A SOURCE REFERENCE FOR THE STUDY OF THE PETROLEUM INDUSTRY AND ITS TERMINOLOGY ESPECIALLY FOR THE BOROR COUNTY SCHOOL SYSTEM

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A SOURCE REFERENCE FOR THE STUDY OF THE PETROLEUM
INDUSTRY AND ITS TERMINOLOGY ESPECIALLY FOR
THE ECTOR COUNTY SCHOOL SYSTEM

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Presented to the Graduate Council of the North
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For the Degree of

MASTER OF SCIENCE

By

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CHAPTER I

INTRODUCTION

Statement of the Problem

The problem, to make a study of the petroleum industry in Ector County, Texas, and, in addition, a study of the terminology of this industry, was selected as a result of the realization that the major industry of the community was not understood by the teachers, and that it did not have a place in the curriculum. The study deals with a general discussion of the petroleum industry and Ector County in particular, the geographical location of the county and of the oil-producing areas within the county, the geological formations, the importance of the various fields, drilling of a well in the TXL Field, production of petroleum, the piping of oil from the county, utilization of oil within the county, and an estimate as to how long the petroleum industry will hold a place of importance in the county.

Origin of the Study

Realizing the need among teachers in the Ector County school system for information on the petroleum
industry, a detailed research on the subject has been made. This work has been prepared with a view of its need because it is estimated that approximately ninety per cent of the patrons in the county are engaged in the petroleum industry. Moreover, teachers should become familiar with this industry in order to utilize the community as a source of learning and to connect classroom instruction with community life.

The successful teacher is one who studies most diligently the pupils with whom he is to deal and those aspects of the environment, in school and out, with which these pupils come in contact. Such an appraisal of human materials and environmental factors constitutes the first sound step in intelligent teaching.¹

It has been the writer's privilege to hear various discussions among teachers of their unfamiliarity with the terminology of the petroleum industry as well as of industry in general. When registering in such a growing school, which occurs daily, children will answer questions about their fathers' occupations with such words as "roughneck," "tool pusher," or "head roustabout." This seems to prove that teachers' ability to understand students is handicapped by a lack of knowledge of the main industry and its terminology. After such observations the writer has felt the need of a study of this

¹Herbert B. Bruner and others, What Our Schools Are Teaching, p. 3.
subject to assist teachers in connecting the curriculum with community life.

Sources of Data

Some of the data used in this study were obtained from the reading of (1) books, (2) magazines, (3) bulletins, (4) maps, and (5) letters of correspondence.

A large portion of the facts contained in this paper was gained by talking with men engaged in the industry.

Much information was obtained through field trips.

Procedure

Talking with teachers and living in one of the oil fields in Ector County gave rise to a desire to attempt a rather extensive study of the petroleum industry.

An intensive study was made of both published and unpublished materials in the Ector County Library. Many magazines for employees and stockholders of the different oil companies were used. These magazines were furnished by the children in the Goldsmith School of the Ector County school system. Each child in the third grade contributed much information from home environment during a classroom study. At the same time observations were made as to the utilization of the
petroleum industry in the curriculum.

Many field trips were made in order to obtain concrete experiences with the industry and to learn the language used by the oil-field workers.

Much information was obtained from personal contact with employees of the oil companies. Two major oil companies permitted the collection of data from confidential reports in their respective offices in the North Cowden and Goldsmith Fields.

Correspondence with men engaged in the industry proved a great help. The Railroad Commission of Texas, Oil and Gas Division, of Austin, Texas, and the North Basin Pools Engineering Committee of Midland, Texas, furnished much needed material for the study.

Limitations of Problem

The problem is limited to one industry in the county; however, other phases of the community activities would have been an asset in connecting the curriculum with community life. Since this complicated industry holds such an important place in the county, detailed study was made of it. Therefore, this study was confined to a general discussion of the petroleum industry and Ector County in particular, as it would have been
impossible to include all the activities within the community in a study of this length.
CHAPTER II

DEVELOPMENT OF THE PETROLEUM INDUSTRY

From Edwin L. Drake's discovery well drilled near Oil City, Pennsylvania, in 1859, to the discovery of the TXL Field in Ector County, Texas, in 1945, the petroleum industry grew from a handful of men to an army of 1,500,000 people who depend upon oil for a livelihood.¹ From the crude slab-sided wooden derrick, the donkey steam engine, and the spring-pole drilling device used on that first hole has evolved the skyscraper steel derricks, the electric Diesel engines, and the rotary drilling tools in use in the deep TXL Field today. Guess work, reliance on spirits and the supernatural, and kindred methods of locating pools have given way almost one hundred per cent to the geologists, the seismograph crews, and geophysics crews.

The oil industry was slow in starting in Texas. "The first real oil well completed in Texas was near Oil Spring in Nacogdoches County in 1866 by Lynis T. Barrett."²

¹John J. Floherty, Flowing Gold, p. 5.
²C. A. Warner, Texas Oil and Gas Since 1543, p. 5.
After the encountering of oil at Corsicana in June 1894, in a test well being drilled for water, the completion of a small oil well there on October 15, 1895, marked the real beginning of the oil and gas industry in Texas.\textsuperscript{3}

The Corsicana field was important not only as the first commercial field in Texas, but also as the field in which the practicability of the rotary rig was shown.\textsuperscript{4}

The industry was even slower in moving to West Texas.

The West Texas district was frequently referred to, prior to 1921, as the "Petroleum Graveyard of Texas." This appellation aptly describes in four words the results of the scattered tests that had been drilled in the area of 69,874 square miles included in the 46 counties of West Texas. Oil and gas fields discovered and developed in this region since 1921, however, have vindicated the opinions of the hardy wildcatters of earlier years that profitable production would be secured there.\textsuperscript{5}

The Permian Basin of West Texas was named for a geological term applied to one of the two discovery sands in West Texas.

Ector County became an oil-producing county in the Permian Basin with the discovery of oil December 28, 1926, in a well drilled by the Cosden Company on the Connell Ranch, about sixteen miles southwest of Odessa. The well produced only about twenty barrels daily; and further exploration was delayed until October, 1929.

\textsuperscript{3}\textit{Ibid.}, p. 83. \hspace{1cm} \textsuperscript{4}\textit{Ibid.}, p. 84.

\textsuperscript{5}\textit{Ibid.}, p. 310.
When Penn Field was discovered, followed in 1930 by the discovery of the North Cowden Field in North Ector County. Following in order came other discoveries in Ector County of the Harper, South Cowden, the Johnson, Goldsmith, and other fields.
CHAPTER III

OIL-FIELD GEOLOGY

Oil is a greasy liquid found at or beneath the earth's surface. It is found in porous rock formations rather than in underground lakes or streams. Sandstones and some limestones have enough porosity to trap oil particles. The early pioneers in the oil industry used little or no scientific methods in early search for oil. Theories were advanced to the fact that new fields were discovered in certain localities.\(^1\) It was after the turn of the century that science proved itself in theory and practice.\(^2\)

\(^1\)Max W. Bell, *This Fascinating Oil Business*, p. 63:
"In 1861 T. Sterry Hunt, developing suggestions previously made by William Logan and H. D. Roger, advanced the theory that oil accumulates on anticlines. . . . In 1883 Dr. I. C. White, State Geologist of West Virginia, revived or rediscovered the anticlinal theory, and succeeded in convincing most geologists and a few oil men of its correctness. That started the real science of oil geology, and Dr. White has well been called the father of it."

\(^2\)Wilbur F. Cloud, *Petroleum Production*, Introduction, p. x: "... Logan and Rogers predicted the anticlinal theory of oil and gas accumulation which was fully formulated by Hunt in 1861. However, this theory did not attract much attention among oil operators until it was
Today, that branch of science known as "structural geology and stratigraphy" holds the only key to nature's undiscovered petroleum reserves. The geologist knows that oil is trapped in certain formations; he believes that oil originated from certain animal and vegetable remains slowly distilled under great pressure in what is known as "source rocks"; he is sure that the oil is moved from the source rock into a "reservoir rock" that has become sufficiently porous to receive it; and that the oil was trapped there by surrounding impervious formations that would not allow it to escape. The geologist looks for three things in his search for the formation that will yield oil in commercial quantities: first, the source rock that in its early life contained organic material capable of being converted into oil; second, the reservoir rock to hold the oil in quantity, since the oil in the source rock would be dispersed too widely for a profitable yield; and third, a reservoir

forcefully revived by I. G. White in 1883. In fact, this first American use of geophysical instruments was in Texas in 1917. The Eotvos torsion balance sided in the discovery of a salt dome in Texas in 1924. Also, about this same time micropaleontology, micromineralogy, and airplane photography appeared to assist in correlation of formations and structural study. Allied geologic sciences and the application of modern scientific instruments played a part in the estimation of the world's twenty-four billion barrels of oil reserve made in 1933."
with a trap or structure where the oil is accumulated and held.

The earth has been in a constant state of change for millions of years. Mountains rise from pressures below and are eroded away to lower levels by wind and rain. The streams carry soil, animal remains, and vegetation to seas and oceans. There, due to slowing down of the current, these articles are deposited on the watery floor. Also, dead fish and sea vegetation settle to the bottom. Ages pass, and the ocean floor begins to rise from some inner pressure of the earth. This upheaval and erosion have gone on for millions of years. The extreme pressure causes changes in the mud and silt formations. It changes the mud and silt to shale as the water is squeezed out; the sands become sandstone; and the limy ooze becomes limestone. These rocks are called "sedimentary" rocks because of their origin, but there are other rocks with which the geologist must deal. These are "igneous" rocks and are formed from the molten state. When this melted rock has been forced up from deep in the earth and has almost reached the surface while still molten, it is called lava. It forms volcanic cones, sheets, and "form sills" between beds of other rocks. If it solidifies far below
the surface, it is called "plutonic" rock. When sedimentary rocks and igneous rocks are subjected to enough heat and pressure, they change to what are called "metamorphic" rocks.

These three types of rocks are important to the geologist in his search for favorable oil-bearing formations. As pressure and heat gradually change the appearance and character of sedimentary rocks to metamorphic rocks, they also change the character and appearance of the mineral matter into oil and gas. As the pressure and heat become greater, the oil goes through a transformation from a tarry, heavy, viscous substance to a lighter oil as the pressure and heat continue to increase.

In the source bed the oil is disseminated in small particles over such a wide area as to be of no value. However, since the shales and compacted limestones have practically no porosity, the oil is squeezed out into the more porous sandstones. From five to thirty percent of the volume of sandstone is made up of pore-space. Sandy limestone, a limestone part of which has been dissolved by water, and a dolomite formed from

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3 Lester Charles Uren, *A Textbook of Petroleum Production Engineering*, p. 16: "The average sandstone has a porosity of about 16 per cent."
limestone all have pore space. These are the reservoir rocks in which the oil and gas accumulate.

When the oil is squeezed out into the reservoir bed, it is usually free to travel; and through the ages the oil does move. It is normally carried along by water until there is no place to go. This can be caused by the formation being pinched out by an upper or lower formation of non-porous rock, or by the reservoir formation curving up and down, trapping the oil at the top of the curve, or by reason of the formation being broken off by an upheaval so that a non-porous segment blocks off the end of the reservoir bed. When the oil can no longer move, it is trapped. The study of these traps is the study of stratigraphy. Structure in the field of geology and examples of these traps are shown in Figure 1.

The attitude of the rocks of an area -- the folding or fracturing or displacement or lack thereof that they exhibit -- is called the area's "geologic structure." The individual folds or fractures or displacements are also called geologic structure. Oil traps that are due to geologic structure, such as those on anticlines or against faults, are therefore known as "structural traps."\(^4\)

\(^4\)Ball, \textit{op. cit.}, p. 54.
Fig. 1. -- Geological structure and stratigraphy.
... oil, however, may be caught by a trap that is not due to structure but is due instead to a discontinuity of the stratum in which the drop [oil] is traveling.\(^5\)

When a barrier prevents further onward movement of oil, the substances of oil, gas, and water, which have been traveling along the same paths, are segregated according to their specific gravities. Gas, being light, collects in the upper portion of the trap; oil forms below the gas; and if water is present, it collects beneath the oil.

Water, when present, usually enters the formation at some place where the formation comes to the earth's surface. This is a surface outcrop. Water weighs forty-three pounds per square inch for each hundred feet of depth. The depth of the water in hundreds of feet multiplied by the weight of water per hundred feet gives the force or pressure in pounds per square inch necessary to hold the oil and gas in that trap. This is known as the "hydrostatic head" or "bottom hole" pressure.

There may be several traps in one horizon or formation. If the earth in its slow upheavals raised some part of the formation faster than others, then what had

\(^5\)Ibid., p. 55.
been a flat ocean bottom at one time would now show a sedimentary oil-bearing formation in a series of waves. The crest or peak of one of these waves is called an "anticline." The valley or sag between two anticlines is a syncline. The hydrostatic pressure causes the higher gravity oil and gas to accumulate at the peak of the anticline. There are several types of anticlinal structure varying with the shape of the wave. Another type of trap is the "dome." Domes are usually formed as a result of two or more intersecting anticlines. Sometimes they result from pressures of intrusive igneous rocks or from crystallization of large bodies of salt.

The "monocline" results when the crest is eroded away from an anticlinal fold and a partial cross section of the strata making up the fold is exposed at the earth's surface. This is the type of structure responsible for the drilling of the first wells in America. The exposed strata allow the oil to escape on the surface of the earth.

The uplifts, caused by earth forces, sometimes cause a fracturing of several formations. When a fracture occurs in an upheaval, one side of the break usually rises above the other. This line of break is called a
"fault." Impervious formations of shale or clay are sometimes moved to form a barrier to the migration of oil through a porous stratum, thus forming a trap for the accumulation of oil and gas. An "unconformity" is the result of a period of erosion between two periods' deposition. During one period sedimentary material is laid down; then follows a period of upheaval, tilting, and erosion. Finally a period when impervious layers of shale and clay are laid down over the older series makes a problem difficult for the geologist to decipher. "Lenticular" deposits result from a variation in the porosity, grain structure, cross bedding, and other irregularities in the original deposition of the reservoir rock. Oil is found in the more porous patches in the formation.

Each layer of strata or formation has been given a name by the geologists. They have identified the formations according to the time in which they were laid down. The age of the earth has been divided into eras. Three of these eras are Paleozoic, Mesozoic, and Cenozoic. Geologists also divided these eras into systems. There are seventeen major systems represented in the formations outcropping over the state of Texas. Each
system is further divided into groups, and the oil men have given local names to producing formations in these groups. Figure 2 shows the eras, systems, groups, and some of the oil-producing formations.

Early geologists believed the Permian Basin to be a uniformly developed syncline. Its surface appearance, however, does not give a true picture of the subsurface conditions. Widespread drilling operations have shown that the underlying strata are interrupted in many places by anticlinal uplifts, buried mountains, and faults. The Pecos Uplift of Winkler, Ector, Ward, and Pecos Counties had its influence in the formation of many producing structures in its immediate vicinity.

In the years from 1926 to 1938 the important producing formations were from the Permian, the Ordovician, the Cretaceous, and the Triassic Ages. In recent years

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6 Warner, op. cit., p. 313: "The producing horizons in the Permian formations are known as the Yates Sand, the Big Lime, the Big Lake Lime, the Pecos Valley Sand, the Delaware Sand, and other local names."

7 Ibid., pp. 312-313: "The ages of the formations in which the oil and gas producing formations of West Texas are encountered are, in the order of their importance for past production, Permian, Ordovician, Cretaceous, and Triassic.

"Strata of Permian age are currently productive in each of the 26 counties producing in the district and have accounted for approximately 95.5% of the oil
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<th>SYSTEM</th>
<th>GROUP</th>
<th>FORMATION</th>
<th>LOG</th>
<th>FIELDS</th>
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<td>RECENT</td>
<td>PLEISTOCENE</td>
<td>Sand and Limestone</td>
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<td>Detrital</td>
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<td></td>
<td></td>
<td>MIOCENE</td>
<td>Red Sand and Sand</td>
<td></td>
<td>Sonol</td>
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<td></td>
<td></td>
<td>PLEISTOCENE</td>
<td>Mostly Salt, Little Anhydrite, Sand and Mud</td>
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<td>Shale</td>
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<td></td>
<td></td>
<td>TRIASSIC</td>
<td>Dolomite, Limestone, Some Sand</td>
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<td>Salt</td>
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<td></td>
<td></td>
<td></td>
<td>San Andres (Big Lime)</td>
<td></td>
<td>Dolomite, Salty Limestone, (GLOVERA)</td>
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<td>PERMION</td>
<td></td>
<td>LEONARD</td>
<td>Dolomite, Some Limestone, Salty Limestone</td>
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<td>Limestone</td>
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<td></td>
<td>(Glenrock)</td>
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<td></td>
<td>Algoma</td>
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<td></td>
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<td>Detrital, Limestone and Shale</td>
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<td>Chert</td>
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<td></td>
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<td></td>
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<td>Chert and Limestone, while Limestone</td>
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<td></td>
<td></td>
<td>DEVONIAN</td>
<td>Black Shale</td>
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<td></td>
<td></td>
<td></td>
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<td>Cuyahoga</td>
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<td>Limestone, Coal, Limestone, Shale, Sand</td>
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<td></td>
<td></td>
<td>ORDOVICIAN</td>
<td>Purgatory</td>
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<td>Limestone, Coal, Shale, of Bed</td>
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<td></td>
<td></td>
<td>PRE-CAMBRIAN</td>
<td>Amorphous and Algal Matter</td>
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<td>Granitic</td>
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Fig. 2. — Geological ages, systems, and formations.
oil in commercial quantities has been discovered in the formations from other ages, notably, the Devonian and Silurian in the TXL Field of Ector County.

The same formations identified in different fields of the Permian Basin and in Ector County are found at different depths. The San Andres Lime, or the Big Lime of the Permian Age, is topped at 3,700 feet in the Penwell Pool of southern Ector County and at 4,375 feet in the North Cowden Pool of northern Ector County. The Ellenburger Lime is found at 9,600 feet in the TXL Field of western Ector County and at 8,960 feet in the Penwell Deep Pool of southwestern Ector County.

Other producing horizons of Ector County are found between the Big Lime and the Ellenburger. The Holt, or Glorietta, pay-oil producing formations, are reached at about 5,200 feet in the North Cowden Deep Pool. The Clear Fork is found at 6,200 feet in the North Goldsmith production from the district, to January 1, 1938.

"The Ordovician producing horizons have accounted for 3% of the production from the district to January 1, 1938.

"The Triassic sand, which is reached at an average depth of approximately 500 feet or less in the Yates pool, and the Cretaceous horizon, at a depth of 400 feet or less in the Tobarg pool, both in Pecos County, have together accounted for less than 0.6% of the district's production."
Deep Pool. The Wolfcamp is at about 7,500 feet in the TXL Field. Devonian is found at about 8,200 feet in the TXL Field and Silurian at 8,500 feet in the same field.  

CHAPTER IV

FIELDS IN ECTOR COUNTY

The discovery of oil in Ector County, Texas, in 1926 marked the beginning of the petroleum industry in a county which today, twenty years later, is one of the most active in exploratory work in the state. Location of the various pools opened since the initial discovery is shown by the maps in Figure 3. The discovery well was drilled by the Osden Company on the Connell Ranch about sixteen miles southwest of Odessa. This discovery was made in the Big Lime or San Andres pay at about 3,700 feet. The well produced only twenty barrels a day; and as a consequence, there was a lag in exploratory work in Ector County. In 1929, in this same locality, the discovery well for the Pen or Pennell Field was drilled to the San Andres Lime. At the end of 1946, this field with 177 wells had produced 27,748,865 barrels of crude oil.¹ The gravity of this oil averages

Fig. 3 (A). -- Map of Ector County oil fields.
Source: "Oil Field and Pipe Line Map," prepared by the North Basin Pools Engineering Committee, Midland, Texas.
Fig. 3 (B). -- Map of Ector County Oil Fields, well location.
Source: "Executives' Map of Permian Basin."
from thirty-two to thirty-seven. Sixty-five of the 177 wells still flow. These figures indicate the life of a well in the Permian Age pay. In 1946, the Phillips Petroleum Company also discovered a new pool in the Penwell Field when their Ridson-Scharbauer Unit 1 flowed at the rate of 1,065 barrels of 43.5 gravity oil through half-inch choke at a depth of 8,920 feet to 8,950 feet in the Ellenburger dolomite of the Ordovician Age. Producing wells and production in Ector County fields are tabulated in Table 1.

The North Gowden Field was discovered in 1930. At the end of 1946 there were 639 wells, 316 of which were still flowing; and the field had produced 56,833,569 barrels of thirty-seven gravity crude oil. The San Andres Lime averages 4,406 feet in the North Gowden Pool. In 1939 a deeper pay of Permian Age Lime, the Holt

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2Ball, op. cit., pp. 154-155: "The chokes or 'beans' or 'flow beans' are heavy steel nipples inserted into and closing the flow lines except for an orifice in each choke. The rate of flow, or the amount of back pressure maintained on the well, is regulated by the size of the choke orifice. In speaking of the production of a well, therefore, it is customary to mention the size of the choke orifice through which it is producing. We might say, for example, that Johnson Roe No. 1 is 'doing 793 barrels through a one-inch choke.'"

<table>
<thead>
<tr>
<th>Field</th>
<th>Year of Discovery</th>
<th>Average Depth</th>
<th>Wells at the</th>
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<td>North Cowden</td>
<td>1930</td>
<td>4,406</td>
<td>33</td>
<td>316</td>
<td></td>
</tr>
<tr>
<td>Harper</td>
<td>1934</td>
<td>4,211</td>
<td>37</td>
<td>11</td>
<td></td>
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<tr>
<td>South Cowden</td>
<td>1933</td>
<td>4,238</td>
<td>31-36</td>
<td>53</td>
<td></td>
</tr>
<tr>
<td>Johnson</td>
<td>1935</td>
<td>4,180</td>
<td>36</td>
<td>52</td>
<td></td>
</tr>
<tr>
<td>Goldsmith</td>
<td>1935</td>
<td>4,223</td>
<td>36</td>
<td>903</td>
<td></td>
</tr>
<tr>
<td>Foster</td>
<td>1936</td>
<td>4,244</td>
<td>36</td>
<td>141</td>
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<tr>
<td>North Cowden Deep</td>
<td>1939</td>
<td>5,171</td>
<td>33-36</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>North Goldsmith</td>
<td>1940</td>
<td>4,465</td>
<td>33</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>TNL, Devonian</td>
<td>1945</td>
<td>8,031</td>
<td>41</td>
<td>72</td>
<td></td>
</tr>
<tr>
<td>TNL, Ellenburger</td>
<td>1945</td>
<td>9,832</td>
<td>43</td>
<td>61</td>
<td></td>
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<tr>
<td>Andecker</td>
<td>1946</td>
<td>7,956</td>
<td>44</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Goldsmith, Clear Fork</td>
<td>1946</td>
<td>6,290</td>
<td>40</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Goldsmith, Devonian</td>
<td>1946</td>
<td>7,956</td>
<td>43</td>
<td>3</td>
<td></td>
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<tr>
<td>Goldsmith, Silurian</td>
<td>1946</td>
<td>8,250</td>
<td>36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Artificial Lift</td>
<td>Total</td>
<td>Daily at End of 1946</td>
<td>Year 1946</td>
<td>Cumulative Through 1946</td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>-------</td>
<td>----------------------</td>
<td>-----------</td>
<td>------------------------</td>
<td></td>
</tr>
<tr>
<td>112</td>
<td>177</td>
<td>2,700</td>
<td>1,139,324</td>
<td>27,748,865</td>
<td></td>
</tr>
<tr>
<td>323</td>
<td>639</td>
<td>21,000</td>
<td>9,668,486</td>
<td>55,833,569</td>
<td></td>
</tr>
<tr>
<td>173</td>
<td>184</td>
<td>1,000</td>
<td>393,407</td>
<td>9,957,851</td>
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<tr>
<td>80</td>
<td>133</td>
<td>2,700</td>
<td>1,153,988</td>
<td>7,609,869</td>
<td></td>
</tr>
<tr>
<td>77</td>
<td>129</td>
<td>2,400</td>
<td>1,055,195</td>
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<td></td>
</tr>
<tr>
<td>90</td>
<td>993</td>
<td>20,700</td>
<td>8,671,176</td>
<td>72,658,457</td>
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<tr>
<td>464</td>
<td>605</td>
<td>1,700</td>
<td>6,343,528</td>
<td>36,923,619</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>22</td>
<td>2,300</td>
<td>429,704</td>
<td>750,177</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>60</td>
<td>21,227</td>
<td>196,628</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>78</td>
<td>11,000</td>
<td>2,833,921</td>
<td>3,443,054</td>
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</tr>
<tr>
<td>61</td>
<td>61</td>
<td>15,000</td>
<td>2,478,433</td>
<td>2,631,242</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>100</td>
<td></td>
<td>11,439</td>
<td>11,439</td>
<td></td>
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<tr>
<td>3</td>
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<td>59,435</td>
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<tr>
<td>3</td>
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<td>73,805</td>
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<td>8,143</td>
<td></td>
<td>8,143</td>
<td>8,143</td>
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</table>
TABLE 1 -- Continued

<table>
<thead>
<tr>
<th>Field</th>
<th>Year of Discovery</th>
<th>Average Depth</th>
<th>Wells at the Gravity</th>
<th>Flowing</th>
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</thead>
<tbody>
<tr>
<td>Penwell, Ellenburger</td>
<td>1946</td>
<td>9,020</td>
<td>43</td>
<td>1</td>
</tr>
<tr>
<td>TXL, Clear Fork.....</td>
<td>1946</td>
<td>5,630</td>
<td>36</td>
<td>2</td>
</tr>
<tr>
<td>TXL, Wolfcamp.......</td>
<td>1946</td>
<td>7,860</td>
<td>34</td>
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</table>

<table>
<thead>
<tr>
<th>Artificial Lift</th>
<th>Total</th>
<th>Daily at End of 1946</th>
<th>Year 1946</th>
<th>Cumulative Through 1946</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50</td>
<td>13,877</td>
<td></td>
<td>13,877</td>
</tr>
<tr>
<td>2</td>
<td>100</td>
<td>10,603</td>
<td>289</td>
<td>289</td>
</tr>
</tbody>
</table>
(Glorieta), was discovered about 5,150 feet. At the end of 1946, this pool had produced 750,177 barrels of 33-36 gravity crude oil from twenty-two wells, fourteen of which are still flowing.

The South Cowden Field was discovered in 1933. The San Andres Lime averages 4,238 feet in this pool. The cumulative production at the end of 1946 was 7,609,869 barrels of 31-36 gravity crude oil from 133 producing wells. Fifty-three of these wells are still flowing.

The next field to be discovered was the Johnson Field. From 1934, when the field was opened, to the end of 1946, this field, with 129 wells, had produced 6,489,091 barrels of 36 gravity oil from the San Andres Lime. The average depth of pay is 4,180 feet.

The Harper Field, about twelve miles west of Odessa, was discovered in 1933. The San Andres Lime in this field averages 4,211 feet. Initial production rates in this field were high. In 1944 the field produced 591,178 barrels of 37 gravity crude oil from 184 wells. In 1946 the field produced 393,407 barrels from 184 wells. The cumulative production from 1933 to the end of 1946 was 9,957,851 barrels. One deep test has been drilled to 12,529 feet for a dry hole.
The Goldsmith Field was found in 1935. The field had a total of 993 wells producing from the San Andres Lime at the end of 1946. The cumulative production at that time was 8,671,176 barrels of 36 gravity oil. The Gulf Oil Corporation has "19,840 acres more or less" (sign at the entrance to the lease) in one block in this field, and it is said that this is one of the largest individually owned leases in the world. Over four hundred wells have been completed; and drilling development, limited by scarcity of casing, is still being carried on by the Gulf Oil Corporation. This company has just completed a well in a deep test on its acreage in the Goldsmith Field. This well, drilled to the Ellenburger, was plugged back to the Devonian and on test "flowed 128 barrels of 38.5 gravity oil and 163 barrels of water, with the gas-oil ratio 676/1, on initial gauge through half-inch choke from perforations at 7980-90 feet."4

Three deep pays were discovered in 1946 in the Goldsmith Field; the Clear Fork Pool at 6,200 feet, the Devonian Pool at 7,900 feet, and the Silurian Pool at 8,250 feet. The Goldsmith-Clear Fork Pool discovery well, Stanolind et al Scharbauer, was completed March 30,

4"Field Operations," The Oil Weekly, CXXV (May 5, 1947), 68.
1946, at the north edge of San Andres production. The Clear Fork Lime of Permian Age was encountered from 6,090 to 6,290 feet. This well was drilled to 9,155 feet but was "plugged back" and completed for pay in the Clear Fork. On test the well flowed at the rate of 398 barrels of 40 gravity per day through fourth-inch choke. At the end of 1946 three producing wells from this zone had produced 59,435 barrels of 40 gravity oil.

The North Goldsmith Field was discovered in 1940. This pool with ten wells at the end of 1946 had produced 21,227 barrels of 33 gravity oil. The North Goldsmith Devonian discovery well, Stanolind's Grisham-Hunter Corporation 1, offsetting 4,400 feet in San Andres production, was an old failure deepened from 6,499 feet. The well was completed on April 21, 1946, at 7,956 feet in cherty lime of Devonian age. This well flowed at the rate of 445 barrels of 43 gravity oil through fourth-inch choke. At the end of 1946 three wells in the new pay had produced 73,805 barrels. The Goldsmith-Silurian pay was discovered in the Phillips Petroleum Company's R. B. Cowden Bum 1, one-half mile southeast of the Devonian discovery location. The well was completed October 10, 1946, in Silurian Lime from 8,255 feet to 8,280 feet. On test it flowed at the
rate of 226 barrels of 36.2 gravity oil and sixty-four barrels of water through half-inch choke. The well had produced 8,143 barrels by the end of 1946.

In 1936 the Foster Field, lying between the North Cowden and the South Cowden Fields, near the city of Odessa, was discovered. This field with 605 wells at the end of 1946 had a cumulative production record of 36,923,619 barrels of 36 gravity oil. Drilling to the San Andres Lime continues in the Foster Field. Seven new wells were completed there in the month of January, 1947.

In 1945 the TXL Field was discovered half-way between Odessa and Kermit. The discovery well, Shell-Cities Service's T. P. Land Trust No. 1, was drilled to 10,181 feet and completed on January 3, 1945, at 7,886 to 8,020 feet in Devonian Lime of Devonian Age for 1,911 barrels of 41 gravity crude oil through half-inch choke. Later in the same year, May 15, 1945, Shell's E. R. Thomas 1-A, drilled to 9,852 feet, encountered a new pay, the Ellenburger dolomite of Ordovician Age, and flowed on test at the rate of 1,547

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5E. H. King, "The TXL Field," The Oil Weekly, CXVIII (July 2, 1945), 34: "Since the area is primarily open ranch country and removed from any designated town, the name TXL is derived from the stock market abbreviations of the Texas Pacific Land Trust's listing."
barrels of 44 gravity crude oil through half-inch choke. The TXL Devonian Pool had produced 3,443,054 barrels of crude oil from seventy-eight wells to the end of 1946. The TXL Ellenburger Pool with sixty-one wells produced a cumulative total of 2,631,242 barrels. In 1946 three new oil pays were found in the TXL field. Phillips Petroleum Company's T. F. Land Trust No. 1-E-A, one mile east of the south end of the TXL Devonian Pool, after being drilled to 11,506 feet, was completed from 5,615 to 5,630 feet for a producer in the Clear Fork Lime. On test the well flowed through half-inch choke at the rate of 139 barrels of 36.5 gravity oil for twenty-four hours. At the end of 1946 Clear Fork production totaled 10,603 barrels from two wells. On June 11, 1946, the Shell Oil Company-Arkansas Fuel Oil Company's E. R. Thomas 1-E, offsetting Devonian production in section 32, block 45, T-1-5, was completed for a new pay for the TXL Field in Wolfcamp Lime of Permian Age. On test the well pumped sixteen barrels of 34.5 gravity oil and sixty-five barrels of water. The TXL Silurian pay was discovered by Superior Oil Company in the J. E. Parker Number 1 at the southern edge of the TXL Field. This well, completed on December 20, 1946, at 8,535 feet in Silurian Lime, flowed 314 barrels of
34.5 gravity crude oil through 7/16-inch choke.

Three new fields were opened by exploratory drilling in 1946: Southeast TXL, the Murchison south of TXL, and the Anductor near the Ector-Andrews county line. The TXL Southeast Field is one mile south of TXL and is a separate reservoir. The discovery well, Texas Company's T. P. Land Trust Fraser 1-D, was completed on February 7, 1946. It was bottomed at 10,975 feet with one hundred feet of Ellenburger dolomite in the pay horizon from 10,790 to 10,890 feet. On test the well flowed through half-inch choke at the rate of 1,700 barrels of 41.9 gravity pipe-line oil.

The John W. Murchison et al's T. P. Land Trust-Texasco 1, three and one-half miles south by west of the TXL Field, was completed on September 10, 1946, for a producer in Devonian chert from 8,510 to 8,566 feet. The well pumped twenty-nine barrels of 40 gravity oil and thirty-three barrels of water.

The Anductor Field discovery October 1, 1946, was drilled by Humble Oil and Refining Company. This field is one and seven-eighths miles north of the Goldsmith-Devonian Pool discovery. On test this well flowed at the rate of 1,176 barrels of 44.2 gravity oil through 3/8-inch choke from Ellenburger dolomite encountered between
8,548 feet and 8,585 feet. By the end of 1946, 11,439 barrels of oil had been produced from this field.
CHAPTER V

DRILLING A WELL

Before an oil company begins drilling a well, it is necessary that an oil lease be acquired. The usual oil lease gives the land owner one-eighth of the oil and gas produced, and the operator receives seven-eighths. If there is no production in the near vicinity, the lease price is low. Sometimes the land owner will give a company the lease, provided a test well is drilled by a given date. Leases usually run for ten years with a lease bonus payment and a yearly acre rental. Some contracts are drawn with an expiration date so that the company must drill within a certain time limit or forfeit the drilling right. The TXL Field is a good example of leasing practice. Information gained from the San Andres failures and geophysical surveys in the TXL area established a pronounced anticlinal feature extending in a northwest-southeast direction. Lease prices rose to between $7.50 and $10.00 per acre in 1939; and, when the Wheeler Field was discovered just over the line in Wheeler County, leasing activity increased. With the
discovery of Devonian production in Ector County on January 3, 1945, competitive bidding broke loose. The Texas and Pacific Land Trust Company has a policy of holding open some acreage around a wildcat (first well drilled in an area) until it is proved. It also retains one-sixth instead of the usual one-eighth on such transactions.

Owners of the discovery assumed 2 drilling obligations in acquiring lease on 163 acres in Section 19, Block 45, and 3 1/2 of N 1/2 of Section 19, Block 46, paying $100 per acre cash and $3500 per acre, payable from 1/ of the 5/6 working interest.1

When Ellenburger pay was discovered by the Shell and Cities Service, E. R. Thomas 1-A, offsets and diagonal offsets had to be drilled immediately. The Railroad Commission ordered forty-acre spacing for the field. One major oil company was forced to drill as it had eighty acres running east and west in Section 7 with one location a direct offset to the west from the discovery. The estimated cost to drill this well is itemized in Table 2.

A Dallas, Texas, drilling contractor was given the contract to drill the well. Drilling prices have been cut considerably since this well was drilled, but at that

1 King, op. cit., pp. 34-35.
time contractors were getting $9.00 per foot for the first eight thousand feet. Below eight thousand feet the contractors went on day work: $750 per twenty-four-hour day between eight and nine thousand feet and $800 per twenty-four-hour day from nine thousand feet to ten thousand feet with the operator furnishing the bits below eight thousand feet.

The drilling contractor who moved in the equipment to make this offset well to the discovery bought all new heavy-duty Diesel drilling machinery to drill the well. His rig (machinery, derrick, etc.) was one of the show places in the field when he started the well, but today, less than two years later, improvements in drilling equipment have made this rig just another average rig.

Before rigging up to drill, the first task is to stake the location accurately. An application is made to the Railroad Commission to drill. Their permit establishes the exact place, a definite number of feet from the section lines, on which to spud (starting pit or cellar for bit) the well. When this site is located by civil engineers, the drilling contractor has his mud pit and reserve pits built. These may be earthen pits, dug out by a bulldozer, or steel welded pits. Practically all pits in the TXL Field are earthen. There is some
### TABLE 2

**ESTIMATE OF COST TO DRILL AND EQUIP A WELL IN THE TXL ELLENBURGER HORIZON**

1. **Material**

   - 500 feet, 9 5/8-inch 40# ft. Casing $1,145.
   - 1,400 feet, 7 -inch 29# ft. Casing $2,885.
   - 2,600 feet, 7 -inch 26# ft. Casing $4,271.
   - 6,000 feet, 7 -inch 23# ft. Casing $8,442.
   - 10,000 feet, 2 7/8-inch 6.5# Tubing $360.
   - 1,000 feet, 2 3/8-inch 3.75# Line Pipe $180.
   - 400 feet, 4 -inch 11# Line Pipe $100.
   - 2,000 feet, 3 -inch Regular Line Pipe $360.
   - 1 13 3/8" x 9 5/8" x 7" x 2" 1,000# Test Casinghead Hookup $3,000.
   - 2 400 barrel Steel Welded Tanks Complete with Stairway and Walkway $1,400.
   - Miscellaneous Tank Battery Connections $300.

   **Total Material Cost:** $33,913.

2. **Fuel and Water**

   **Water (First $1,600, worth of water furnished by contractor)** $900.

3. **Insurance, Fees, Expense, and Overhead**

   - Well logging service $1,000.
   - Insurance $225.
   - Schlumberger, temperature, and caliper surveys $1,200.
   - Fees and expense $225.
   - Overhead $225.

   **Total Insurance, Fees, Expense, and Overhead:** $2,875.
### TABLE 2 -- Continued

4. Contract and Day Work

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>To drill 8,000 feet at $9. per foot</td>
<td>$72,000</td>
</tr>
<tr>
<td>5 days day work time at $700. per 24 hour day above 8,000 feet</td>
<td>3,500.</td>
</tr>
<tr>
<td>25 days day work time at $750. per 24 hour day 8,000 to 9,000 feet</td>
<td>18,750.</td>
</tr>
<tr>
<td>30 days day work time at $800. per 24 hour day 9,000 feet to 10,000 feet</td>
<td>24,000.</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$118,250</td>
</tr>
</tbody>
</table>

5. Teaming, Trucking, and Freight

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contract truck: haul cement, casing, mud, tubing, tanks, separator</td>
<td>2,300.</td>
</tr>
<tr>
<td>Contract team: build roads, grade location, mud pits</td>
<td>1,500.</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>3,800.</td>
</tr>
</tbody>
</table>

6. Roustabout and Other Labor

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement 13 3/8, 9 5/8, and 7-inch casing</td>
<td>750.</td>
</tr>
<tr>
<td>Connect up tanks, lay flow lines, etc.</td>
<td>400.</td>
</tr>
<tr>
<td>Build concrete tank grade</td>
<td>200.</td>
</tr>
<tr>
<td>Lay water line, test line, connect up well</td>
<td>500.</td>
</tr>
<tr>
<td>Build fence and clean up location</td>
<td>200.</td>
</tr>
<tr>
<td>Cutting, welding, etc.</td>
<td>200.</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>2,250.</td>
</tr>
</tbody>
</table>
TABLE 2 -- Continued

7. Miscellaneous Repairs, Supplies, etc.

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
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</thead>
<tbody>
<tr>
<td>Bits (estimated 54) 8,000 to 10,000 feet</td>
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</tr>
<tr>
<td>Drilling line</td>
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</tr>
<tr>
<td>4,000 sacks cement</td>
<td>4,000</td>
</tr>
<tr>
<td>Drill stem tests</td>
<td>750</td>
</tr>
<tr>
<td>Mud, boroid, and drilling clays</td>
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</tr>
<tr>
<td>Perforating service</td>
<td>750</td>
</tr>
<tr>
<td>Casing, shoes and miscellaneous supplies</td>
<td>2,000</td>
</tr>
<tr>
<td>Cement, sand, and gravel for tank foundations</td>
<td>100</td>
</tr>
<tr>
<td>Fencing material</td>
<td>100</td>
</tr>
</tbody>
</table>

Total cost $24,900.

$186,888.

Variation in the sizes, but the average layout is one deep pit near the location about ten feet wide, fifty feet long, and five feet deep with a reserve pit beyond, made by pushing earth up for a wall around a square one hundred feet on a side. Roads are built by the oil company to the location. In the TXL Field caliche for surfacing the road costs around five dollars per dump-truck load.

The derrick may be skidded to the location where the terrain is level, as in the TXL Field, if the distance is not too far; or it may be built from the ground up. Rig builders erect, or skid, the derricks and set up pipe racks.
For the man who is not sure of foot or who fears high places there is no room in the fra-
ternity of rig builders. These steel hangers are members of a highly specialized profession, which from the early days of the oil industry has attracted only men with a brand of skill and courage especially suited for this type of work.

Rig building today is a far cry from what it was some 40 years ago when derricks were built of heavy timbers to heights ranging from 60 to 90 feet. Today’s all-steel derricks are scientifically pre-fabricated structures, engineered for efficient and safe operation under loads up to 800,000 pounds. They must be erected according to an approved pattern, and most of those used in present day deep well drilling rear their heads 136 feet high.2

Rig builders receive about twenty-four dollars per eight-hour day and require from three to five days to complete their work.

While the derrick is being erected or skidded, the drilling contractor is busy moving the equipment onto the location. While rigging up is in progress, the drilling crews are working on daylight tours (shifts, pronounced "towers"). The crews are divided into day, night, and morning shifts; but they all work during the day until they have set up the engines, draw works (controls and drum for cables), pumps, and line connections. A tool pusher supervises the three crews. He may be in charge of one or more rigs.

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2 "Rig Builders," The Humble Way, I (September–October, 1945), 10.
When the assembly is completed and the rig is ready to start drilling, the crew break tour (divide up into shifts). One driller and four or five roughnecks (worker, other than the driller in a drilling crew) comprise a drilling crew. One roughneck is the derrick man who works on a tiny board about ninety feet up in the derrick when a trip is being made. Another is the engine man. The two or three others are floor men working when needed to screw or unscrew the sections of drill pipe. One is called the pipe racker, and one is called the lead tong man. The daylight crew works from eight a. m. to four p. m. and is relieved by the night crew, who work until twelve midnight. The night crew is relieved by the morning crew, who work until eight a. m.; and then the cycle repeats itself.

The first task in drilling is to drill the rat holes (holes drilled a few feet from the main hole). The forty feet of Kelly joint (a steel pipe with square surface for fitting into a rotary table), when not in use, is set into one of these. The other, sometimes called a "mouse" hole, is used to hold the joint (section) of drill pipe for making up (screwing together) in string (series of joints) or breaking out (unscrewing) of string. After the rat holes are drilled, the driller
is ready to spud (start). Sometimes a cellar (square or round hole under the derrick) is dug to help start the bit, to give room under the derrick floor for putting control valves on casing that has been run, and to make room for Christmas trees (the mass of high-pressure valves and connections necessary for a flowing well) to be put up and adjusted when the well is finished. The derricks of today are built with the derrick floor about ten feet above the ground level; consequently, large cellars are unnecessary. Figure 4 shows rotary drilling rig equipment and formations likely to be encountered in the TXL Field.

In the TXL Field the first twenty feet usually run from surface soil through caliche, and from there to two hundred feet is sand and rock. The shallow water sand in the TXL is absent in many locations. Then from two hundred feet to 1,100 feet red rock and other types of rock are found. Somewhere below the surface water table in good footing (solid formation) surface pipe is put in the hole. The purpose of the surface pipe is to keep the surface earth from falling into the hole as it is deepened, to seal off surface water so that it will not interfere with drilling, and to keep the water from becoming contaminated for drinking purposes. The average
Fig. 4. — A rotary drilling rig equipment and usual formations for the EKI Field.
depth is between 250 and 300 feet. Several operators run 13 3/8-inch, forty-eight pounds per foot, pipe for the surface string. The driller uses a 17 1/2-inch bit to drill this section of the hole and can drill it in two or three days.

When the total depth for the surface string has been made, the drill pipe, which has been added a joint at a time as the hole deepened, is raised just off the bottom; and the drilling fluid is circulated to clean out and condition the hole for running casing (screwing together joints of casing) and cementing. The drill pipe is then racked (stood in sections, usually three called a "stand") in the derrick, or laid down (broken down and put on pipe racks outside of the derrick). A caliper survey is made of the hole to determine its clearness and the amount of cement necessary for securing the surface string.

When the surface pipe is run, it is customary for the tool pusher to have the crews double over (work two hours) because of the extra work. A casing shoe is screwed on, or welded to the lower end of the first joint of casing. The purpose of the shoe is to reinforce the end of the column of pipe so that it may be driven past minor obstructions in the hole. The derrick man has a
stabbing board (platform for the man who aligns pipe) placed across the derrick at about the length of a joint of casing above the floor. Here he aligns or "stubs" the top end of the pipe so that the floor men can screw the joint into the "collar," or coupling, on the preceding joint. In running casing, two or three roughnecks "roll" the casing from the pipe racks onto the catwalk (narrow walkway between pipe racks). From there it is raised into the y-door (opening on pipe-rack side of derrick) by means of a catline (cable and rope line through pulley or sheave). The power for the lifting operation comes from the draw works through a "cathead." The cathead operator throws a rope over the cathead and after taking three or four "wraps" on it, pulls on the free end of the rope. The rope, through frictional gripping, lifts the weight on the other end of the line. A line which has been tied to the traveling block (the heavy pulley which moves at the end of the hoisting cable) serves as a pick-up (line with noose for end of pipe) line to raise the joint over the hole. As soon as the joint is replaced in the rim of the collar and stabbed, the driller lowers the traveling block; and the "elevators" are latched (fastened around the pipe) onto the upper end of the pipe by the derrick man. One of
the floor men adjusts a *spinning rope* (rope for making up pipe) on the lower end of the joint above the threads; and as soon as the derrick man has the joint stabbed, the spinning line cathead man takes the joint up as far as it will go with the rope. While one floor man adjusts the rope at the start of this operation, another latches the *back-up* (a large wrench to hold joint being screwed into) tongs on the joint which is held in the *slips* (the slips are curved steel wedges which fit into a "spider," or liner, to hold the weight of the column of casing). The joints are finally made up by the *make-up* tongs which are operated by the spinning rope cathead operator. The rope on the tongs is not pulled on through by the operator, but the tong men take the line back with a succession of pulls for a new grip on the pipe. The operator of the spinning rope cathead is usually the doubling-over crew's driller. Automatic catheads, operated by the driller, are used in making up drill pipe but are not used on casing.

There is one extra joint made into the string. It is called a "landing" joint, and its purpose is to place the casing coupling at the correct level with reference to the ground and to hold it there until the cement sets. The majority of operators set the Christmas-tree
connections above the ground. If the surface casing is landed with the top of the collar fourteen to sixteen inches below the surface of the ground, the casing head when screwed on will have its gas outlets about level with the ground. After the pipe is landed, drilling fluid again is circulated. The purpose in circulating the drilling fluid at this time is to clean out the area between the casing and the walls of the hole.

While the casing is being run, the cementing company has been preparing for the cement job. Cement is purchased in bulk form; however, the term "sack" is used to designate the volume used. On surface casing about 250 sacks of cement are required. The cement mixing truck is moved in close to the derrick and four-inch water hoses are connected to the pumps on the truck. Flexible, jointed sections of two-inch pipe are laid from the mixing bins to the derrick floor. The mixing bin sets on the ground and a cement hopper which sets at the end of the bulk cement truck is connected to it by a large diameter line.

When the circulation operation has gone on long enough to satisfy the company man (representative for the operator), the cementing of the casing commences. A small motor on the bulk truck dumps dry cement into the
hopper; from the hopper it is washed by a stream of water into the mixing bin. The product of the mixing is called neat cement (cement and water -- no sand) and weighs about fifteen pounds per gallon. This mixture is pumped into the casing. As it is pumped down the casing, it pushes the drilling fluid ahead of it; and this fluid flows out at the surface and along a ditch to the mud pit. Cement is pumped in until it either shows at the surface of the drilling fluid or until the entire amount is used. When the pumping of cement into the casing has been completed, a plug is run in on top of the cement. The plug for surface pipe is a large piece of wood about the size of the inside diameter of the pipe. It is forced down by pumping water into the casing. As the plug is pumped down, a weight similar to a plumb bob on the end of a steel measuring line is let down to follow it and record the depth it reaches when the pumping is stopped. The plug holds the cement down until it sets. This plug is usually stopped a few feet above the bottom of the casing. After the cement sets, which requires twenty-four hours, the plug and cement remaining in the lower end of the casing are drilled out; and the next phase of the drilling job is under way.

In the TXL Field the intermediate string, the string of pipe between the surface string and the oil string,
is called the "salt" string. This is because of the salt strata encountered at varying depths and of varying thicknesses down to about 2,800 to 2,900. The drilling fluid used here is water saturated with salt. It is necessary to keep the salt in the formation from dissolving in the drilling fluid. If it dissolves out of the formation, cavities are likely to form, or the hole is apt to become abnormally large. This would make drilling a straight hole difficult. As weight is put on the drill pipe, it tends to lie against a side of the hole as it rotates. A crooked hole or large cavity will cause the drill pipe to break. Then progress is delayed while the broken end of the column is fished out, a process of removing any broken drilling equipment from the hole.

After the surface pipe has been run and the cement has set for twenty-four hours, drilling is resumed with a 12 1/2-inch bit. The hole to be made is for 9 5/8-inch casing. At approximately 1,100 feet the geological formation changes somewhat in the TXL. From red rock it goes to red bed and lime to about 1,500 feet. From 1,500 feet to about 3,850 feet anhydrite, lime, and salt show up in the samples. Samples are usually caught every ten feet beginning immediately below the surface pipe on wells where the company geologist wants a complete log on the well. One function of the drilling fluid, or
drilling mud, is to carry in suspension the rock cut up by the bit. The mud circulates through the drill pipe and out through the bit at the bottom of the hole and then back up the space between the walls of the hole and the drill pipe. As it comes out of the well, it is carrying particles of the formation; and in order to get these out of the mud so that it will be clean as it returns to the drill pipe, the mud passes through a shale shaker.

A shale shaker is a circular screen-covered device which rotates as the mud passes through. The drilling fluid passes through the screen and runs back into the mud pit. The shaker is tilted slightly so that the cuttings left in it are worked out at the lower end. Here one of the roughnecks takes a sample for every ten feet drilled. He washes and dries the sample and sends it for the operator's representative. As the hole deepens, the samples have to be lagged, that is, time is allowed for the travel of the cuttings up the hole. The samples are watched closely as the hole nears the casing point (point at which next string of casing will be set). When the petroleum engineer or the geologist decides that the casing point, from 3,650 to 3,850 feet in the TXL Field, has been reached, drilling is suspended and preparations are begun for running the intermediate string.
This string is usually 9 5/8-inch or 8 5/8-inch casing.

The preparations for running this string of pipe are similar to the preparations for running the surface string: the hole is washed out by circulating; a caliper survey is run; the casing is carefully measured; the stabbing board is raised; tong rope and pipe pick-up ropes are spliced; and all the various other tasks connected with the running of pipe are done. Some contractors hire casing crews to run the pipe while the driller and his crew assist. Other contractors have their drilling crews double over until the job is done. It usually takes eight or ten hours to run 3,800 feet of a 9 5/8-inch casing and to cement.

The first joint in the intermediate string has a shoe similar to the surface string, and it also has a float collar. The purpose of the float collar is to help hold the cement in place against the pressure of the cement standing in the hole below the float and between the pipe and the walls of the hole. The float collar is usually put in on the top of the first joint. This makes it necessary to drill out at least one joint filled with cement when drilling commences after the cement has set. If there is a high formation pressure in addition to the weight of the cement, two float collars may be run.
As the pipe is run, the pressure on the outside of the pipe increases as the column goes deeper into the hole; therefore, it is necessary to stop the pipe-running operations frequently to fill the column with drilling fluid or water to prevent pipe collapse.

When the last joint is run, the pipe is raised slightly off the bottom, and drilling fluid is circulated for an hour or two. Into the landing joint, the well cementer screws a cement control head. This head is a short piece of pipe of the same diameter as the casing and has outlets the size of the cement slurry pipe. This permits the pipes from several cement pump trucks to be attached; consequently, it allows several pumps to work, with the result that the cementing job can be done much more rapidly.

For the salt string, the usual amount of bulk cement used is from 300 to 3,500 sacks. Three pumps are usually used so that if anything happens to a pump it will not be necessary to stop operations. The plug used in the new type collars is the ball and seat type which permits fluid to pass through but closes the passage against back pressure. It takes about 1,250 pounds per square inch to squeeze away (force it down by pump pressure) the cement. The cement in the salt string should circulate
when the plug is pumped down. If the cement does not
circulate, a temperature survey is made. The top of
the cement may be determined by this temperature log if
the survey is made while the cement is in the process of
setting due to the extra heat generated.

When the last joint is landed, the cement is run;
the plug is pumped down; and slips are set to hold the
string about two feet off bottom. These slips are a
part of the casing head assembly. The large bowl, or
spool, that fits the surface pipe has been screwed into
the surface pipe collar which is about sixteen inches be-
low the surface of the ground. In its upper part, the
slips are placed around the joint of 9 5/8-inch casing.
When the pipe is levered, the slips set into the casing
head, grip the outside of the pipe, and hold it.

At some time while drilling is suspended and while
the cement is setting (about forty-eight hours), the
pipe above the slips is cut off; and the upper end of
the casing string is welded to a welding ring or to the
casing head.

When drilling is resumed, the drilling is a little
more difficult. In the lower Permian to the Ordovician
the driller can expect extremely hard limestones and
dolomites. The cherts and flints of the Devonian Age may
slow drilling down to as low as six inches in twenty-four hours. Formations which are folded and faulted cause straight-hole drilling to be difficult and expensive. Drilling contractors in the TXL Field depend upon several practices to overcome the difficulties. To make a hole, it is generally agreed that there must be weight upon the bit. This weight cannot come from the weight of the drill pipe alone because compressing the drill pipe shortens its life. The total weight of the drill pipe may not be on the bit, part of it being applied to the sides of the hole. The best way to put the weight on the bit is by means of drill collars. These are pieces of drill pipe the same length as the other drill pipe and with the same inside diameter, but where the drill pipe has upset ends, the drill collar has the same outside diameter from end to end. This makes it extremely heavy. It does not follow, however, that the greater weight affords faster drilling. Other factors to be considered are the rotating speed and the life of the bit. It has been found that from sixty to sixty-five revolutions per minute is the best maximum rotating speed to use. A drilling time chart is kept by the driller which shows the time required to make a certain number of feet, usually ten. When the drilling rate slows
down too much, it is time to change the bit. When the
bit is used too long or with too much weight, bearing
failure may result. If cones or bearings are lost in
the hole, it necessitates a fishing job. Fishing for
rock bits is usually not difficult. One trip with a
cone or junk basket is usually sufficient; however, one
operator in the TXL Field spent more than three weeks at
more than 8,500 feet fishing and milling (grinding steel
to powder) on cones and bearings. Fishing for drill
collars is another problem. The normal method is to
use a size which will permit the use of an overshot
(tool which goes down over the end of the pipe with slips
which grip the pipe when it is lifted) to fish it out
if the need should arise.

When the drill has reached a depth of 7,500 feet
in the TXL Field, it is time to introduce special muds
into the drilling fluid.

When rotary drilling was used in 1901 in the Spindle-
top Field, the chief purpose of the drilling fluid was
to remove cuttings. Today it is effectively employed in
doing the following:

1. Removing cuttings.
2. Cooling the cutting edge of the bit.
3. Walling the hole.
4. Controlling high pressure.
5. Holding cuttings in suspension when cir-
culation is stopped.
6. Lubricating the drill pipe.
7. Supporting part of the drill pipe weight and casing.
8. Releasing cuttings and gas at the surface.

Albert B. Stevens sums up the ideal drilling fluid as a fluid with viscosity such that it would flow freely, lubricate the drill pipe and slush pumps, cool the bit, and carry the cuttings to the surface without requiring excessive velocity. It would have gel characteristics which would allow the cuttings and gas to escape readily from it into the mud ditch or pit, and at the same time keep cuttings settling to the bottom of the hole when circulation is stopped. It would have wall-building properties of such a nature that with very little loss of fluid it would form a thin, impervious mud sheath on the walls of the hole to prevent loss of fluid into the formations penetrated. It would be heavy enough to control pressures encountered during drilling, and it would be low in abrasive material and salt content.

Although mud treating through the salt section consists of having the drilling fluid salt saturated, and the treatment of the mud down to around 7,500 feet is confined to water thinning of the natural red bed muds, the fact is that the estimate of mud for one well in the TAL Field costs around $10,000, which makes mud control a major problem. A fresh water bentonite mud treated with caustic soda and Quebracho (bark from a South American

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3E. H. Short, Jr., "Drilling Fluids End 'Refresher' Courses at Texas A. & M.," The Oil and Gas Journal, XLV (May 25, 1946), 105.

4Ibid.
tree) is best suited for the TXL formation. The \textit{viscosity} (amount of time necessary for fluid to pour through funnel) of this type of mud runs from thirty-four to thirty-eight seconds API; weight low, about 9.5 pounds per gallon; \textit{filtration rate} (water lost to formation) as low as safe drilling requires; and \textit{cake} (thickness of hole wall) about 2/32-inch.

At 5,800 or 5,900 feet the formation is limestone. The limestone changes to Devonian chert near 7,850 feet. In some sections of the TXL the Devonian section has been eroded away, and it is very thin. In the eastern part of the field it is thick. If the well being drilled is near the fault line between Devonian pay and Ellenburger pay, the operator is likely to run a drill stem test in the Devonian.

A drill stem test is taken if the operator believes the formation being drilled may be a productive horizon. The hole is not cased, but a drill-stem tester is run in on the bottom of the drill pipe. This tool will keep the drilling fluid away from the producing sand and will permit the gas, oil, and water in that formation to rise in the drill pipe. From the length of time the tool was open and the amount of gas, oil, or water in the drill pipe when it is pulled (brought out of the hole), the
rate of production is estimated.

Even though the contract for the well is to the Ellenburger, drill-stem tests may be taken for the Devonian, the Silurian, or other possible producing horizons because the operator will never have a better opportunity for testing these zones; and in time he may want to plug back up the hole and produce one of them. In some fields it is permissible (Railroad Commission controls) to produce from two horizons in what is called a dual-completion; one formation produces through tubing and the other through the casing.

There are two methods of completing the well with reference to the oil string casing. In one the casing is run and set above the producing horizon, and drilling is resumed with a smaller bit until total depth is reached. In the other method total depth is reached, and holes or perforations are made in the casing. For this operation, a gun perforator is used. The gun perforating companies have a device which is lowered into the hole on a line. When the desired depth is reached, bullets are fired into the steel casing. The device for this job resembles a piece of pipe about twelve feet long. There are recesses in this pipe at regular intervals up and down and around it. Into these recesses the
charges and steel bullets are placed. The discharging is done electrically. Several trips into the hole with the device are necessary, and the device must be loaded each time; consequently, it takes considerable time to gun perforate a thick zone.

For Devonian production, operators in the TXL ordinarily set their casing through the pay horizon because chert is hard to drill; and it takes the weight of drill collars to make the hole. Because the Ellenburger Lime is easier to drill, operators ordinarily set the oil string on solid footing above the pay. A small drill pipe string and a smaller bit is then necessary because of the small diameter, seven inches or five and one-half inches, of the casing. Tubing may be used for drilling in the well. Mud control during this phase is especially important as the bit is penetrating an area of high pressure. The mud must outweigh this pressure. Of course, the casing is equipped with a blow-out preventer which may be closed in case the mud fails to hold back the pressure. The blow-out preventer is a high-pressure valve which is fitted with rams. These rams are two rubber-faced steel wedges, one on each side of the valve, which close in on the drill pipe when the long safety handles are used to screw
the wedges in against the pipe.

Samples are taken at closer intervals, five feet or less, so that an accurate log may be had of the formation. Some operators use reverse "circulation" in this phase of drilling. Reverse circulation pumps mud through the casing, out the tubing, and makes a cleaner hole with faster cutting returns. When the total depth is reached, the drill pipe is removed; and the tubing is run. The tubing for an Ellenburger well is normally the 2 7/8-inch upset end pipe (pipe that has thicker walls at ends to allow for cutting away some of the pipe in making threads). This pipe weighs 6.5 pounds per foot. In order for such a long, heavy string of pipe to hold together, the upset end is necessary. The first joint is perforated or slotted so that oil may enter the tubing. After the tubing is run, the Christmas tree or well head is set.

The Christmas tree, which costs about $3,000, is delivered to the location partly assembled. The lower bowl, or landing head, is screwed into the collar of the surface pipe; and the intermediate string is set with slips into this landing head. The next landing head is bolted on above it, and the oil string is set in it. When the tubing is landed, it is set in this same landing
head. The assembly sets on this bowl and is bolted down. This assembly consists of the master gate (high-pressure valve for shutting off the flow of the oil through tubing), high-pressure nipples, unions, tees, and a choke. The choke is a calibrated device for adjusting the flow of oil from the well. With the Christmas tree installed and flow lines connected to the test separator and test tanks, the well is ready to be flowed. Some wells will flow naturally when the mud which is holding the oil back is pumped out. One method of removing this mud is to pump oil from storage into the hole to replace the mud. This is called "washing in" the well.

Some wells may be induced to flow by swabbing. A line fitted with a suction cup is made to fit the tubing and is lowered into the fluid which, when pulled out, brings some fluid with it. This method may bring the well in with a few pulls, or the process may take days.

The well may have to be shot with nitroglycerin, or it may have to be treated with acid to induce it to flow. Nitroglycerin is lowered into the hole in specially built containers. A pre-set clock in the first container sets off the charge. The purpose of the shot is to fracture the formation. Acid, when used, is pumped into the tubing and kept under pressure until the formation
absorbs it. Hydrochloric acid dissolves and channels the limestone so that the oil may flow more freely.

(When the well is flowing under its own power, it is first flowed into a pit because it contains mud and water from the drilling fluid. There is usually little pressure on either the casing or the tubing during the first few hours of flowing. As soon as the well has cleaned itself out, the oil and gas are put through the "separator." The gas flows out the top of this tank and the oil flows out through a dump valve to storage tanks. The well is tested for six hours to find its potential (amount it should make in twenty-four hours). The following items are checked each hour for the six hours: the number of barrels of oil, number of barrels of water per cubic foot of gas, the gravity of the oil and its temperature, and the per cent of basic sediment present.

After a satisfactory test is concluded, the rig is released. This means that the contractor has brought his contract to a conclusion.)
CHAPTER VI

PRODUCTION OF OIL

The production of oil does not hold the romance of drilling for oil, but it does provide more and steadier employment. The production department takes over the well when the drilling department has finished it; and since the well may produce oil in commercial quantities for twenty-five years, it follows that the production department employees are the type of people who live a more normal life than the drilling fraternity. Many of the production employees live in company camps similar to the one pictured in Figure 5 or in lease houses for pumpers as in Figure 6.

The size of the lease affects the way in which wells are handled. There must be some variation in operation between the one-well ten-acre lease as found in the outskirts of the city of Odessa and the 19,840-acre lease of the Gulf Oil Corporation near Goldsmith. The majority of operators have storage tanks located in the center of the lease or on large leases in the center of an eight- or sixteen-well area. See Figure 7 for a tank battery.
Fig. 5. -- A company camp.
Fig. 6. -- Pumper's lease house.
Fig. 7. -- Tank battery in the Goldsmith Field.
of the type used in the Goldsmith Field. The amount of oil produced daily determines the size of the storage tanks in a battery (two or more storage tanks). The sizes vary from sixty-five-barrel tanks in the Fenwell Field to as much as 1,000-barrel tanks in the TXL Field. The average size tank is between 250 barrels and 500 barrels. In the tank battery treaters are placed if the oil must be heated to rid it of water and paraffin. The majority of companies place separators in the battery. These are usually in pairs -- one for flow and one for testing. If there are several wells flowing into the battery, the flow lines from the wells come together in a header, or manifold. This assembly permits turning the oil into the regular flow separator or into the test separator. From the separators the regular flow line will enter the treater, if one is present, and thence through a flow line which enters each tank in the battery.

The line from the test separator may enter one or more tanks. In batteries where the flow is heavy, a device is used to help the pumpers (employees who operate wells and batteries) by automatically flowing the oil from a full tank to the next one. These are called "equalizer lines" or "equalizers." In order to get the
oil out of the tank to the pipe-line companies, outlets are provided at about one foot from the bottom. On the other side of the tanks, in the bottom, are "bleeders" provided to draw off water which may settle out of the oil. A "manhole" plate is provided so that when the basic sediment gets too high to meet the specifications of the pipe-line company, the tank may be cleaned. A tank may not be cleaned without the permission of the Railroad Commission.

Wells are produced by various methods. In Ector County the majority of wells have started by flowing. See Figure 8 for a flowing well hookup equipment, with flowing head assembly and individual separator. These, in time, lose their gas pressure, or water intrudes, and they flow intermittently controlled by "stop cocking" and by gas lift as pictured in Figure 9. Later when the pressure is so low that they will not flow at all, pumping equipment is used.

(The operator flows his well by keeping his casing pressure shut in so that his casing fills with gas. The gas pushes down on the oil in the casing; since the tubing has perforations in one joint, the oil fills the tubing. When the choke is opened, the oil flows. When the pressure on a flowing well begins to weaken, a small
Fig. 8. -- Flowing well equipment.
Fig. 9. -- Artificial lifting by gas lift.
diameter line may be used to connect the tubing and the casing head. If this line is allowed to remain open, the pressures equalize; and when the choke is opened, the well will usually flow for a while. If judgment is exercised in the flowing of a well, its life as a flowing well will be extended.

If a well is allowed to produce too rapidly, the pressure at the bottom of the well drops below the point at which gas begins to escape from solution. In that case some of the gas will escape from the oil and make its way to the well, leaving behind part of the oil in which it was dissolved.¹

When this happens, the ratio of gas to oil is increased until the gas is rapidly depleted.

... When the pressure at the bottom of the well becomes less than the weight of the well-full of oil diluted and "aerated" with gas, then the oil must be lifted out of the well by some other means. From that time on the well is "on the pump" and is a "pumper."²

The smaller wells, the wells around the margin of the field, and the wells in tight spots in the sand are likely to quit flowing first. Months or even years may elapse between the time the first and last wells in a field go on the pump. Sooner or later, however, practically all of them become pumpers.

The simplest form of pump is a working barrel with appropriate valves. The working barrel is screwed onto the bottom of the tubing. The valve mechanism inside the working barrel is

¹Ball, op. cit., pp. 140.
²Ibid., pp. 142-143.
actuated by a string of steel rods, called sucker rods screwed together length by length, after the fashion of casing or tubing. The up-and-down motion of the sucker rods opens and closes the valves and lifts the oil to the top of the hole.  

The rods are raised and lowered by walking beams and pump jacks. Power to operate these devices in Ector County comes from electric motors, gas engines, gasoline engines, and Diesel engines. Some operators have one large engine for central power and had rod lines running to pumping jacks at the locations. Others have individual units at each well. One operator in the Foster Field has an electric motor and pump jack at each location. One of these units is shown in Figure 10. The lease produces oil twenty-four hours per day by means of time clocks at each motor which start and stop it automatically for pumping the well three hours and resting it six. The time of pumping for the nine wells on this lease is staggered so that a uniform power load for minimum lifting per barrel is maintained.

Recently, hydraulic pumps and bottom-hole electric pumps have begun to be used in Ector County. Several operators have installed the Kobe, a hydraulic system, in the Foster and the North Cowden Fields. A Kobe unit

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3Ibid., p. 161.
Fig. 10. -- Artificial lifting by pump jack.
and tank battery of the North Cowden Field are shown in Figure 11-A and Figure 11-B. The hydraulic system employs a central power plant which drives a triplex pump. The triplex pump forces power oil along one-inch lines to the individual wells. Here it enters the power-oil string, 3/4-inch upset tubing, and goes to the bottom of the hole. At the bottom end of the string is a hydraulic pump. The force of the oil in the pump actuates a small engine which operates on the principle of a steam engine. The small engine is housed in a pump case and is connected to a pump which operates by a system of valves. The pump picks up oil from the bottom of the well together with a quantity of oil which escapes through ports in the hydraulic engine and returns it to the surface, and then it flows through flow lines to the tank battery. The oil for the power fuel is the crude petroleum which is being pumped from the wells after it has gone through a heater and a settling tank to remove water and some paraffin.

The production department for the different oil companies is responsible for the maintenance and upkeep of the lease property, such as wells, tank batteries, lines, and roads. The major companies keep crews, called "roustabouts," who do general lease work. Small
Fig. 11 (A). -- Artificial lifting by hydraulic methods.
Fig. 11 (B). -- Tank battery for Kobe unit.
companies and some major companies contract much of this work. The roustabouts work in groups, called "gangs," under the supervision of "head roustabouts," "gang pushers," and "lead-off men." For companies that operate their own well-pulling units (removal of sucker rods or tubing and rods when wells do not pump satisfactorily in order to change pumps, replace broken rods, parted rods, or leaking tubing), there is a gang for this work under the supervision of a unit operator. The connection, or "bull" gang, does practically any kind of work required from cutting and threading pipe and "connecting up" tank batteries, wells, gas and oil lines to mowing the lawns in the companies' camps.

Wells are not produced at the maximum rate. The Railroad Commission of Texas has worked out for each field a maximum effective rate of production. This has been done so that each field may be given a reasonable amount of oil which it may produce each month. This "allowable" or rate of production is based on what it can produce without harming future production and what is needed by pipe-line companies and refineries. One of the most important factors concerning the maximum effective rate of production is the gas-oil ratio.

The number of cubic feet of gas produced with each barrel of oil is known as the gas-oil ratio and the constant effort of the production staff is to keep the gas-oil ratio as low as
possible. A high gas-oil ratio means that full use is not being made of the explosive force of the gas, that the gas pressure will be prematurely depleted, and that ultimate recovery of oil will be less than should have been.

The proper gas-oil ratio is different in every field, and may be different for every well in the same field. It can only be determined by study of and experimentation with each individual well. The outstanding fact is that in at least nine cases out of ten, during the flush production stage, the proper gas-oil ratio will not be attained by producing the well to capacity. A flush well flowed wide open nearly always has a high gas-oil ratio, which means that it is depleting the explosive force on which its maximum ultimate production depends.

The ideal gas-oil ratio is the proportion of gas that is dissolved in the oil at the reservoir pressure. If a sample of oil is taken at the bottom of the well at the reservoir pressure, and if when brought to the surface and reduced to atmospheric pressure the amount of gas that escapes from it is equivalent to six hundred cubic feet for each barrel of the oil, then 600 is the ideal gas-oil ratio, which means that under ideal operating conditions the well would be allowed to produce only six hundred cubic feet of gas for each barrel of oil.\(^4\)

The Railroad Commission sets a maximum gas-oil ratio for each field, and each well is tested frequently. When the ratio exceeds the maximum for the field, the well is penalized on its allowable. This lower allowable stays in effect until work has been done to cut off the waste. This may be done by packing off, by cementing, or by using plastics on the gas zone above the oil.

In its program of proration the Railroad Commission

\(^4\)Ball, op. cit., p. 145.
takes into consideration factors other than gas-oil ratio to arrive at field allowables. One of these is well spacing. In the TXL Field forty-acre spacing is used. Acreage drained plays a large part in bringing regulatory bodies into the oil business. Before there was a Commission to control and conserve oil and gas production, producers in fields voluntarily prorated (produced a stipulated proportion of what the well was capable of producing) their fields and individual wells. However, if one operator flowed a well at capacity, the reservoir gas and oil moved in the direction of the well from all directions because of the pressure drop and consequently drained oil from other operators' leases.

Another factor used in prorating is based on the reservoir or bottom-hole pressure. This is necessary in order to protect edge wells. Cloud in Petroleum Production says:

When the ideal method of prorating has been perfected it will be one that will control the drilling of additional wells, and thus eliminate rapid off-setting; provide for the drilling of wells only when the law of supply and demand warrants it; protect all edge wells from forced or premature suspension; and permit a maintenance of production from the entire field as well as from the various tracts in the field at a specified quota or percentage based upon acreage reserves as well as upon an average potential production --
all of which should change materially our present practices of drilling and development, and thus assist the industry in establishing itself upon a different economic basis.\(^5\)

\(^5\)Wilbur F. Cloud, Petroleum Production, p. 71.
CHAPTER VII

PIPE LINING THE OIL

Each lease has its local storage facilities, but this storage is equal to only two or three days' allowable. For example, Texon Oil and Land Company's Midland National Bank Lease in the North Cowden Field has a daily allowable of 665 barrels from the six wells on this lease. The Railroad Commission has ordered twenty producing days for the month of May, 1947, making a total of 13,300 barrels to be produced. The lease has a tank battery of eight 250-barrel storage tanks. The oil must be produced at a steady rate since Cities Service Gasoline Plant takes the residue (gas not dissolved in the oil) from this lease and must have it uniformly to prevent waste. In order to produce 13,300 barrels from this lease with only two thousand barrels of storage room, it is necessary for the pipe-line company buying the oil to keep it moving from the battery at a steady rate.

The storage tanks on this lease and on practically all leases in the county are connected to a pipe-line
company's lines. All tanks are measured so that the
capacity per vertical inch is known. An employee of the
pipe-line company, called a "gauger," works on a schedule
whereby he can keep oil moving from a lease at a rate
to pipe-line the lease allowable by the end of the month.
When the gauger comes to the tank battery, he gauges,
or measures, the full tanks of oil, thieves (takes sample
with thief) them for bottom conditions, centrifuges
samples for basic sediment and water, and takes the
gravity and temperature of the oil. If the basic sedi-
ment in the bottom of the tank is at a level of more
than four inches below the pipe-line connection and the
basic sediment and water still included in the oil is
not more than one per cent, the gauger turns the oil
into the line. After the oil has been pumped into the
pipe-lines' gathering system, the gauger returns to the
battery and measures the depth of the oil remaining in
the tank. The production company's representative, the
lease pumper, witnesses the gauging.

The gathering system brings the oil from various
lease tanks into large storage tanks of about 55,000-
barrel capacity.

Humble, Shell, and Gulf are the principal pipe-line
companies in Ector Company. From their gathering systems'
tanks, the Ector County oil moves in various ways.

The Shell Pipe Line Corporation sends oil from the eighty-two batteries in the Goldsmith Field, the Devonian and Ellenburger production from the TXL Field, and some from the Harper Field through a six-inch line to a large tank farm at McCamey. One half of the oil from McCamey goes through a ten-inch line to Houston; the other half goes to Cushing, Oklahoma, through two ten-inch lines.

Shell Pipe Line gathers all of the oil from the 154 wells on 67 leases in TXL and the 35 wells on 17 leases in Wheeler. Because of numerous cases of segregated production from two different zones in a single well, or from adjacent wells on a single lease, there are connections to 77 and 26 lease-tank batteries in the two fields respectively. The Company has two separate and complete gathering systems, with 50 miles of pipe in TXL and 21 miles in Wheeler.

At present the deepest and sweetest production, the Ellenburger crude, is gathered in one system, and the relatively small amounts of Clear Fork and Silurian crudes are gathered with the semisweet Devonian in the other system. The Ellenburger crude is delivered in batches through Shell trunk lines via McCamey and Cushing to Shell Oil at Wood River Refinery, and from the field station to Atlantic and Magnolia pipe lines which pass south of it enroute to the Beaumont-Port Arthur area. The Devonian crude is batched through Shell Pipe Line via Monahans and Abell Junction to the Texas-New Mexico Pipe Line's station at Crane whence it is moved by that carrier via Houston to Sour Lake, thence by Empire Pipe Line to Lake Charles, Louisiana.

Shell's Wheeler Station, capable of delivering 28,000 barrels daily at 400 pounds pressure and now being enlarged, differs from Shell's other
larger pump stations by having reciprocating pumps driven by multi-cylinder gas engines. The natural gas fuel is obtained from a well near the station. All gathering system lines, including a lateral line from Bedford field (located 18 miles north), converge at Wheeler Station which is just south of Wheeler field at an elevation low enough to permit most of the gathered oil to gravitate into the station tanks. Wheeler Station is not required to pump out all the gathered Devonian crude as it usually will gravitate 16 miles to Monahans Station enroute to Crane.¹

The Humble Pipe Line Company's Ector Station located in the North Cowden Field has a gathering system which includes the North Cowden, North Cowden Deep, Foster, Harper, South Cowden, Johnson, and the Penwell Fields of Ector County. Humble is constructing a six-inch pipe line to take TXL production from the north end of the TXL Field beginning June 1, 1947. The oil from the leases in the above mentioned fields is pumped into three storage tanks, two 55,000-barrel and one 64,000-barrel, at the North Cowden Ector Station. From the storage tanks it is pumped out into three eight-inch lines to the Humble Judkins Station in southern Ector County. The pumps in the North Cowden Ector Station have a total of 1,350 horsepower and total thirteen pumps in number, ranging from sixty-five horsepower to two with

¹"Shell Pipe Line Plays Important Part in TXL and Wheeler Fields in West Texas," The Go-Devil, VI (January, 1947), 4-5.
250 horsepower each. The pumps are powered by six gas engines and seven Diesel engines. Goldsmith- Ellenburger crude is used for fuel in the Diesel engines. The pumps vary in capacity from 142 barrels per hour for Pump Number 1 to 385 barrels an hour for Pump Number 7. Oil is being pumped into the station daily and is being pumped out daily. On May 23, 1947, 36,700.97 barrels were pumped out and 37,683.52 barrels were received at the North Cowden Ector Station. This station handled oil from Andrews County along with Ector County oil. North Cowden Ector Station receives 750,000 barrels of oil per month from the North Cowden Field.

Oil is pumped from the North Cowden Ector Station to Judkins, the next station along the line. From Judkins the bulk of it goes to the Humble Refinery at Baytown near Houston and the Humble Refinery at Aransas Pass. Excess oil, or amounts that are too great to be used by these refineries, is sold to the Atlantic Pipe Line Station or the Magnolia Pipe Line at Midland. Oil going to the Humble refineries goes via three eight-inch lines from Judkins to Crane, to McCamey, to Big Lake. At Big Lake the oil is split (divided), with part of the oil going by Comine Station and the other going by San Angelo Station to Baytown, near Houston, and to
Aransas Pass. However, part of Humble's crude oil is sold and exported from Aransas Pass to Europe. France and England are the principal buyers.

Pipe-line leaks in the gathering system are located by line walkers (men whose job it is to walk along pipe lines and locate leaks), but the longer lines are checked by plane. Low-flying planes of the Piper Cub, or reconnaissance type, are used. The line from Houston to Judkins to North Cowden Ector Station on to the Means Field in Andrews County is checked weekly by plane.

Another of the colorful figures of the oil industry, the pipe line walker, has given way to modern science. The thousands of miles of line which he and his fellows patrolled on foot, on horseback, or in a stripped down car, are now being covered quickly, efficiently, and more often by pilot-inspectors in light airplanes.

Flying pipe lines is not brand new to the oil industry, nor to Humble Pipe Line Company, but it was only recently that Humble completed arrangements to fly its entire main line system. It all began as an experimental venture about 18 months ago when a contract was signed with a retired Pipe Line Company employee to patrol the Southwest Texas division lines by plane. When the experiment proved highly successful, plans were made to handle the entire system by air. Four light planes were ordered and pilots were engaged who were both expert fliers and experienced pipe line operations men.

The Southwest Texas division is still being flown on contract basis; the other four divisions are patrolled in Pipe Line ships by Company pilot-inspectors. Between the five planes, some 3600 miles of main line right-of-way are flown at least once a week. Pilot-inspectors fly a little to the side of the right-of-way, look out of
the windows of their ships from levels between 100 and 500 feet, and watch for tell-tale oil spots indicating leaks and for other irregularities that may require the attention of repair crews.

Pilot-inspectors keep before them aerial patrol report forms. When they find trouble on the line, they fill in the form, giving full information on the location and nature of the trouble, place it in a metal container, attach this to a small sandbag, and drop it at the nearest pump station. Pilot-inspectors circle the station until they see that the message has been picked up, and then go on their way secure in the knowledge that a repair crew will soon be on its way to remedy the trouble.

On the basis of experience to date, aerial patrol of the pipe line system has proved far more satisfactory and considerably more economical than the old system of walking or riding.¹

During May, 1947, large numeral signs were erected along Humble Pipe Lines in Ector County in order that the pilot-inspectors may report leaks between certain numbers.

CHAPTER VIII

OIL AND GAS USED IN ECTOR COUNTY

Not all oil and gas leaves Ector County, as there are four national gasoline plants and the largest carbon black plant in the world located here. These are Cities Service Gasoline Plant in the North Cowden Field, the Phillips Plant in Goldsmith and Harper Fields, the Odessa Gasoline Company plant near Odessa, and the United Carbon Black Plant near Judkins.

Gas moves oil in the reservoir beneath the earth's surface; it raises the oil through the tubing and is separated from the oil in the oil and gas separator, but its usefulness is not ended. Lines from the separator are tied into gas-gathering systems which take the gas to natural gasoline plants. Here the gas is either compressed and cooled until it drops its liquid fractions, or it is passed through absorbers, charcoal or oil, where the liquid fractions are absorbed.

The natural gas is described as "wet" or "dry." Wet gas contains liquids such as gasoline, propane, butane, and others; and the dry gas has little, if any, of the liquids present.
Part of the "dry gas" from which the liquid fractions have been recovered may be used as fuel for the operation of gasoline plants, and heating, or may be pumped back into the wells in repressurizing or gas-drive or gas-lift operations. The remainder, which too often is much the larger part, is sold if there is a market for it; otherwise it is wasted into the air. The burning "flares" that make some oil fields so spectacular at night represent dry gas for which there is no immediate local market and are a sad sight when you know what they mean. The gas of one such flare would heat a good-sized office building in a cold climate.¹

Unlike most problems which confront the petroleum industry, the subject of casinghead gas can never be ignored. The countless brilliant gas flares brightening the night and the rear of separator and gasoline plant vent lines create more general public interest in the ultimate use of casinghead gas than could be kindled by volumes of precisely prepared and widely publicized statistics.

Demands for the more efficient utilization and conservation of casinghead gas are natural results of this interest. This in turn has created a major educational problem for the petroleum industry. As always, the various state and federal agencies must be kept fully informed concerning the production of casinghead gas and its current and projected disposition. In addition, a continuous program must be conducted to insure that operators and royalty owners, who normally seek a quick return on their oil investments, are fully aware of the benefits to be obtained from conserving casinghead gas and the methods by which this may be effected.

A popular misconception holds casinghead gas to be synonymous with "natural gas," a broad term which covers all gaseous hydrocarbons produced by the earth. This lack of definition has sometimes tended to confuse issues under discussion. In a strict interpretation "casinghead gas" must be considered as that gas, which because of temperature and pressure conditions existing in the oil and gas reservoir is dissolved in the oil. Thus, originally, casinghead gas (dissolved gas) is a form of petroleum. As the oil is brought

¹Ball, op. cit., pp. 155-156.
to the surface, gas which contains the lighter vaporizable hydrocarbons is permitted to separate from the liquid and become a separate entity.

Also present in many oil reservoirs is associated (gas cap) gas. When both dissolved and associated gases are produced with the oil, each gas loses its identity in the thorough mixture which results. At the surface the oil and the gas are separated, and it has become common practice to classify as "casinghead" all gas obtained coincident with the production of oil. By its very nature casinghead gas is thus coupled to the oil industry, for casinghead gas cannot be obtained without the simultaneous production of oil and in only rare instances can oil be produced without entailing the production of some casinghead gas.2

The Railroad Commission has closed one field in Texas and has had hearings concerning the flaring of gas in other fields including the Goldsmith and the North Gwden. In Ector County much has been done and much remains to be done in line with the conservation of gas.

The Texas Railroad Commission this week concluded hearings at which operators in 15 fields throughout the state were directed to show cause why those fields should not be shut in until gas now being flared is diverted to legal use. During the series of hearings, Commission Chairman E. O. Thompson issued a statement in which he stated that the purpose of the "show-cause" hearing was to expedite the working out of a gas-saving plan for each field concerned on a fair, reasonable, and economically feasible basis.

The commission's purpose, he stated, was not to punish any operators but to spur action on projects designed to utilize waste gas in the state.

West Texas operators reported considerable progress in utilizing sour casinghead gas and look for complete elimination of waste in the near future where gas utilization is economically possible. In North Cowden the sole gasoline plant is being expanded to a capacity of 40,000,000 cu. ft. daily which will take care of gas now being flared. Further cooperation of producers with natural-gasoline plant operators in leveling off daily flow schedules was recommended to allow full utilization of gas now produced in the field.

More uniform flow schedules, workovers, and transfer of allowable to low gas-oil ratio wells has accounted for reduction of gas flared in Goldsmith from 38.5 per cent a year ago to less than 19 per cent now.3

The Cities Service Gasoline Plant, which gathers the gas from 540 wells in the North Cowden Field, has a capacity of 60 MCF (thousand cubic feet) of gas per day but plans to expand to 40,000 MCF per day. In the meantime this plant is working with operators in flowing schedules so that a minimum of gas will be wasted. Dry or residue gas from this plant is piped to West Texas Gas Company's lines, to the de-sulphurizing plant adjacent to its own plant, and thence to the Carbon Black Plant near Judkins in Ector County.

The Phillips Plant near Goldsmith handles between 45 MCF and 55 MCF of gas from 936 wells per day at present, but plans for expansion have been approved. At the Phillips Goldsmith Plant a storage tank for

gasoline receives the gasoline from the Phillips Plant at Crane and Judkine, the Cities Service-North Gowden, and the Phillips Goldsmith Plant. It is pumped from this 40,000-gallon storage tank to Borger, Texas, through a New Mexico-Texas six-inch line. The refinery at Borger blends this casinghead gasoline into the finished product. The Phillips Goldsmith Plant sends a volume of 30 MCF to 40 MCF daily to the carbon black plant after de-sulphurization has been completed in a carbon black unit built at the gasoline plant.

The Barnsdall Oil Company Gasoline Plant near Odessa is now the Odessa Gasoline Company; it is a small plant with a capacity of 14 MCF daily and serves the 515 wells in the Foster and South Gowden Fields.

The TXL Field is the site for the largest gasoline plant to be erected in Ector County.

Midway between Odessa and Kermit on the treeless plains of the Permian Basin is an infant town that should have a long and lusty life. Located in the heart of the TXL oil fields in West Texas, the "mesquite-framed" village of Netreex is the site for Shell's newest Gasoline Plant. The Gasoline Plant which the Company began constructing last December is a good story in its own right. Yet it really is but a part of the story, for Shell activities range far and wide in the development of the whole TXL district, a district which seems destined to become a major oil reserve.

In the two years following the TXL discovery well, a total of 160 producing wells have been drilled by operating companies having acreage in
the area. Shell operates 58 of the wells which are spread over a territory of about 27 square miles. The area that today measures nine miles by three miles is growing rapidly, however. Eastern and western limits of the field have been fairly well defined but the field is gradually reaching out to both north and south.

Actually located about a mile east of Mo-ntrees, Shell's new plant is designed to handle between thirty and forty million cubic feet of gas every day. When completed late this year, it will process gas gathered from both TXL and nearby Wheeler Field. Over eleven miles of piping make up the three main gathering lines connecting the fields to the plant.

Propane, butane, and 26# RVP (Reid Vapor Pressure) gasoline will be extracted from the gathered crude gas by use of eight 800 horsepower gas engine compressors and three 800 horsepower gas engine driven generators, together with the necessary boilers, distillation and fractionation equipment. Storage facilities will be adequate for 27,000 barrels of manufactured products. After being stripped of these liquid products, the residue gas will be sold to the El Paso Natural Gas Company.4

The world's largest carbon black plant, located eight miles west of Odessa, was built in 1944 to meet the urgent demand of the synthetic rubber industry for channel carbon black for strengthening man-made rubber. Two of the three proposed units have been completed at a cost of approximately $6,000,000. A gas gathering system of forty-six miles of pipe line brings sour gas to the carbon black plant. At each source of gas a "treater" plant has been installed to remove impurities before the

4"TXL in the Heart of This Two-year-old Oil Field Shell Is Constructing Its Newest Gasoline Plant," Shell News, XV (March, 1947), 22-23.
gas is piped to the plant.

Carbon black is produced by two methods: the channel process, and the furnace process. The relative merits of the processes are of importance to gas producers.

Commission Chairman Olin Culberson is particularly interested in the relative merits of channel as compared with furnace type plants. His information indicates that recovery from channel plants is from one to two pounds of black per thousand cubic feet of gas, whereas furnace plants obtain 10 to 14 pounds from the same volume. Representatives of the B. F. Goodrich and Seiberling companies, however, testified at a recent hearing in Amarillo that furnace black is 35 per cent less efficient than channel black for tire making purposes.5

The carbon black from this (Odessa) plant is produced by the channel process in which gas is burned in a limited supply of air to produce small smoky flames which impinge on the slowly moving iron channels. These in turn, pass over fixed scrapers placed in stationary hoppers six feet apart. The black is scraped off and falls into the bottom of each hopper where a moving screw conveys it from the burner houses to a central conveying system leading to a packing house. There it is freed from hard calcined particles, mixed with water and then agitated to form tiny pellets, in which form it is shipped to rubber plants.6

United Carbon Black Company, Incorporated, Unit "A," has a capacity of 26,824 MCF per day and is supplied from the North Covden Field.

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5"Carbon Black Situation in Texas to Be Surveyed by Rail Commission," The Oil Weekly, XXXIV (December 2, 1946), 14.

Unit "B" has a capacity of 46,500 MCF per day and is supplied from the Goldsmith Field.\footnote{"Oil and Gas Production Date of the Permian Basin," unpublished bulletin, North Basin Pools Engineering Committee, Midland, Texas, August 1, 1946, p. 9.}
CHAPTER IX

RESERVES

Geologists have been able to write the history of coal with almost as much accuracy as if they had witnessed its formation; for coal, being a solid, has stayed fast in its beds. They are able to estimate the reserves of coal underground; but petroleum, having moved from its source, affords no such simple task.¹

Each year the American Petroleum Institute in an annual report makes an estimate of the oil reserves in the United States.

Proved reserves are both drilled and undrilled, the report says. The proved drilled reserves, in any pool, include the oil estimated to be recoverable by the production systems now in operation, whether primary or secondary, and from the area actually drilled up on the spacing pattern in vogue in that pool. The proved undrilled reserves, in any pool, include reserves under undrilled spacing units which are so close, and so related, to the drilled units that there is every reasonable probability that they will produce when drilled.

In the case of new discoveries, which are seldom fully developed in the first year and in fact for several years thereafter, the estimates of proved reserves necessarily represent but a part of the reserves which may ultimately be assigned to the new reservoirs discovered each year. For a one-well field, where development has not yet gone beyond the discovery well, the area assigned as proved is usually small in regions

¹American Petroleum Institute, Oil, 1940 ed., p. 15.
of complex geological conditions, but may be larger where the geology is relatively simple. In a sparsely drilled field the area between wells is only considered to be proved if the information regarding the geology of the field and the productive horizon is adequate to assure that such areas will produce when drilled. The total of new oil through discoveries estimated as proved in any given year is comparatively small and the total of new oil through extensions is comparatively large. As knowledge of the factors affecting production and well performance become available, and as these factors are studied, reserves in older fields can be estimated with greater precision and revised accordingly. Therefore, the oil assigned to new discoveries, plus the oil proved through extensions, comprises the total quantity of new proved reserves for the year.2

Estimated proved petroleum reserves in the U. S. were increased again as usual in 1946 and stood at a new all time high of 21,287,673,000 barrels as of January 1, 1947, according to data compiled by The Oil Weekly.

Although production in 1946 was the greatest ever recorded, it was more than compensated by the proving up of new reserves. The net increase in reserves for 1946 was 460,860,000 barrels, since the total at the beginning of the year had been 20,826,813,000 barrels, as estimated by the American Petroleum Institute.

While reserves have been maintained in recent years at levels about 12 times the annual production, experience has indicated that the reserves have been close to minimum requirements to supply needed production without waste. Viewed from this angle, a less tight reserve position would be desirable. The prewar ratio of reserves about 14 to 14.5 times annual production would be nearer normal and perhaps satisfactory. But the regaining of that position would require material stepping up of annual provings of new reserves above the rates of recent years. And such increase of provings would have to be achieved in

2"API Makes Reserves Estimates," The Oil Weekly, CXXI (March 4, 1946), 11-12.
the face of the fact that exploratory drilling has
been exceptionally heavy in each of the past sev-
eral years. Consequently, a very intensive ex-
ploratory effort appears necessary for the next
several years, along with fairly full and prompt
development of new fields as they are found. 3

The West Texas proved reserves of January 1, 1946,
as estimated by The Oil Weekly, totaled 2,757,476,000
barrels and new reserves proved in 1946 totaled 346,342,000
barrels. The amount of oil produced in 1946 totaled
190,536,000 barrels, which leaves a net change in re-
erves for January 1, 1947, of 155,806,000 barrels. A
picture of the size of these reserves may be gained
from the following statement:

. . . The Permian Basin, where hundreds of oil
companies are tapping proven reserves almost
three times as large as the combined known un-
derground stores in all the states east of the
Mississippi . . . 4

In 1944 it was estimated that the supply of oil and
gas then known in Texas would last from twenty-five to
forty years. Since that date new reserves have been
discovered. In the EKL Field, which in 1945 was rated
as the most important discovery of the year in West
Texas, the Devonian yield per acre has been given an
arbitrary minimum of one hundred barrels of oil per

3 "U. S. Crude Reserves Reach All-time Peak," The Oil
Weekly, XXXIV (February 10, 1947), 139, 143.

4 "Hub of the Permian Basin," Shell News, XV (Janu-
ary, 1947), 8.
acre-foot; and the Ellenburger pay anticipated 20,000 barrels per acre recovery.

There is conflicting opinion as to how long the oil industry will hold its place of importance in Ector County. However, a large number of men engaged in the industry think that fields in the Permian formations, such as the North Cowden, South Cowden, Foster, and Johnson, will last several years longer than the Harper and the Pembell. These last fields have been producing for approximately twenty years. The Goldsmith Field is an exception as it is structurally located on a gas cap, and the general opinion is that it will last for only about twenty years longer. The deep pays in the TXL Field should last for thirty years. The future of Ector County depends chiefly upon its deep-drilling campaign, which is still "in full swing" with new extensions and discoveries being made regularly, and upon secondary recovery from all fields when the present flush supply is exhausted. It is to be expected that by the time the fields of Ector County are ready for secondary recovery, methods now being used will be improved to such an extent that the ultimate recovery will extend the life of the fields for a great many years.
CHAPTER X

SUMMARY AND CONCLUSIONS

Summary
This study has reviewed the petroleum industry in general and in Ector County, Texas, in particular with much of the information being received from pupils and patrons of the Goldsmith School. In correlation of the facts furnished by pupils, through interviews with parents, and field trips in connection with this problem, the writer made an evaluation of the community as a teaching aid within the curriculum. It was found beneficial in that the unit stimulated interest among the pupils, developed appreciation and desirable attitudes, and led to initiative and creative thinking, together with the development of increased anticipation and participation. In short, the unit resulted in a broader scope of learning.

Conclusions
This study shows that:
First, this subject provided children with concrete worth-while life experiences.
Second, by the community's being used as a teaching aid, the children were further helped to develop desirable attitudes and stimulated to further learning of valuable knowledge that tends to enrich and enlighten life.

Third, guidance in understanding their environment deepened the children's enjoyment and appreciation, thus sharpening their powers of observation and enriching their daily lives.

Fourth, it increased the meaningfulness of language to communicate ideas by encouragement of verbal expression of familiar facts and objects.

Fifth, children taught in this unit in ensuing years could extend their knowledge of this year. Class field trips could be taken to an advantage. The problem showed that content of subject matter could become more comprehensive on each grade level and could be adaptable for children on different maturation levels.

Sixth, this compiled information will save much time for teachers. It seems that many are becoming aware of the responsibility and importance of the industry.

Seventh, by this information the writer hopes to encourage teachers who are seriously interested in improving their teaching technique in such a way as will
lead to the meaningful growth and development of the children, through an understanding, by both teachers and pupils, of the advantages of unique aids in the community for learning.

Eighth, such a study directed in any community where oil is an enterprise of any economic value will result in greater teaching efficiency and accomplishments. By utilizing their own situation, teachers will be able to formulate needed methods.
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North Cowden, Star Route, Odessa, Texas.

Benefield, M. J., Manager of the Odessa Chamber of Com-
merce, Odessa, Texas.

Burton, F. W., Gauger, Humble Pipe Line Company, Star
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Crane, Ernest, Head Stock Gauger, Humble Pipe Line, Ector
Station, North Cowden, Star Route, Odessa, Texas.

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Kennerley, K. S., District Engineer, West Texas District, Gulf Oil Corporation, Goldsmith, Texas.

Miller, Harry, District Superintendent, West Texas, Continental Oil Company, Box 511, Big Spring, Texas.

Miller, J. A., Tool Pusher, Gulf Oil Corporation, Goldsmith, Texas.

Pollard, F. W., Gauger, Shell Oil Company, TXL Field, Goldsmith, Texas.

Ray, E. K., Pumper, Texon Oil and Land Company Midland National Bank Lease, North Cowden Field, Continental Oil Company, Star Route, Odessa, Texas.

Saum, Harold, Clerk, Stanolind Oil Company, Star Route, Odessa, Texas.


Shaw, Frank, District Clerk, Production and Drilling Department, Continental Oil Company, Star Route, Odessa, Texas.

Sherrill, J. W., Engineer Gauger, Gulf Pipe Line Gathering System, Goldsmith, Texas.

Smith, Harvey A., Farm Boss, Continental Oil Company, Star Route, Odessa, Texas.

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