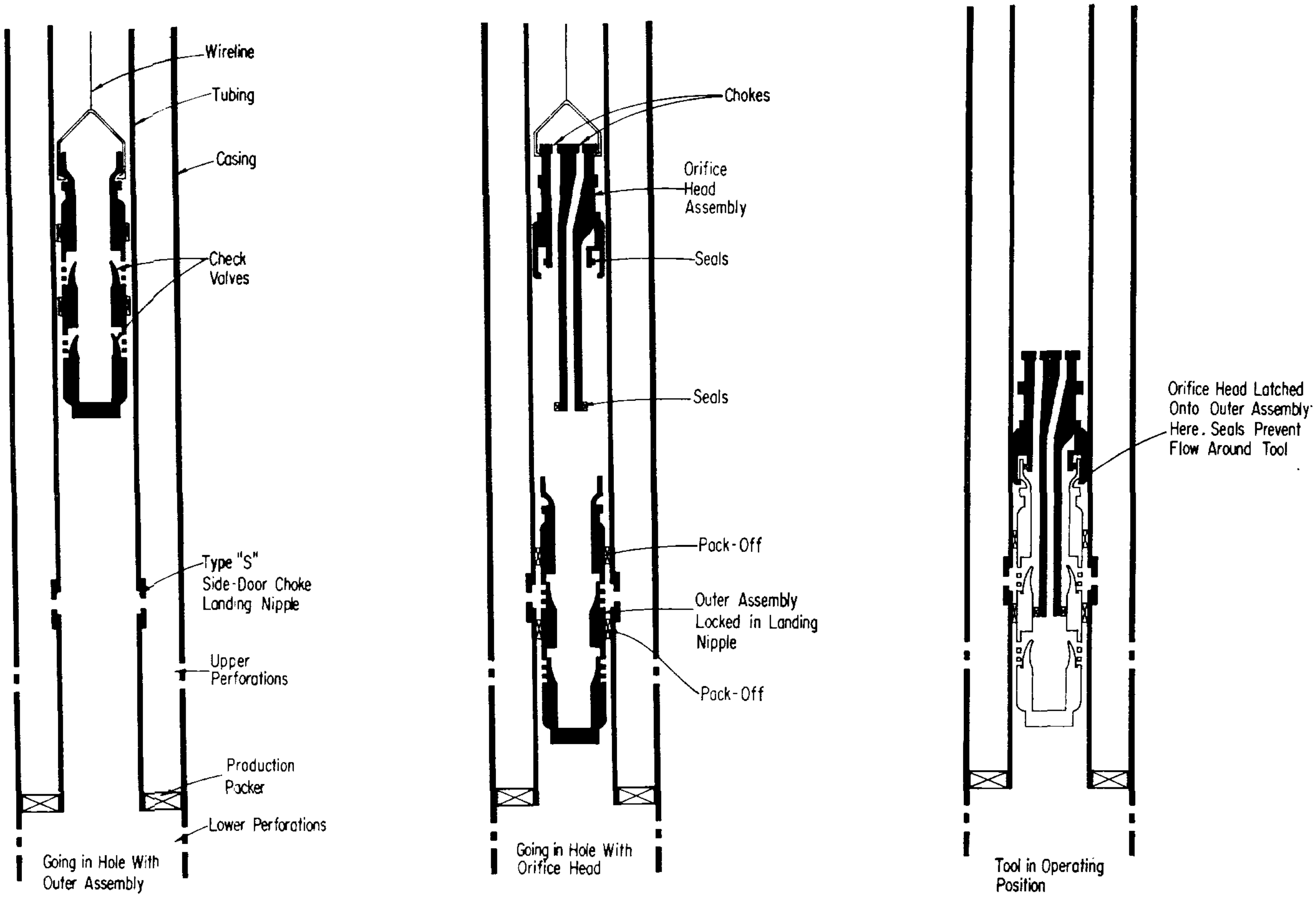


FIGURE 4—Inner and outer assemblies are run separately as shown. Note in center drawing that resilient check valves in outer assembly prevent interzone flow.

production rate and tubing size. Published flowing gradient curves covering almost any set of conditions now are available and can be used for this purpose. Pressure at the point of commingling and productivity index of the weaker well will determine its maximum rate of production.

Use of the multiple completion tool as a gas lift mechanism offers interesting possibilities. When gas direct from the formation is used to lift liquids through the tool, the gas is put to work at maximum depth and pressure thus obtaining maximum efficiency. Single point injection with a retrievable flow valve, considered by many to be the ultimate in gas lift, can be attained with the multiple completion tool.

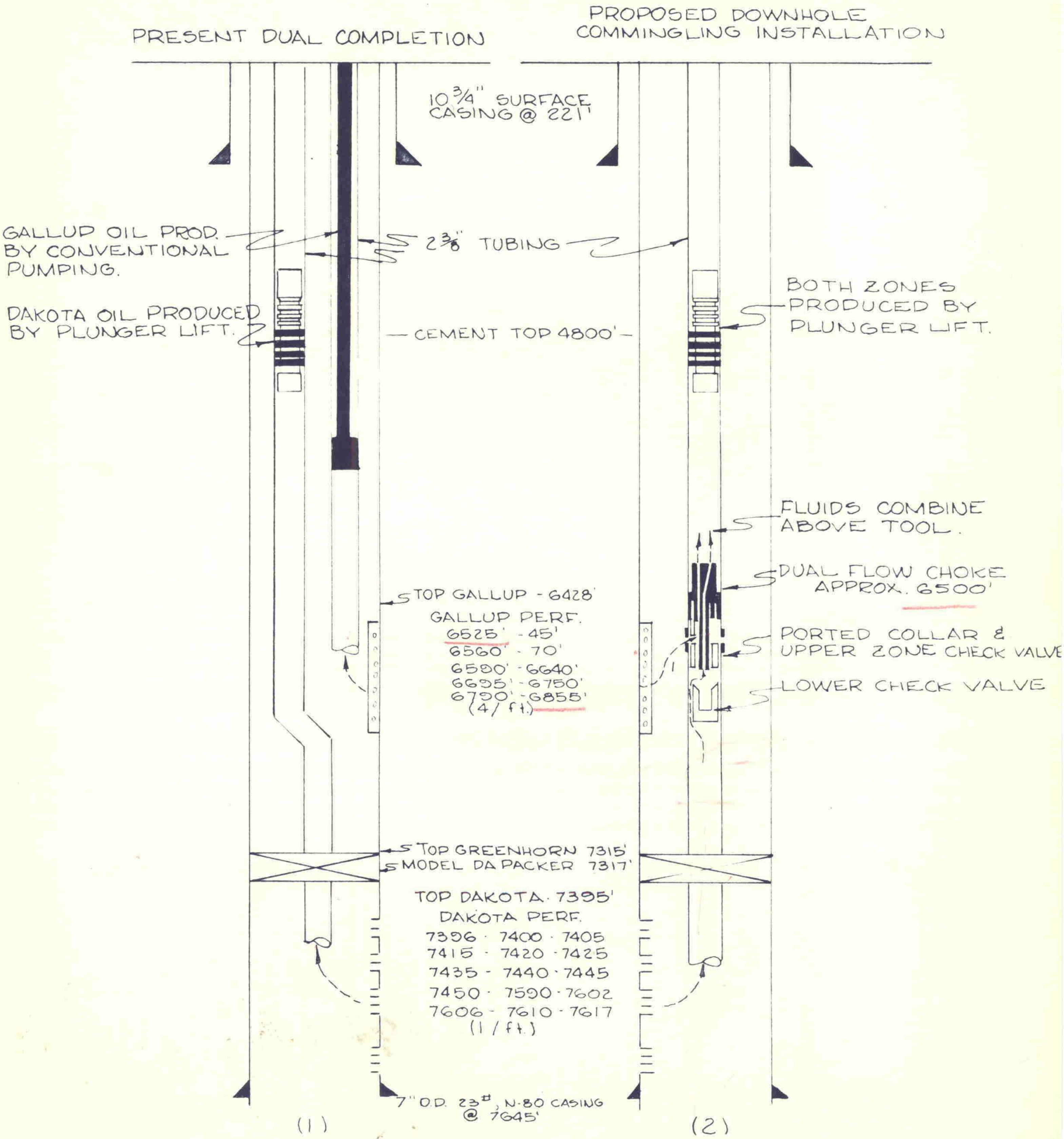
Field tests of the multiple completion tool have demonstrated it to be a means of increasing current income as well as ultimate recovery at reduced operating costs. This should appeal to all segments of the industry —oil companies, royalty owners and regulatory agencies.

Future development of the multiple completion tool depends to a large extent on acceptance by conservation commissions, as well as the oil industry. Acceptance in turn depends on a thorough understanding of the tool and an appreciation of its potential worth. Some traditional ideas and concepts must be re-examined. There is a great difference between controlled and uncontrolled subsurface commingling. Sun has clearly demonstrated in field tests that wireline tools can be used to separate the production from two reservoirs, to control the rate of production from each and to change the rate of production as required.

The interest and cooperation shown by the Louisiana Department of Conservation has been a material factor in the present stage of development of this new production technique.

About the Author

J. W. Hodges received a B.S. degree in petroleum engineering from The University of Texas in 1938. He joined Sun Oil Company upon graduation and has worked as seismographer, roustabout, roughneck, pumper, drilling engineer, production engineer, field superintendent, division petroleum engineer and administrative engineer, his present position. He holds several patents on oil field tools and has several pending, including one on the multiple completion tool discussed in this article.



JICARILLA 28 WELL No. 1

SCHEMATIC DIAGRAM SHOWING PRESENT CONVENTIONAL DUAL GALLUP DAKOTA COMPLETION(1) AND PROPOSED INSTALLATION OF "DUAL FLOW CHOKE ASSEMBLY" DUAL ZONE DOWNHOLE COMMINGLING(2).