STATE OF ILLINOIS
ADLAI E. STEVENSON, Governor
DEPARTMENT OF REGISTRATION AND EDUCATION
NOBLE J. PUFFER, Director

DIVISION OF THE
STATE GEOLOGICAL SURVEY
M. M. LEIGHTON, Chief
URBANA

CIRCULAR NO. 153

FLOODING WITH RE-USED WATER

By
FREDERICK SQUIRES

Reprinted from World Oil, pp. 152-54, April, 1949

PRINTED BY AUTHORITY OF THE STATE OF ILLINOIS

URBANA, ILLINOIS
1949

Flooding with Re-Used Water

PROGRESSIVE USE of flood water from higher and depleted sands to lower and still productive zones is suggested as a means for obtaining the necessary volume, and at the same time avoiding the treating and purification operations which frequently are required when brine or other subterranean water reaches the surface and is exposed to air. This article is published by permission of the Chief, Illinois State Geological Survey.

By FREDERICK SQUIRES,
Petroleum Engineer, Illinois State Geological Survey,
Urbana, Illinois

THIS article describes a method of injecting the water from an upper flooded-out oil sand to flood a lower oil sand and so increase the percentage of oil recoverable.

This suggestion is based on a process described in Illinois State Geological Survey's Circular 101, "Oil-Field Flooding Streamlined for War," in which the writer advocated flooding an oil sand with water from a higher water-bearing sand. This was done successfully on the Basin McClosky where the McClosky "lime" was flooded with water from the Cypress sandstone.

The simplicity and the immediate success of the McClosky operation depended on the fact that the McClosky was so highly permeable that the Cypress water traversed it under static head. The same result may be expected under similar conditions, whether the upper sand contains natural water or water that was introduced to flood out oil.

However, if the lower sand is not permeable enough, the difference in head between it and the water from the upper sand will not develop enough pressure to flood the lower sand. Under this condition new pressure will have to be added, and it is here proposed that the additional pressure can be supplied by compressed air or gas.

There are many oil fields in Illinois that have several producing sands, all or many of which may be benefited by flooding. These fields include the old Lawrence County fields, New Harmony, Louden, Salem, and many others. So far the method used has been to flood the upper sands first, as at Siggins and Patoka. The Benton field may have floodable oil sands below the Tar Springs which is now about to be flooded. The Bridgeport sand in Lawrence County is being flooded ahead of the lower Kirkwood and Tracey sands. In every case the flooded-out sand is apt to carry enough water to flood a lower sand.

The measured plan and section (Figure 1) shows a combination of three wells that were drilled to two sands, and the perspective drawing (Figure 2, Page 4) illustrates the method of using an old "five spot" in an upper flooded-out sand to flood a new "five spot" in a lower oil-producing sand.

Wells 1 and 3 (Figure 1) were water input wells, and well 2 was an output well in the upper sand. This sand has been completely flooded-out and is full of water. It is now desired to use the water to flood the lower sand. The first step is to deepen all wells to the lower sand and to case and run tubing or four-inch pipe on packers as shown in Wells 1 and 3, and to run a liner in Well 2. If the sand is highly permeable and the flooded out sand is considerably above the lower, part of the water in the upper sand may flow by gravity into the lower. If these conditions are not present in the proper degrees, then a source of increased pressure must be found. Air pressure through the annulus between the casing and tubing in Wells 1 and 3 provides the necessary extra pressure on the water-filled sand to force the water to enter Well 2 and to enter and traverse the lower sand at 2.

Well 2 is cased to the surface, which provides a long separating cylinder so that any oil or gas which may enter Well 2 will separate by gravity in the fluid column and may be drawn off at the surface. Well 2 and all repeat wells of this kind may be provided with flow meters so as to measure and control the amount of water admitted through them to the sand ZZ.

Because air is forced into the sand but is not withdrawn at any point, the total volume of air required will be small in comparison with the amount of air used in a repressuring operation in which air is withdrawn. Air pumped into Wells 1 and 3 cannot bypass the water while the sand is full or nearly full of water because the water would have no place to go. At first the air will displace water around Wells 1 and 3. Eventually of course, air will reach Well 2 but by that time most of the water will have been forced out of the upper sand into the lower. If more water is needed to complete the flooding of the lower sand it can be taken from water produced with the oil from Wells 1 and 3 and reinjected through tubing on a packer set above the lower sand in Well 2.

The cost of water is apt to be a large part of the total flooding expense. It is here suggested that the water injected into an upper sand may be used again in lower sands either under static pressure alone or combined with artificially applied air pressure.

About the Author

FREDERICK SQUIRES, petroleum engineer for the Illinois State Geological Survey, is credited with the first successful applications of repressuring and intentional water flooding in the Illinois oil fields. He holds degrees from Williams College and the School of Mines of Columbia University. He formerly was partner and field manager of Squires Brothers, Remlik Oil Company and Dinsmor Oil Company, which were organized at the inception of secondary recovery. He has invented several oil field processes and has contributed a number of technical papers on petroleum engineering.

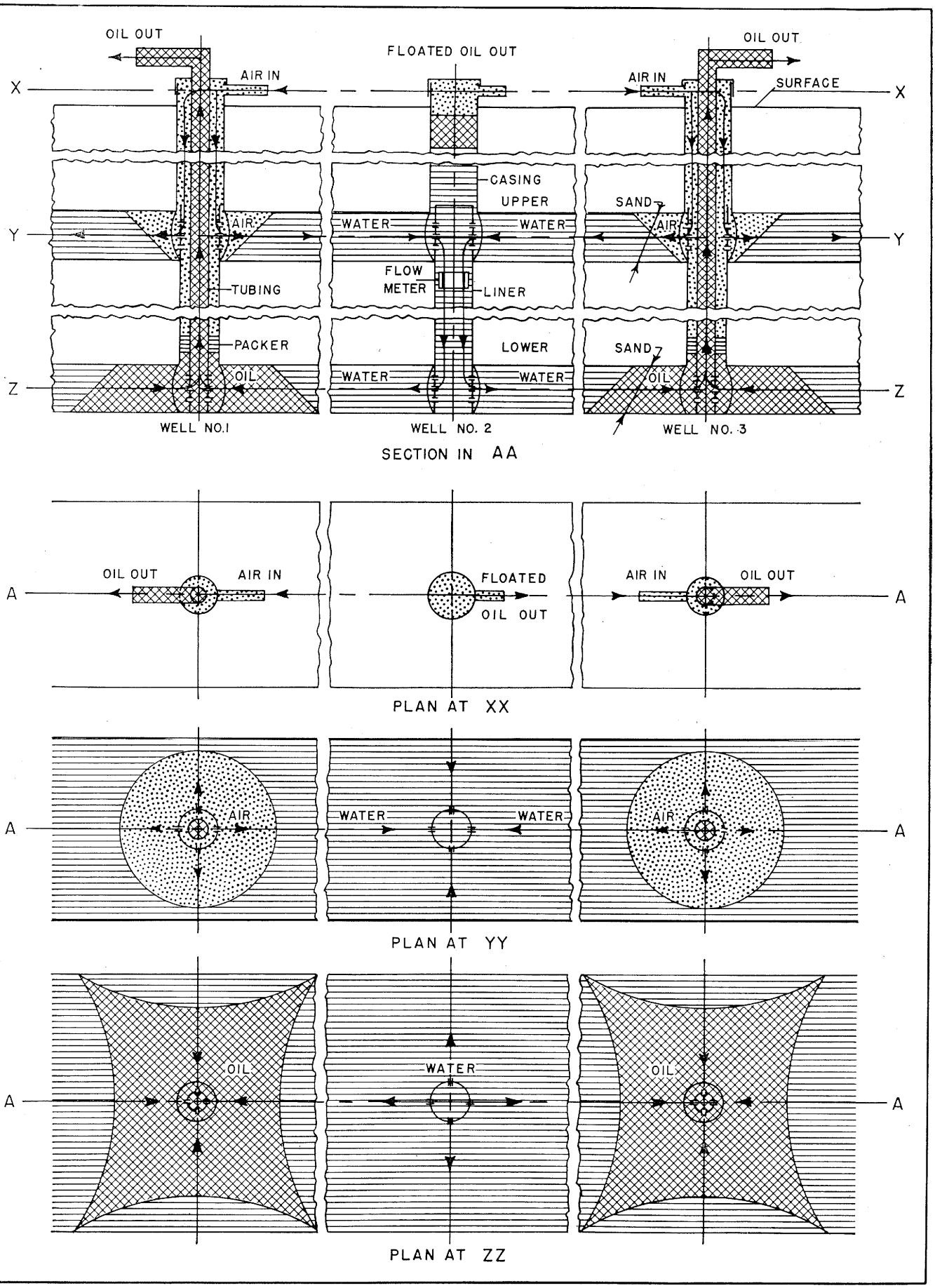
OIL OUT
FLOATED OIL OUT
OIL OUT
AIR IN
AIR IN
SURFACE
X
X
CASING
UPPER
SAND
Y
AIR
WATER
WATER
AIR
Y
FLOW
METER
LINER
TUBING
PACKER
LOWER
SAND
Z
OIL
WATER
WATER
OIL
Z
WELL NO.1
WELL NO. 2
WELL NO. 3
SECTION IN AA
OIL OUT
AIR IN
FLOATED
OIL OUT
AIR IN
OIL OUT
A
A
PLAN AT XX
AIR
WATER
WATER
AIR
A
A
PLAN AT YY
OIL
WATER
OIL
A
A
PLAN AT ZZ

FIGURE 1

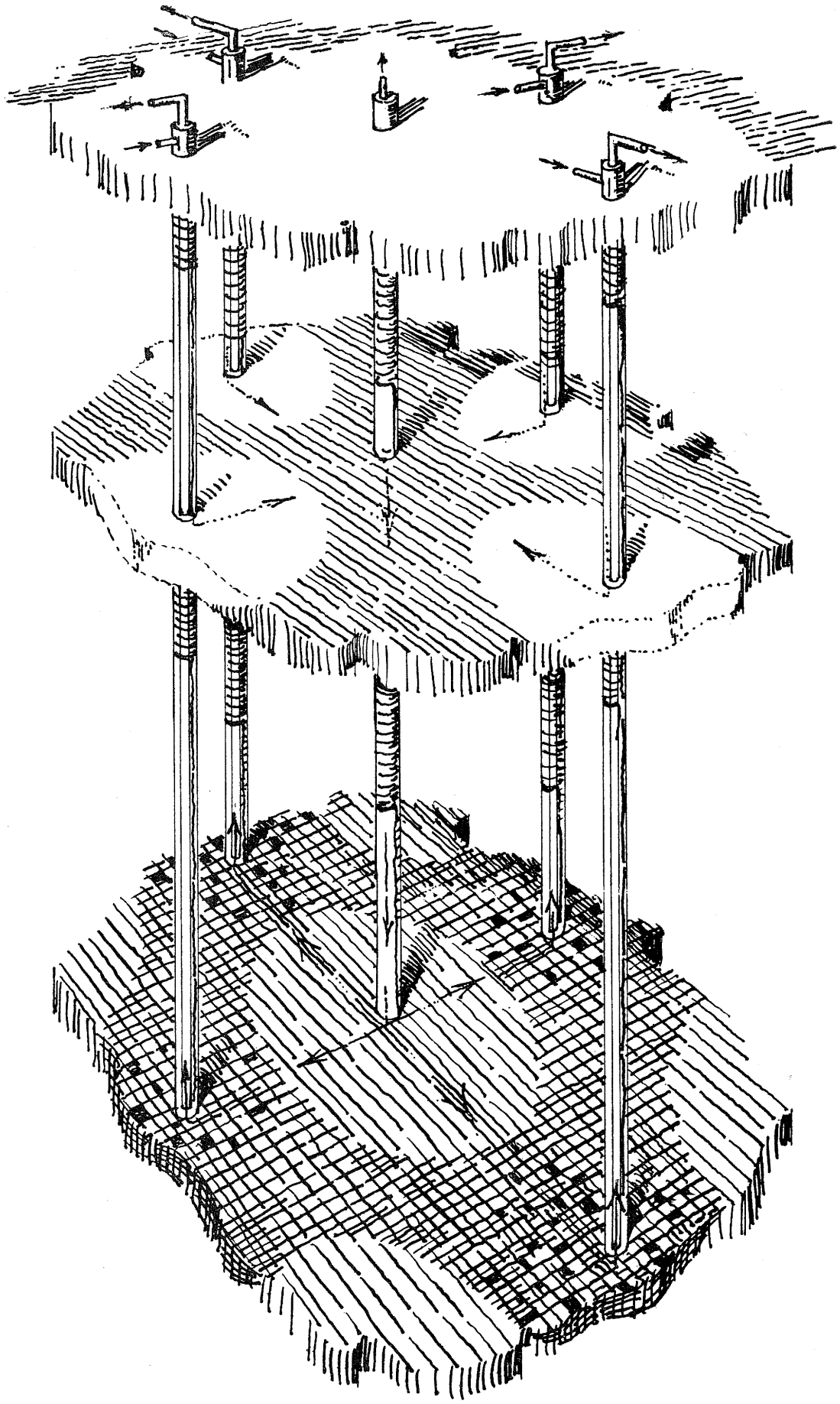

FIGURE 2