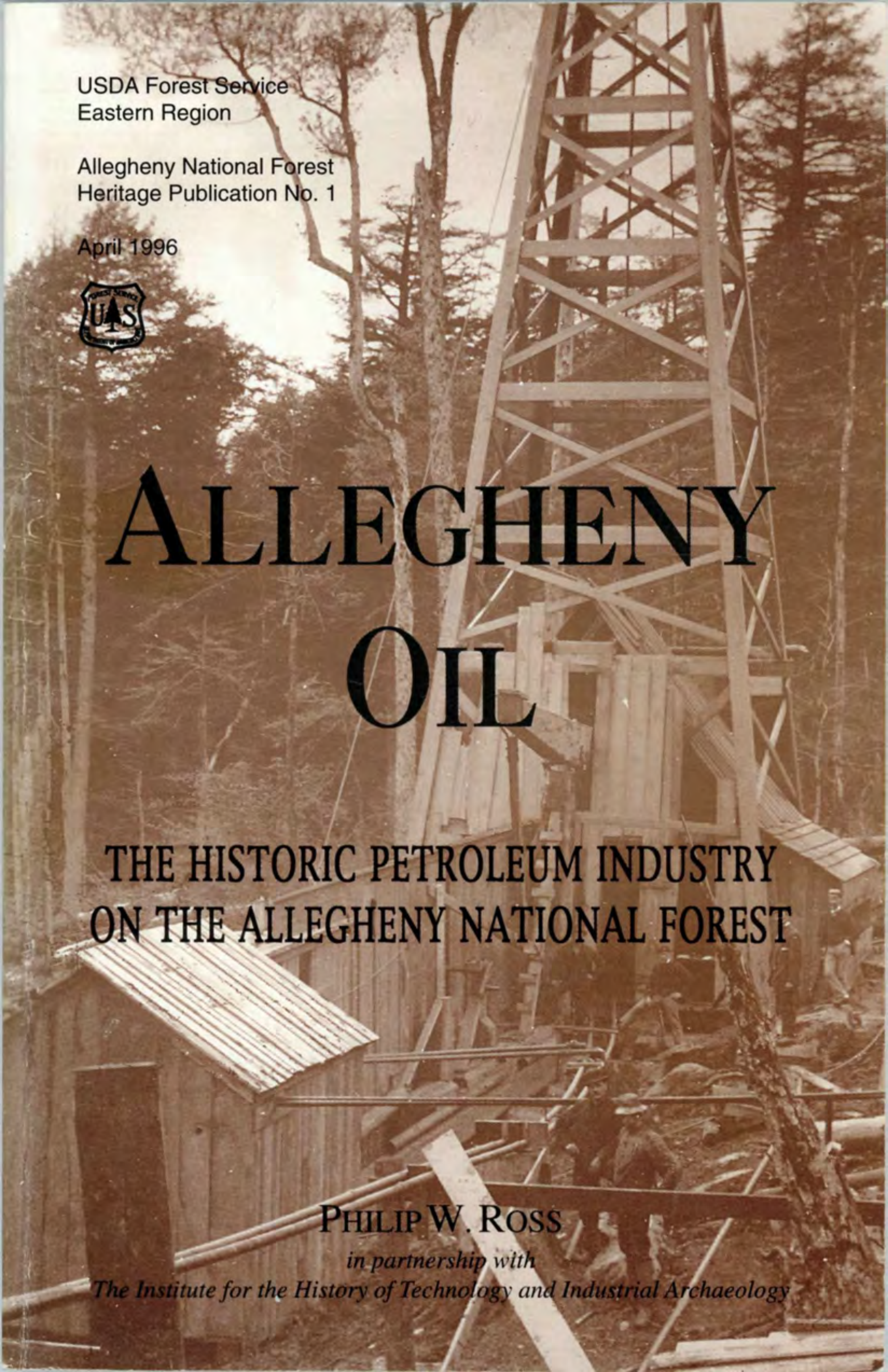

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ALLEGHENY OIL

THE HISTORIC PETROLEUM INDUSTRY ON THE ALLEGHENY NATIONAL FOREST

PHILIP W. ROSS

in partnership with

The Institute for the History of Technology and Industrial Archaeology

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Cover Illustration: The Anchor Oil Company's first well on Lot 647, Cherry Grove, June 1882. It became known as the "Burning Well" after it caught fire and burned spectacularly for ten days – while gushing oil at a rate of 2,000 barrels a day. *Photo courtesy Drake Well Museum*

Back Cover: Forest industrial sculpture. Visitors to the forest encounter constant reminders of the area's petroleum heritage. *USDA Forest Service*

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Allegheny Oil

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Preface

The Allegheny National Forest (ANF) is located in northwestern Pennsylvania, and encompasses some 513,000 acres of Warren, McKean, Elk, and Forest Counties. The modern petroleum industry had its birth just west of this region at Titusville with the drilling of the legendary Drake Well in 1859. Subsequently, the region now encompassed by the boundaries of the ANF was proven to contain numerous oil and gas fields, many of which are still producing today. One hundred and thirty years of petroleum production have left a considerable amount of material culture scattered throughout the region, artifacts which have heretofore attracted little attention from the historical community. This is somewhat surprising given the level of interest in oil folklore and history in the Oil Region today.

In the Fall of 1993 the Institute for the History of Technology and Industrial Archaeology at West Virginia University entered into a cooperative agreement with the Allegheny National Forest to evaluate the historical significance of the petroleum industry within the forest boundaries. Much of the material culture left behind by the industry consists of the components of "central power" pumping systems in various stages of deterioration, mostly dating to the early part of this century. Since these artifacts have now entered into the realm of "cultural resources," it has become incumbent upon the resource managers of the Allegheny National Forest to judge what among this scattered collection of machinery is historically significant and thus might require preservation of some sort. Such an evaluation would allow the ANF to focus its efforts in preservation and documentation on those sites which most deserve such treatment.

The following monograph includes both a narrative contextual history of the subregional petroleum industry and a detailed technological history of the development of the central power system, a process that enabled the continued local production of oil on a rational economic basis—thereby consolidating and stabilizing a regional processing and refining industry. As the remains of central power systems are so prevalent in the ANF—and since so little work has been done on their history—this report takes a detailed look at the development of the various components of central power systems. The history of each major type of equipment found on the ANF is discussed and placed within its context in the regional and national petroleum industry.

We wish to thank all those persons who contributed their time and expertise to this project. Dr. Emory Kemp, Director of the Institute for the History of Technology and Industrial Archaeology, was instrumental in his support for this research. Billy Joe Peyton kept the scope of work under control and on some approximation of its schedule. At the Allegheny National Forest, Rick Kandare gave unselfishly of his time, even to the point of working on Saturday of his Memorial Day weekend holiday. Thus thanks are also due to his wife Pam and son Cody. Janeal Hedman of the Information Resources Team at ANF has patiently shepherded this monograph through its lengthy transformation from a simple project report into a real book. It is safe to say that it would have remained "gray literature" without her encouragement. We also appreciate the assistance and encouragement of Heather Harvey, Ecosystems Management Team Leader; Linda Houston, geologist; Kathe Frank of the Information Resources Team; and Robert Scott and Jack McLaughlin, district archeologists. Thanks also to Edith Serkownek, Chase Putnam, and Derek McKown at the Warren County Historical Society; Barbara Zolli and David Weber at the Drake Well Museum, Titusville, Pa.; Paul Harvey and Mike Fuoco, Coolspring Power Museum, Brookville, Pa.; Jim Bryner, Penn-Brad Oil Museum, Custer City, Pa.; and Chester Bills, engine and literature collector, St. Marys, W.Va. We apologize for any omissions as an oversight.

Michael Caplinger

Philip W. Ross

Introduction

When Edwin Drake's well tapped a stray oil sand on Oil Creek near Titusville, Pennsylvania, in August 1859, his discovery prompted scores of would-be oil men to seek land likely to produce the liquid mineral. In the following months dozens of wells were drilled, dug, and kicked down over a wide area from western New York to western Virginia and southeastern Ohio. The ensuing exploitation of the Oil Creek region is now legendary in American history and quickly gave birth to what remains one of the most important global industries. Titusville and nearby Oil City soon became established centers of commerce and industry.

About seventy miles to the east of Titusville was the lumbering and dairying village of Bradford, population four hundred, nestled in the valley of Tunungwant Creek in McKean County. News of the Drake well had also reached Bradford, and in 1862 promoters drilled a well to a depth of two hundred feet near the east end of town. It was a dry hole, and ten years passed before drillers again took interest in the Bradford area. In 1871, wildcatter Job Moses struck a ten-barrel-a-day well at a depth of 1,110 feet, the oil emerging from a dark gray, almost black sandstone. More wells followed. The oil was of unusually good quality, and though their wells did not flow as heavily as ones in the booming Clarion-Butler area to the southwest, the Bradford drillers soon noticed that they produced steadily, declined more slowly than most, and unlike other oil-producing areas magically rewarded almost every drilling effort with a paying well. The Bradford field soon became known as the nearest thing to a sure bet in the industry, and by the late 1870s and early 1880s supplied nearly ninety percent of the world's demand for oil. The Bradford Third Sand field, at 84,000 acres, has proven to be the largest continuous reservoir of petroleum in the Appalachian Basin oil field. The industry born on Oil Creek came to its adolescence at Bradford.[1]

Oil Creek and Bradford during their boom eras serve here as parentheses for a four-county area spanning the distance between the two fields. Large portions

[1] Charles E. Fettke, *The Bradford Oil Field, Pennsylvania and New York*, Bulletin M21 (Harrisburg: Topographic and Geologic Survey, 1938), 1; G.G. Bauer, "Early History of the Bradford Field," *Producers' Monthly* (November 1946): 16-17.

Manipulative speculators who had also bought heavily waited for the trend to catch; they then sold their shares short and reaped the harvest as prices tumbled.[63]

As a result of such experiences, producer-investors began to notice two disquieting trends. One was that "wildcat" wells in areas of unproven production could affect the market adversely; if a well promised to open new territory, the potential new field would add to the stocks (excess inventory already above ground but unrefined), and tended to depress oil prices. The other trend was the emergence of the professional oil manipulator, who used rumor and uncertainty to affect the momentum and direction of the market.[64] One class of manipulator was comprised of some of the operators themselves. Their tool was the mystery well.

Mystery Wells and Oil Scouts

Petroleum exploration was in its infancy when the first operator declined to share information about his well. In the early days, this was for purely personal reasons; if a well in unproven territory—a "wildcat"—was successful, the lucky operator might succeed in leasing the surrounding area without competition. As previously noted, by the 1880s most big operators had become heavy investors in the speculative market. The earliest well where the link between speculation and mystification became apparent was the Van Scoy "Dew Drop" well, near the mouth of Kinzua Creek. In August 1880, the owners of the wildcat well alternately reported gas, then a show of oil, then salt water a few days later. Then they stopped giving information altogether. Meanwhile "pestiferous" rumors abounded in the exchange, wreaking havoc on the market.[65] Boyle notes the response:

> For their own protection, the leading interests in the trade adversely affected by rumors, employed trained men to watch the oil fields and report daily on conditions. These scouts foregathered for the first time at Kinzua and kept watch on its mystery of the Dew Drop; prominent among them were B.S. Tupper , Si [S.B.] Hughes, Jo. B. Cappeau, Jim Giles, Harry Beam, representing the oil trade; Frank H. Taylor, Tom E. Kern, J.C. McMullin and Pat Boyle, representing the press.[66]

Daniel Goettel, an "active" trader, had first conceived the need for a field

[63] *Petroleum Age* 1 (Nov. 1881) 19.

[64] Boyle, in *The Oil Scouts*, 10-11.

[65] *Derrick's Hand-Book* 1, 327, 331; Boyle, in *The Oil Scouts*, 11.

[66] Boyle, in *The Oil Scouts*, 10-12.

reporter to counter market-damaging rumors and had hired Silas B. Hughes as his scout. Other traders noted the innovation, and Hughes soon had several colleagues, placed there by brokers, producers, and other interested parties.Most of the scouts cooperated with each other and shared information. The job of the scout was to keep tabs on the new wells likely to be important to the trade, whether mysteries or not; to make accurate estimates of the total production of a field, and keep his principal well informed of developments. His reward was a salary of about $150 a month, plus a percentage of the profits made resulting from information he furnished. His expenses, including bribes, were furnished by his sponsor.[67]

The activities of this fraternity have passed into the regional lore. The oil scouts exemplified all of the manly qualities most prized in the business world of the late 1800s: pluck, nerve, ingenuity, resourcefulness, and bravery in the noble battle with the manifestation of economic evil: the manipulative speculator and his mystery well. Since the purposes of the mystery well were indeed less than ethical, the scouts used whatever means were necessary to obtain information about the "true inwardness" of the well. Property rights were blithely ignored. Some scouts simply sneaked under the derrick and obtained a sample of oil, or surreptitiously measured the depth of the well. Others resorted to bribery and burglary.[68] The overall effect may be likened to countering a card shark with marked cards.

The Van Scoy "Dew Drop" well was pronounced by the scouts to be a small well. That information, relayed to their principals in the exchanges, allowed their sponsors to profit by that news before it became general knowledge, as the market rose in response.[69] No account exists of those unfortunates who lost heavily for not being privy to such information.

Cherry Grove, 1882

At the beginning of this period, most of the land that lay between the Bradford and Venango-Butler developments was essentially wilderness. Tionesta Creek winds in a spiral around an elevated plateau known as the "Big Level" in Cherry Grove Township of Warren County. As it enters Forest County, it cuts a

[67] Whiteshot, 139; A.R. Crum, ed., *Romance of American Petroleum and Gas*, Vol. 1 (Oil City: Derrick Publishing Company, 1911), 104.

[68] Boyle, in *The Oil Scouts*, 10-12.

[69] *Ibid.* Though the discovery well was a small producer, it led the way to considerable drilling and activity in the immediate area. The Kinzua development peaked in 1885.

petroleum. Oils from the Bradford and Clarendon-Tiona formations were prized for their lubricating qualities and usually commanded a premium over lesser-grade crudes. The huge production from new fields in the Southwest was of comparatively inferior quality.

That the oil commanded higher prices was fortunate, because another characteristic of oil from the Appalachian Basin fields was notoriously non-sustainable production. Even wells with huge initial production quickly stopped flowing in the Pennsylvania fields and required pumping, and after several years produced only a few barrels, or often just a fraction of a barrel each day. The necessity of employing a pumper and dedicating hundreds of dollars of machinery to each well during the early boom era caused many wells to be abandoned shortly after they stopped flowing.[6] By the mid-1880s Pennsylvania operators devised several systems to pump groups of wells with a single power source, reducing both labor and equipment costs. The general introduction of gas engines around the turn of the century replaced steam engines for pumping purposes, and the standard configuration for pumping wells evolved into a gas-powered prime mover belted to a horizontally-rotating geared eccentric, which operated pumping jacks at each well by iron or steel rod lines that were connected to the eccentric. A well-engineered system employed the upstroke of one well to counterbalance the downstroke of another, and a carefully-designed, balanced central power could pump thirty or more wells with no more than a fifteen- or twenty-horsepower engine. The economic feasibility of such systems allowed wells that would otherwise have been abandoned to be pumped profitably for many years. The economy and reliability of these systems account for their prolonged use in the region—in scattered cases, even through the present era.[7] In most cases, though, gasoline or electric-powered unit pumpers have replaced the central powers.

Operators also sought to improve their volume of production through other means, practices generally known as secondary recovery. This involved restoring or replacing gas pressure in the producing sand to force the oil into the well. The earliest incidences of secondary recovery occurred accidentally when surface water entered abandoned wells and flooded the producing sand, and production in adjacent wells increased as a result. The "water flood" was one of

[6] Testimony of P.C. Boyle before the Industrial Commission (Standard Trust Hearings), 1899, in Charles A. Whiteshot, *The Oil Well Driller: A History of the World's Greatest Enterprise, the Oil Industry* (Mannington, W.Va.: 1905), 385. Boyle quotes from John Ponton, "A Crisis in the Oil Region," 1867.

[7] H.C. George, "Surface Machinery and Methods for Oil Well Pumping," U.S. Bureau of Mines Bulletin 224 (Washington: GPO, 1925): 1, 66-76.

the early successful methods in some sands. Other formations do not respond to water pressure at all. In some cases, natural gas is injected into non-producing wells, and serves to stimulate production in nearby wells. This process is known as "gas drive." Other processes use air, steam, and even in-situ combustion, or "fire flooding." Secondary recovery gave new life to the northern Pennsylvania oil fields. In the case of the Bradford field, especially conducive to water flooding, it created the semblance of a boom as production in the long-established fields soared.[8]

It will be useful to divide the first eighty or so years of the Allegheny region's petroleum industry into several distinct historical periods. Each of these periods is characterized by events both in the region, on its periphery, and in the national petroleum market. Italics indicate an important field within the ANF proclamation boundary.

1859-1874: Early Phase. The birth of the industry. Major development in the Venango Field: Oil Creek valley, 1859 through 1865; Pleasantville, 1867; *Fagundus* and *Triumph*, 1868 through 1872; also in the Butler-Clarion field, 1867-1874. Local developments at *Tidioute*, 1860 and 1866; *West Hickory and East Hickory*, 1870. Themes: Basic cable tools, shallow drilling, introduction of casing and shooting. Pipelines to railroads. Generally high prices for oil. Standard enters refining business.

1875-1881: Flourishing Phase. Rapid increase in production. Major development in the *Bradford* field, from first commercial well in 1875 to massive, wasteful overproduction from 1878 to 1881. Local developments in the *Warren-Glade* field, 1875; *Stoneham-Clarendon* and "Kinzua" *(Guffey)* in 1878, *Kinzua, East Kinzua,* and *Dew Drop* in 1880. Discovery wells in Forest County (*Balltown* and *Cooper* areas), 1877. Themes: Declining prices, overproduction, speculation in oil markets. Drilling tools improved, rig building process standardized, deeper formations reached. Entrance of Standard Oil Trust, which builds pipelines to distant seaboard refineries.

[8] G.G. Bauer, "Secondary Recovery and Natural Gasoline Industry are Developments of Bradford Field," *Producers Monthly* (December 1946), 22. This magazine was organized in 1936 to serve the interests of the secondary recovery operator. Other methods: "Petroleum Panorama," D30.

1882-1885: **Speculative Phase.** Instability and overproduction. Major boom developments at *Cherry Grove, Balltown,* and *Cooper*, 1882; Richburg and Allegany, N.Y., 1881-1883; Butler-Thorn Creek, 1884; and *Kane*, 1885. Steady local developments continue in *Clarendon* and *Tiona,* and expand to *Wardwell,* 1883. Themes: Boom sociology; wildly fluctuating prices and volatile markets; rampant speculation, mystery wells, oil scouts and operator/scouts.

1885-1902: Stabilization Phase. Major geographical shift in development to the southwest: Macksburg, Ohio, 1885; Lima, Ohio-Indiana, 1885; Washington, 1885-1887; Mount Morris; 1887; McDonald, 1891; Sistersville, 1892; northwestern West Virginia, 1889-1900, Spindletop, Texas, 1901. Local developments: *Watson-Duhring*, 1890; *Klondike-Watsonville,* 1896 through 1898; *Bull Hill*, 1899; *Deerlick*, 1900; *Red Brush*, 1902. Themes: Outmigration of drillers; consolidation and settled production; utilization of natural gas. Generally stable but low prices. Standard enters production in 1889 and squelches speculation in 1895.

1903-1945: **Settled Phase.** General decline in drilling accompanied by steady developent of efficient production. Few major regional developments; nationally, oil production characterized by huge gusher fields in the Southwest. Bradford field revives with water flooding. Local developments: *West Branch, Salmon Creek,* 1907; *Guitonville and Lacy*, 1908; *Lewis Run,* 1909; *Queen*, 1922; *Marshburg,* 1929; *Music Mountain,* 1937. Themes: Planned development, rationalized production (central powers, air leases, etc.), redrilling with portable rigs, water flooding, gas drive, casinghead gasoline production, salvage operations.

1. Geological Considerations

The Pennsylvania oil region is part of the larger Appalachian Basin oil field, which stretches non-continuously from southern New York to Tennessee, through West Virginia, eastern Ohio, and eastern Kentucky. Its greatest production, historically, has come from Pennsylvania, West Virginia, and Ohio. The portion of this field that lies in the Allegheny National Forest is near the northern extent of the productive area. Here, petroleum and natural gas are found in sedimentary formations, almost exclusively in porous, permeable sandstones. These formations were laid down in the Paleozoic era and, in this area, mostly in the Upper Devonian period. The filling of the Appalachian trough continued through the Permian period, but over the immediate area the higher Mississippian, Pennsylvanian and Permian rocks have eroded or been glaciated.[9]

Petroleum reservoirs in Pennsylvania generally stretch along a northeast-southwest axis and are usually longer than they are wide. Most geologists believe that these formations represent the ancient lagoons and sand bars of a shallow sea that covered the Appalachian Basin in the Upper Devonian period. As subsequent deposits covered these areas, these sand bars hardened into sandstone and the mud from the lagoons and sea floor solidified into impermeable shales, which trapped the organic deposits in the sandstone. This type of structure is known as a stratigraphic trap.[10]

The porous sandstones often contain petroleum, natural gas, and water. In time these substances settle in the formation, the gas generally occupying the highest level, petroleum the middle level, and water (usually saline) the lowest level. The ability of these substances to migrate within the formations is controlled by the permeability of the reservoir rock. Few of these formations have remained perfectly level and undisturbed as folding and faulting have occurred over time, and the formations have often assumed a wavelike structure. The crests of these waves are known as "anticlines," and the troughs "synclines." Gas generally occupies the top of an anticline, petroleum the next level, and water yet lower.[11] Thus a driller, lacking knowledge of the relative position

[9] W.R. Wagner and W.S. Lytle, "Geology of Pennsylvania's Oil and Gas," Educational Series No. 8 (Harrisburg: Topographic and Geologic Survey, 1968), 5-7. In the southwestern part of the state and in West Virginia some production comes from Pennsylvania and Mississippian formations.

[10] *Ibid.*, 8-10.

[11] *Ibid.*, 10-18.

of fluids in the reservoir, might first strike gas, oil, or salt water—or nothing at all.

The two groups of formations of direct interest are the Venango and Bradford (historically called the Catskill and Chemung), which generally occupy an interval of about 2,200 feet.[12] From top to bottom, the economically important formations are arranged thus:

VENANGO GROUP		BRADFORD GROUP	
First Venango	750	Warren First	1580
Second Venango	1040	Warren Second	1700
Third Venango	1100	Speechley, Glade	2010
Fourth		Tiona, Clarendon	2200
Fifth, McDonald	1200	Balltown, Gartland	
		Cherry Grove	2300
		Sheffield, Cooper	2450
		First Bradford	
		Third Bradford, Deerlick	2700
		Kane, Elk	2850 [13]

From west to east on a line of even latitude through the four-county region, the shallower formations predominate and then give way to the geologically deeper ones, indicating a general westerly dip; the region lies on the eastern rim of a large basin that extends westward into Ohio. Thus the Triumph Streak of the Third Venango at Tidioute, the earliest found, was at a much shallower depth than the same sandstone formation farther west in Venango County. Likewise, when the early oil hunters at Bradford found a producing sand at a depth similar to that of the Oil Creek formations, they called it the Bradford "Third" Sand—even though it was at least 1,500 feet below the Venango horizon, which crops out of the hillsides at Bradford. Such local names for the oil-bearing sands are

[12] In recent years, much of the stratigraphic nomenclature has changed. The geological marker generally used in the Appalachian oil field is the Pittsburgh coal, at the top of the Pennsylvanian series. The top of the Venango is about 1,550 feet below this horizon, and the bottom of the Bradford is about 3,770 feet below. The deeper Onandaga and Oriskany formations have been productive of gas in more recent times. 50th Annual Field Conference of Pennsylvania Geologists, *Guidebook: Geology of the Upper Allegheny River Region in Warren County, Northwestern Pennsylvania* (Warren, Pa.; October 1992), 3; Ernest Raymond Lilley, *The Geology of Petroleum and Natural Gas* (New York: D. Van Nostrand, 1928), 124.

[13] Since the Pennsylvania age rocks have been entirely eroded in Northern Pennsylvania, the Burgoon Sandstone is the marker formation there. Depths above are from this horizon, which crops at the tops of hills in the Warren region. J.D. Sisler, "Contributions to Oil and Gas Geology of Western Pennsylvania," Bulletin M19 (Harrisburg: Topographic and Geologic Survey, 1933), 6.

common in the region and add to the confusing array of producing formations in the Devonian rocks. The upper Bradford formations are extremely lensy and irregular, which during the drilling era accounted for a large number of dry holes, and confusion for producers as to exactly which horizon had been tapped when the oil search proved successful. Many of the sands that are productive in Warren County are either dry or non-existent elsewhere.[14] Less than accurate well records and the nature of the oil business in the late 1800s often precluded detailed geological investigations, to the consternation of the emerging professional geologists of the day.[15]

Geologists themselves differed on how oil and gas accumulated and what constituted a scientific method for locating it. Regional differences in geological structure accentuated these discussions. Dr. J. Peter Lesley, head of the Second Pennsylvania Survey, and Dr. I.C. White, his assistant during the 1870s and later head of the West Virginia Geological Survey, kept an ongoing and often lively debate throughout the 1880s concerning anticlinal and structural accumulation, and whether such accumulation was more a factor of the characteristics of the reservoir than its relative position. History showed both to be correct under certain circumstances.[16]

Second Pennsylvania Survey geologist John F. Carll laboriously gathered well records (where he was permitted to do so) over a period of fifteen years and contributed significantly to local geological knowledge during the 1870s and 1880s, and was largely responsible for the five extensive volumes of investigations in the Venango, Butler, Clarion, McKean, Warren, and Forest regions published in that era.[17] In general, however, practical oil men ignored any geology that they could not see in their cuttings. As a result, scientific knowledge played very little part in the development in this region.

[14] *Ibid.*, 39. The Clarendon Rocks in the upper Bradford Group are perhaps the most notorious for the multitude of non-continuous producing sands. See also Ingham et al., *Oil and Gas Geology of the Sheffield Quadrangle, Pennsylvania* (1956) and Lytle, *Oil and Gas Geology of the Warren Quadrangle, Pennsylvania* (1965).

[15] See comments of Dr. J. Peter Lesley, circa 1883, on page 44.

[16] Philip W. Ross, "The Turbulent Rise of Practical Petroleum Geology, 1859-1889" (Unpublished Manuscript, 1992). See also J.V. Howell, "Historical Development of the Structural Theory of Accumulation of Oil and Gas," in W.E. Wrather and F.H. Lahee, *Problems of Petroleum Geology: A Symposium* (Tulsa: The American Association of Petroleum Geologists, 1934), 11-12.

[17] Howell, 11.

2. Early Operations, 1859-1874

Tidioute, 1859-1867

Only two days after the Drake strike, a Tidioute storekeeper's son named John L. Grandin built a spring-pole rig and derrick at the site of an oil spring at the mouth of Gordon Run on the Allegheny River seventeen miles east of Titusville. His partner, a mechanic, fashioned a bit from a buggy axle and they proceeded to drill what may have been the first dry hole in the oil industry.[18] Despite this unsuccessful effort, speculators flocked to the small river and lumber town, and more wells went down. J.L. Grandin went on to became one of the region's successful early operators.

As at Oil Creek, the surface indications of oil were strong, and by the summer of 1860 more than sixty wells were being sunk on both sides of the river. Across the river from Tidioute, the Hequembourg well on the Cohell farm began flowing from the Venango Third Sand at a depth of 124 feet in August. Drilled with human power and a spring pole, the well flowed seventy barrels a day. Also in August, the Ludlow well on Tidioute Island was completed with promising results. In order to prospect the area between the wells, several oil hunters built rafts and drilled in the middle of the river—possibly the world's first offshore rigs, with no leases required. A flood swept away the derricks in December.[19]

Across the river, the Economites, a millennial society also known as the Rappists or Harmonists, owned a promising tract of land. The Economites had purchased 6,600 acres of timber lands fronting the Allegheny River in the mid-1850s and built a sawmill. As absentee owners, they operated the tract though trustees. As the oil excitement engulfed Tidioute, the society contracted for drilling on the property and built lodging for their workers. Although the first two wells were failures, during the spring of 1861 the Economy Oil Company drilled four good wells. Unimaginatively named A, B, C, and D, they were shallow wells, none exceeding 150 feet, but very productive. One flowed more

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[18] Ernest C. Miller, *The History and Development of the Petroleum Industry in Warren County, Pennsylvania,* Northwestern Pennsylvania Historical Study No. 5 (Warren, Pa.: Warren County Historical Society, 1983): 11-13.

[19] Paul H. Giddens, *The Birth of the Oil Industry* (New York: Macmillan, 1938); Whiteshot, 73-74; Miller, 15-17. These wells may have been the first to tap the Venango Third Sand, the mainstay of the Oil Creek region.

than six hundred barrels when drilled.[20]

Though the Economites never inhabited the area, their influence on their property weighed heavily. Workers were forbidden to swear (a trying restriction on oil men) or to pump the wells on Sunday. Though conventional wisdom required constant pumping, the wells proved remarkably long-lived and productive with their day of rest. The company operated successfully through the 1860s and sold 100,000 barrels of oil yearly as late as 1868.[21]

Oil prices ranging from $4 to $10 per barrel at the end of the Civil War greatly stimulated exploration in the Tidioute field. Drilling reached its peak of development in 1866 as the Pithole Creek boom in Venango County came to an end. The Dennis Run vicinity hosted the most intensive developments, with up to five wells to the acre, and produced up to 2,700 barrels each day. The Tidioute & Warren Oil-Company and the Dennis Run & New York Oil Company were the largest operators in the area. J. L. Grandin, the treasurer and manager of the Tidioute & Warren Oil-Company—the third earliest oil company on record—paid $1.2 million in dividends on a capital of $10,000 over a period of eight years.[22]

The Tidioute development was at the eastern extremity of a long, narrow, arc-shaped field later called the Triumph Streak, a Venango Third Sand pool with its heaviest development at the heads of Dennis and Gordon runs west of Tidioute.[23] Its production peaked about 1870. Alhough on the periphery of the Oil Region, Tidioute indicated an eastward trend for drillers to follow once the Venango developments declined. The town itself benefited from the nearby oil activity, and today retains a prosperous, tidy appearance. Gothic, Italianate, and other high-style architecture provides a good indication of the date of its boom.

The town retained its respectability during the boom by banishing many of the racier trappings of the Venango boom towns to its outskirts. Since many of

[20] 758-759; Miller, "Utopian Communities in Warren County, Pennsylvania," *Western Pennsylvania Historical Magazine* 49 (October 1966), 311-313.

[21] Whiteshot, 758-759.

[22] John J. McLaurin, *Sketches in Crude-Oil: Some Accidents and Incidents of Petroleum in All Parts of the Globe*, 2nd ed. (Harrisburg: published by the author, 1898), 201; P.C. Boyle, ed., *The Derrick's Hand-Book of Petroleum*, 1859-1898, vol. 1 (Oil City, Pa., The Derrick Publishing Co., 1898): 73, 78. Hereafter abbreviated *Derrick's Hand Book*. Also Miller, *Petroleum Industry in Warren County*, 36-39.

[23] S.H. Cathcart, R.E. Merrill, and L.S. Matteson, *Geology of the Oil and Gas Fields of the Tidioute Quadrangle, Pennsylvania*, Advance Report (Harrisburg: Topographic and Geologic Survey, 1938), 9-10.

the oil field workers sought entertainment "off tour," a service industry established itself along the Warren-Franklin Turnpike where the road crested the hill at the head of Dennis Run.[24] Six of the first eight businesses established at Babylon, as the district came to be called, were "sporting houses" or brothels. The Oil Region's most celebrated brothel keeper, Ben Hogan, established a dance house and "gymnasium" at Babylon in the fall of 1866 and ran a thriving enterprise through the summer of the following year. His flair for the unusual then led him to establish a traveling brothel, and subsequently a "Floating Palace of Pleasure" anchored on the lower Allegheny in the thick of the new Clarion and Butler counties' oil boom.[25] Babylon seems to be unique in Oil Region history in that it was an isolated, dedicated red-light district with no other civic purpose.

Other Pools in the Early Era

During oil industry's formative era several other small pools were opened in Warren and Forest counties. With the bulk of development activity then occurring in the Butler and Venango fields, these fields were of minor importance. The Siggins farm at East Hickory was the site of several small wells and an equal number of dry holes in 1866. A good-sized pool was found at West Hickory in 1865 at the mouth of Stewart's Run; by 1866, the West Hickory Mining Association had drilled over fifty wells, and the White farm and the Siggins farm were the site of much drilling activity. Development waned but returned to the area in 1870 as the Venture well opened the pool on the Fagundus farm, flowing at 228 barrels. Neyhart & Grandin's well, one-quarter mile away, flowed 175 barrels. This pool peaked in December with a daily production of over 3,600 barrels. It remained a good pumping field for many years.[26]

Early Drilling Technology

Although the Drake well was drilled with steam power, many of the early wells drilled in 1860 and 1861 were sunk using primitive cable tools and a spring pole derrick. The first phase of oil exploration was characterized by shallow drilling with crude cable tools, differing little from water-drilling rigs. A

[24] *Derrick's Hand-Book* 1, 76.

[25] Historical accounts of Ben Hogan abound, though most of them seem anecdotal. See Herbert Asbury, *The Golden Flood* (New York: Alfred Knopf, 1942), 228-248, account of Babylon, 237-239.

[26] *Derrick's Hand-Book* 1: East Hickory, 69, 57-61, 129-139 passim.

"string of tools" included a steel bit and iron stem attached to a set of "jars," a joint that allowed the bit to fall freely and to be jarred loose from the bottom of the hole. These early tools were relatively light and drilling proceeded slowly. As the bit progressed downward through the different strata, drillers often encountered softer shale formations that "caved" into the hole, which rendered further drilling impossible and usually resulted in the abandonment of the well. These conditions prevented deeper drilling until the development of the practice of casing wells with iron pipe and then drilling through the casing. This practice came into general use by 1870.[27] Drillers gradually developed improved tools, primarily by increasing their size and weight. "Fishing tools," specialized devices for recovering stuck strings of tools, allowed drillers to complete wells that previously had to be abandoned or moved. As the weight of tools and the depth of wells increased, drilling rig technology also progressed. Various combinations of steam drilling power, rig furnishings, and derricks evolved with practical experience. By the early 1870s, the basic elements of both drilling rigs and drilling methods had been well-established, and by 1880 were remarkably standardized.[28]

The Industry Moves South

As the Tidioute and Venango developments played out in the late 1860s, the new operations began to trend south along the Allegheny. The producers moved to southern Venango County, striking oil at Shamburg and Scrubgrass in 1867, and then into Butler, upper Armstrong, and lower Clarion counties in 1868 with large strikes at Parker's Landing and Foxburg in 1869 and 1870, Brady's Bend in 1871, and Karns City, Fairview, Petrolia, and St. Petersburg in 1872. Operators in the new southern fields found the Third Sand at deeper levels but at much higher pressures, and many of the wells there flowed oil at unheard-of rates. By 1872, the *Petroleum Centre Record* noted that "the steady flow of the producers to the more prolific and flashy territory down the river has had the effect of bringing about almost a total cessation of operations in the territory along [Oil] creek."[29]

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[27] J.E. Brantly, *History of Oil Well Drilling* (Houston: Gulf Publishing Company, 1971), 1254, 1257, *Derrick's Hand-Book* 1, 137.

[28] Brantly, 507-509.

[29] John F. Carll, *Report of the Geological Survey of Pennsylvania, 1886* (Harrisburg, Second Geological Survey, 1886), 599-601. Day-by-day drilling and production activity in the "Lower Regions" noted in *Derrick's Hand-Book* 1, 107 and 150-200 passim.

The Belt Theory

One of the early beliefs about oil accumulation was that oil gathered along the course of streams, and for the first several years of the industry nearly all wells were located along (and sometimes in) rivers and creeks. The first advance in well location methods came about 1864 when some operators left the flats and valleys and began to drill on the surrounding slopes above Oil Creek and the Allegheny River. Though the necessarily deeper drilling entailed extra expense, the drillers found that the hillside wells produced as well as those in the bottomland. This new awareness opened a vast area of possible oil territory.

The next stage in well-location methods took a bit longer to evolve. Cyrus D. Angell, a New York farmer, merchant, and politician, caught oil fever in 1867 and invested $1,000 in an oil venture at Petroleum Centre on Oil Creek. His immediate and considerable profit on the risk encouraged him to try his luck as an operator. After sinking three successful wells at Belle Island in the Allegheny River, he observed that geological conditions were similar at a group of wells nine miles distant. Taking note of the tendency of successful wells to be located in bands, or "belts," he laboriously determined levels between the surface and the productive sand rocks, intervals between different sands, their thicknesses, and the characteristics of the oil found in them. He leased as much land as possible between favorable points and then drilled seventeen wells, sixteen of which were "highly successful." He subsequently laid out another line in the Butler-Clarion district to the south of his initial operations and consistently struck oil there also. Between 1871 and 1873, ninety-five percent of his drilling operations were successful.[30]

From his observations, Angell concluded that:

> (1) oil lies in more or less continuous belts; (2) the direction is Northeast-Southwest; (3) different belts differ in character, but the same belt is uniform throughout; (4) belts do not deviate from a straight line; (5) the under surface of the "Third Sand" rock slopes upward each way from its center; (6) the upper surface of the "Third Sand" is absolutely level; (7) superficial [surface] watercourses have no relation to the belts; and (8) it is possible to detect an oil belt and stake it out on the surface.[31]

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[30] C.E. Bishop, in J.T. Henry, *Early and Later History of Petroleum* (Philadelphia: Jas. B. Rodgers, 1873), 486-492; *Derrick's Hand-Book* 1, 105 (Scrubgrass); William S. Lytle, "Cyrus D. Angell," *GeoTimes* 4 (1959): 18-19, 45.

[31] Bishop, 492.

By the early 1870s, then, the "Belt Theory" was firmly established in the minds of practical oil men. It relied heavily on the gathering of empirical subsurface data, and as such had the blessing of the leading geologists of Second Pennsylvania Survey, particularly John Peter Lesley, Charles M. Ashburner, and especially John F. Carll, who pioneered subsurface contour mapping in 1875.[32]

The belt theory proved remarkably viable in Pennsylvania through the end of the century. It had wide ramifications when operators later arrived at Bradford, looked back toward the southern fields, and noted that portions of Warren and Forest counties lay on a forty-five degree line, northeast to southwest, between the established areas.

[32] F.A. Randall, *Observations of the Geology Around Warren, Pennsylvania*, vol. 1 (Second Pennsylvania Survey, 1878), 50-55.

3. The Flourishing Era, 1875-1881

Bradford, 1875

The Bradford field set the pace for the American petroleum industry from the mid-1870s through the early 1880s. Even as other fields burst onto the scene and just as quickly faded, the Bradford field steadily contributed the majority of crude oil to the industry. The Bradford Third Sand was found at a depth of about 1,100 feet—deeper than the Venango sands—but, unlike the spotty distribution of the shallower formations, was spread evenly in a large, parabola-shaped field, its apex on the New York-Pennsylvania state line and pointing to the northeast into Cattaraugus County, New York. As eventually defined, it covered an area of 84,000 acres. Eighty-six percent of it lies in Pennsylvania, and the remainder is in Allegheny and Cattaraugus counties, New York.[33]

Since shortly after the Drake well, prospectors had drilled exploratory wells in McKean County. Job Moses struck a small flow of oil near Limestone, New York, in 1868, but the amount was small and inconsequential compared to developments to the east in Venango County and to the southeast in Clarion and Butler counties. In 1871 the Foster Oil Company drilled the Butts well two miles northeast of Bradford in the Tunungwant Creek valley and tapped the Bradford Third Sand. The oil was dark and had to be pumped from a black, fine-grained sand that quickly clogged the flow. Undeterred, Foster proceeded to drill a number of wells between Bradford and Limestone, and the volume of oil gained slowly through 1874. It was the Crocker well in October 1875, however, that convinced the industry that paying quantities of oil lay below McKean County. Once the water was pumped off, it produced 300 barrels per day. A half interest in the well sold several weeks later for $40,000. Land values rose quickly, and the operators who got into Bradford during this early period became the giants of the Appalachian field.[34]

Bradford in the early 1870s was a small lumbering village in the broad Tunungwant Creek valley with six hundred inhabitants. It had been settled in 1837 by Levitt Little, agent of the United States Land Company, which owned a quarter million acres in the region. The forests were divided into huge tracts, among them Clark & Babcock, Quintuple, Kingsbury, Bingham, and Borden. Woodmen cut timber, rafted it to the mills, and "shantied" in rough huts deep in

[33] E.W. Miller, "Natural Production in the Bradford Field, 1860-1906," *Producers Monthly* (April 1943), 15; Fettke, *Bradford Oil Field*, 276.

[34] E.W. Miller, 15.

the woods over the winters. The hamlet of Littleton became Bradford in 1858 and became a borough in 1872. A spur of the Erie Railroad served the "Tuna" valley.[35]

John J. McLaurin, a contemporary observer, noted that after the Crocker well "rigs multiplied like rabbits in Australia. . . . The valley soon echoed and re-echoed the music of the tool-dresser and rig-builder and the click of the drill, as well as the vigorous profanity of the imported teamster."[36] Lewis Emery, Jr., one of the early arrivals at Bradford from Oil City, leased the Quintuple tract of 5,000 acres; Marcus Hulings leased the Clark & Babcock tract of 6,000 acres. Both drilled hundreds of paying wells and subleased many more. Emery built a refinery that became the modern Kendall refinery, developed commercial blocks in Bradford, published a daily paper, and served two terms in the Senate. There he opposed the might of the Standard trust and championed the cause of the smaller, independent operators.[37] Hulings, who believed that—following the "belt theory"—a paying field lay on a diagonal northeast from Oil Creek, leased and developed the Clark & Babcock tract northeast of Bradford on this basis. From his profits he developed a narrow gauge railroad from Bradford to Olean, New York. Along the right-of-way grew a number of boom towns, among them Derrick City, Gillmor, Bell's Camp, and Red Rock. Other successful operators who gained prominence in the Bradford field included John McKeown, who leased much of the Bingham tract; J.T. Jones of the Bradford Oil Company, which opened operations on the West Branch; David Kirk of the McCalmont Oil Company; Colonel John J. Carter of the Carter Oil Company; John Gartlan, T.N. Barnsdall, P.M. Shannon, and Colonel J.M. Guffey. Each of these men played an important role in the industry after successful operations at Bradford.

Bradford's rise and decline may be seen in the following figures:

Year	Avg Daily Prod	Annual Prod	% Pa.	% Total
1876	1,046	382,768	4.1	4.0
1877	4,023	1,468,451	11.1	11.0
1878	16,980	6,197,746	40.8	40.3
1879	38,587	14,084,120	71.5	70.8
1880	55,173	20,138,091	77.3	76.7
1881	70,811	25,846,261	94.4	93.8
1882	51,030	18,625,980	89.6	86.5
1883	36,812	13,436,426	58.0	57.6
1884	33,052	12,096,950	50.8	50.5 [38]

[35] McLaurin, 216.

[36] *Ibid.*, 216-219.

[37] See Chester McArthur Destler, *Roger Sherman and the Independent Oil Men* (New York: Cornell University Press, 1967).

[38] *Derrick's Hand-Book* 1, 805; Vol. 2 (1900), 167-170.

By 1881 the Bradford field produced well over ninety percent of the national petroleum supply.

The effects of the opening of the Bradford field can hardly be overstated. In late 1875 the editor of the Titusville *Herald* characterized the McKean County field as "only an imaginary bugbear" and opined that there was more talk than oil there.[39] Yet operators continued to flock to the area, and of just over two thousand wells drilled in a one-year period between 1877 and 1878, only 87, or four percent, were unproductive. In contrast, in the Venango and Butler districts the chances that a well would be a failure were almost one in four.[40]

The boom reached its peak in the period between 1879 and 1881, as the other established fields were abandoned wholesale. In Clarion, Butler, and Armstrong counties, the oil men's outmigration bordered on disaster. Towns emptied, banks failed, and resources were wasted as operators pulled the casing out of good wells and shipped it to Bradford. During just two months of 1878, 143 complete rigs were broken down in Clarion County alone and shipped to new sites in McKean County. So strong was the pull to the northern field that operators sacrificed their established productive fields well before they would have declined naturally.[41]

Guffey, 1878

Though the heart of the Bradford field still offered large areas of promising undrilled land, some operators preferred to strike out beyond the boundaries of proven territory. Colonel James M. Guffey, a native of Westmoreland County, was one of the most successful "wildcatters." He first entered the oil business in the early 1870s in the Butler field; flush from his success there he began prospecting southwest of Bradford along Kinzua Creek in the summer of 1878, where Marcus Hulings had purchased 6,000 acres in fee of heavily forested land. Hulings' test well, the "Old Owl" near the mouth of Town Line Creek at Kinzua Creek, began flowing ten barrels per day and opened a new pool over eighteen miles distant from Bradford, and ten miles in advance of developments. Hulings sold Guffey a half interest in the tract for approximately $100,000 with an agreement to drill ten wells in the following ten months. Hulings & Guffey

[39] *Titusville Herald*, October 30, 1875, quoted by E.W. Miller, "Natural Production in the Bradford Field," 14.

[40] E.W. Miller, "Natural Production in the Bradford Field," 16.

[41] *Ibid.*

immediately began drilling a number of productive and profitable wells there beginning in 1878.[42] This field, dubbed the "Kinzua" field but soon thereafter became known as the Guffey field, is actually an extension of the southwestern lobe of the Bradford field and taps the Bradford Third Sand. This new pool led to a number of leases being taken up in the area and led also to considerable drilling activity between the proven areas of the Bradford field and the pool on Kinzua creek. By the end of 1879, twenty-nine wells had been drilled, and twenty seven rigs were drilling or being built. Production increased so rapidly that the battery of tanks erected at Tally-Ho could not handle the pool's production, and many wells flowed on the ground during the summer of 1880. The pool proved to be isolated from the main field, as several dry holes in the intervening area proved. Later geological exploration showed the pool to lie on a structural "nose" on the axis of the Simpson Anticline, where it increases in pitch.[43]

Just west of the Guffey field, the Producers Consolidated Land and Petroleum Company (PCL&P) drilled on Warrant 3085 following Hulings & Guffey's strikes. On New Year's Day, 1879, their No. 1 found traces of oil but mostly salt water; No. 2, in the center of the warrant, produced only a trace; and No. 3 was positively dry. Numbers 4 through 6, on warrants 3086 and 3089, produced only salt water; and 7 and 8 had varying amounts of salt water and gas, but no oil. Three years and probably upwards of $40,000 was expended by PCL&P for an unmitigated failure.[44]

Instead of being literally dry, wells sunk outside the main oil producing area tended to fill with salt water, which occurred below the level where the pay sand would have been in a paying well. In December 1879, operator M. Brownson turned a well that was pumping mostly salt water and very little oil into a producer by cementing off the lower saltwater horizon, thereby becoming the first operator to employ this valuable completion technique. The bottom seven feet of the well was reamed out to form a shoulder, and Portland cement was placed in the bottom with a bailer. After this modification, the well pumped ten barrels of oil a day.[45]

By 1885, the Union Oil Company owned much of the production in the Guffey field, operating sixty wells that averaged eleven barrels per day, including wells that were seven years old. As the boundaries of the field became known, they drilled only twenty-eight feet into the producing sand to avoid the salt water. By 1940, the Guffey field was the subject of an intensive waterflooding project.[46]

Colonel Guffey, one of the most important figures in the early petroleum industry, went on from McKean County to profitable ventures in the southwestern Pennsylvania field as the industry's momentum shifted there in the mid-1880s. He operated prominently in the McDonald field in Washington County in 1891, the most prolific field to that date. He earned permanent fame for opening the Spindletop field at Beaumont, Texas, which put that state on the oil prospectors' maps and caused an exponentially more wrenching geographical shift in oil production than had Bradford twenty-five years earlier.[47]

Warren, Stoneham, Clarendon, and Tiona

Since the Bradford field attracted the lion's share of attention during this flourishing era, developments outside the area attracted little interest. Operators who could not pay the price of admission to Bradford did, however, look elsewhere. In 1875, just as the Bradford field began to attract notice, David Beaty, an early Oil Creek driller and a successful operator in the Fagundus field, drilled for a domestic supply of gas (literally in his back yard) at his newly-built home across Conewango Creek from Warren. Oil was struck at just 641 feet in the Glade Sand.[48] The Bell well, drilled the following year several rods north of the Beaty well, and the James Roy well, also drilled in 1876, confirmed the new pool. By May of 1876, twelve wells were drilling in addition to four producers.[49] Eventually a field of almost 6,000 acres was defined on either side of the Allegheny River, almost a quarter of which now lies under the city of Warren. Developed concurrently with Bradford, the less prolific field did not attract the attention of the largest drillers. But operators of smaller means found inexpensive leases and a high quality of oil. The Glade Sand is the upper member of the Clarendon series of sands, an irregularly distributed group of formations but locally productive of an exceptionally high quality oil.

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[42] *Derrick's Hand-Book* 2, 276, 282, 285.

[43] *History of the Counties of McKean, Elk, and Forest, Pennsylvania* (Chicago: J.H. Beers & Co., 1890), 248; *Derrick's Hand-Book* 1, 326; Fettke, *Bradford Oil Field*, 277.

[44] *Petroleum Age* (December 1885), 1189.

[45] *Derrick's Hand-Book* 2, 312.

[46] *Ibid.*, 292, *Petroleum Age* (December 1885), 1188; Fettke, *Music Mountain Oil Pool*, 32. See discussion of secondary recovery.

[47] *Derrick's Hand-Book* 1, 845-847.

[48] McLaurin, 200; *Oil City Weekly Derrick*, April 6, 1944; Miller, *Petroleum Industry in Warren County*, 45-47.

[49] *Derrick's Hand-Book* 1, 260-261, 263.

In 1878, drillers first tapped the Clarendon field south of Warren. The first well in the field, the Tolles No. 1 at Bugsbee Mills, near Stoneham, produced only twenty barrels on its first day; it was no gusher, but its production did not decline rapidly either.[50] Development continued slowly but steadily in a southerly direction over the next decade. The first well drilled at Clarendon was the Eagan well in June 1880.[51]

At this same time, storage tanks were running over in the Bradford field; producers could not get their oil shipped, and five thousand barrels of oil ran to waste daily.[52] At no time did the Clarendon field attract the sole attention of the trade, but instead achieved its significance as a steady producer of high-quality petroleum. The oil, amber in color and 48 to 50 degrees specific gravity, was especially prized for refining into lubricating oil. Quotations on Clarendon and Tiona oil carried a premium up to fifteen cents a barrel over the common grades of Pennsylvania oil through 1907.[53]

This field eventually covered an area of 24,000 acres, from Stoneham through the marshes of the upper West Branch of Tionesta Creek, through the boroughs of Clarendon and Tiona, to just southwest of Sheffield. The area was neatly bisected by the Philadelphia and Erie Railroad. The producing sand was distributed uniformly with the richest area surrounding Clarendon, and operators with leases within the boundaries of proven areas could count on drilling paying producers with as much certainty as existed in the business. For example, in May 1886 fifty new wells were drilled in Clarendon and Tiona. The new wells in Clarendon produced between three and six barrels each, and the new Tiona wells each produced between six and eight barrels. New production totaled 310 barrels from the fifty wells. There were no dry holes.[54]

The Clarendon field proved to be one of the few fields outside Bradford amenable to water flooding for enhanced oil recovery.

[50] Lytle, *Crude Oil Reserves of Pennsylvania,* 225; *Derrick's Hand-Book* 2, 294.

[51] Whiteshot, 783; Lytle, 29.

[52] Fettke, *Bradford Oil Field,* 6; for example, see *Derrick's Hand-Book* 2: 299 and *passim* in the chronology for the years 1878 through 1882.

[53] *Derrick's Hand-Book* 1, 459; 3,9.

54 *Petroleum Age* (May 1886), 1348. This number of wells completed in 1886 – several years following the initial discovery in the Clarendon-Tiona field – illustrates the steady, non-boom development pattern of this field.

The Oil Market and Oil Exchanges

The petroleum market is an excellent example of the economic law of supply and demand. Oil from Drake's well sold for $20 a barrel in 1859; in 1861, owing to the glut caused by the Oil Creek boom, it sold for only ten cents a barrel, considerably less than the value of the barrel itself. As illuminating oil found its market in the 1860s and 1870s, a rough parity evolved, with oil prices stabilizing at about three to four dollars a barrel from the mid-1860s to the early 1870s. The prolific Butler field flooded the market in 1873, driving the price to around a dollar by the end of the year. Prices remained low from 1874 through 1876, then rebounded until the Bradford glut drove them down again in 1878. Prices then remained relatively low through the turn of the century.[55]

Early in the history of the industry, oil changed hands from the producer directly to the refiner, who bought the oil in barrels. The advent of shipping oil through pipelines significantly altered the way petroleum was bought and sold. The pipeline companies became intermediaries, purchasing oil from the producers and storing it in bulk until it was sold to refiners. Oil from individual producers lost its identity at this point as the oil was mixed with stocks in storage. The producer was awarded a certificate for one thousand barrels, and the trade became one of "paper oil," rather than actual oil. Pipe line certificates were negotiable and backed by the assets of the relatively stable pipeline companies.[56]

To facilitate the trade in oil, exchanges were established, first in Pittsburgh in 1863, and Titusville and Oil City by 1871. By the mid-1870s, each producing center had its own exchange. The Oil City Oil Exchange was the exchange of record, as the pipeline companies accepted its quotations as official. [57] These trading boards functioned much like any other commodity exchange. While the industry was in its ascendancy, the value of oil rose correspondingly in a "bull" market. By 1873, though, oil values plunged in a "bear" market with the Fourth Sand overdevelopment in the Butler-Armstrong region coinciding with a national recession. From this point forward the market remained volatile as the balance between supply and demand teetered first one way and then the other.

Speculation did not become a prominent facet of the exchanges until this

[55] Whiteshot, 121.

[56] Boyle, introduction to Tennent, *The Oil Scouts,* 8.

[57] *Ibid.*

point, as the "bull" or "long" interests gave way to the "bear" or "short" interests.[58] In a market that could fluctuate twenty cents or more per day, a lucky (or manipulative) speculator could catch the market going either way and make a considerable profit. For the next twenty years, supply and demand only incidentally influenced the market as traders, largely the "short" interests, artificially controlled the quotations. Anyone could play the game who had the price of a certificate—whatever a thousand barrels sold for at that moment. The invariably optimistic amateur traders, called "lambs," quite often lost their investments to the professional traders who manipulated the market to their advantage. This situation, though, did not necessarily influence oil production until the producers themselves began to play. Patrick Boyle, longtime editor of the *Oil City Derrick*, noted that it was illogical for producers to participate in the speculative market. Their business depended on optimism and a rise in prices, but at the same time their own production tended to thwart that goal; according to the law of supply and demand, higher prices come from a scarcer product. Many operators lost heavily.[59]

Drilling and Production Costs

The standardization of drilling practices in the 1870s had a positive influence on the costs of sinking a well. As a steady market for supplies emerged, several firms undertook the supply business. Most prominent among these was Eaton, Cole, and Burnham, later to become the Oil Well Supply Company. These supply houses set up distribution centers in each new field as it opened. Tubing and casing, once quite expensive to manufacture, came down in price as mills such as the Continental Tube Works in Pittsburgh and National Tube Works in McKeesport became more efficient in the manufacture of "oil country goods."[60]

The overall result of the rationalization of the supply industry was a halving in prices. In the early 1870s, the cost of a new well—rig, boiler, engine, casing, tubing, and contract fee for drilling—averaged about $7,000. By the early 1880s, the cost of drilling a well in the Bradford district, drilled to a depth of sixteen hundred feet and completed with a torpedo, was estimated to be only

[58] This speculation in oil certificates should not be confused with the earlier speculation in oil land, leases, and stocks in oil companies that prevailed during the Oil Creek era excitement.

[59] Boyle, introduction to Tennent, *The Oil Scouts,* 8.

[60] *Derrick's Hand-Book* 1, 1053-1057.

$3,434. This was just for the first well, as the boiler and much of the drilling rig not used for pumping could be salvaged and reused.[61]

[61] *Petroleum Age* 1 (February 1882), 105.

4. Ascendancy of the Middle Field, 1882-1885

By the early years of the 1880s, the oil industry was in ferment. Generally low prices prevailed as production outstripped demand by a wide margin. Bradford's production peaked in 1881, and then slowly began to decline. Geologists warned that Pennsylvania's oil resources were finite and must of necessity become more scarce. Charles Ashburner, geologist for the Second Pennsylvania Survey, wrote:

> That the general boundaries of the oil-regions of Pennsylvania are now well established, there is but little doubt; and that all the sands in which oil will ever be found in paying quantities are known and have been drilled though at different localities in the oil-regions seems quite certain, so that we can have no reasonable expectation that any new and extensive field will be found which could compare in area or in the amount of oil to be obtained from it with the Butler, Clarion and Armstrong pool, the Oil City and Pleasantville pool, the great Bradford pool, or the Allegany pool.[62]

Operators who did not hold large acreages in these fields began to look elsewhere for oil. Warren and Forest counties lay directly between the established areas of Bradford and the Venango and Butler regions. A number of exploratory wells, drilled at various times in the 1860s and 1870s, proved that oil did indeed exist in this intermediate area. What had not been proven was that it existed in paying quantities. The exception was the Clarendon-Tiona field, which, like Bradford, continued to reward drillers with small but long-lived wells. The Middle District, as it had come to be called, began to attract more attention from the industry. The groundwork was thus laid for its development.

Market Conditions, Early 1882

As the Bradford field's weakening became more apparent, the oil market, which had been hovering between seventy and eighty cents during the summer, began to strengthen in the fall of 1881. Many investors, certain that the days of "cheap oil" were over, bought heavily in a rising market and were "gored on the spot," reported the *Petroleum Age,* a new trade journal published in Bradford.

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[62] Charles A. Ashburner, "The Product and Exhaustion of the Oil-Regions of Pennsylvania and New York," AIME *Transaction* XIV (1885), 425.

Manipulative speculators who had also bought heavily waited for the trend to catch; they then sold their shares short and reaped the harvest as prices tumbled.[63]

As a result of such experiences, producer-investors began to notice two disquieting trends. One was that "wildcat" wells in areas of unproven production could affect the market adversely; if a well promised to open new territory, the potential new field would add to the stocks (excess inventory already above ground but unrefined), and tended to depress oil prices. The other trend was the emergence of the professional oil manipulator, who used rumor and uncertainty to affect the momentum and direction of the market.[64] One class of manipulator was comprised of some of the operators themselves. Their tool was the mystery well.

Mystery Wells and Oil Scouts

Petroleum exploration was in its infancy when the first operator declined to share information about his well. In the early days, this was for purely personal reasons; if a well in unproven territory—a "wildcat"—was successful, the lucky operator might succeed in leasing the surrounding area without competition. As previously noted, by the 1880s most big operators had become heavy investors in the speculative market. The earliest well where the link between speculation and mystification became apparent was the Van Scoy "Dew Drop" well, near the mouth of Kinzua Creek. In August 1880, the owners of the wildcat well alternately reported gas, then a show of oil, then salt water a few days later. Then they stopped giving information altogether. Meanwhile "pestiferous" rumors abounded in the exchange, wreaking havoc on the market.[65] Boyle notes the response:

> For their own protection, the leading interests in the trade adversely affected by rumors, employed trained men to watch the oil fields and report daily on conditions. These scouts foregathered for the first time at Kinzua and kept watch on its mystery of the Dew Drop; prominent among them were B.S. Tupper , Si [S.B.] Hughes, Jo. B. Cappeau, Jim Giles, Harry Beam, representing the oil trade; Frank H. Taylor, Tom E. Kern, J.C. McMullin and Pat Boyle, representing the press.[66]

Daniel Goettel, an "active" trader, had first conceived the need for a field

[63] *Petroleum Age* 1 (Nov. 1881) 19.

[64] Boyle, in *The Oil Scouts,* 10-11.

[65] *Derrick's Hand-Book* 1, 327, 331; Boyle, in *The Oil Scouts,* 11.

[66] Boyle, in *The Oil Scouts,* 10-12.

reporter to counter market-damaging rumors and had hired Silas B. Hughes as his scout. Other traders noted the innovation, and Hughes soon had several colleagues, placed there by brokers, producers, and other interested parties.Most of the scouts cooperated with each other and shared information. The job of the scout was to keep tabs on the new wells likely to be important to the trade, whether mysteries or not; to make accurate estimates of the total production of a field, and keep his principal well informed of developments. His reward was a salary of about $150 a month, plus a percentage of the profits made resulting from information he furnished. His expenses, including bribes, were furnished by his sponsor.[67]

The activities of this fraternity have passed into the regional lore. The oil scouts exemplified all of the manly qualities most prized in the business world of the late 1800s: pluck, nerve, ingenuity, resourcefulness, and bravery in the noble battle with the manifestation of economic evil: the manipulative speculator and his mystery well. Since the purposes of the mystery well were indeed less than ethical, the scouts used whatever means were necessary to obtain information about the "true inwardness" of the well. Property rights were blithely ignored. Some scouts simply sneaked under the derrick and obtained a sample of oil, or surreptitiously measured the depth of the well. Others resorted to bribery and burglary.[68] The overall effect may be likened to countering a card shark with marked cards.

The Van Scoy "Dew Drop" well was pronounced by the scouts to be a small well. That information, relayed to their principals in the exchanges, allowed their sponsors to profit by that news before it became general knowledge, as the market rose in response.[69] No account exists of those unfortunates who lost heavily for not being privy to such information.

Cherry Grove, 1882

At the beginning of this period, most of the land that lay between the Bradford and Venango-Butler developments was essentially wilderness. Tionesta Creek winds in a spiral around an elevated plateau known as the "Big Level" in Cherry Grove Township of Warren County. As it enters Forest County, it cuts a

[67] Whiteshot, 139; A.R. Crum, ed., *Romance of American Petroleum and Gas,* Vol. 1 (Oil City: Derrick Publishing Company, 1911), 104.

[68] Boyle, in *The Oil Scouts,* 10-12.

[69] *Ibid.* Though the discovery well was a small producer, it led the way to considerable drilling and activity in the immediate area. The Kinzua development peaked in 1885.

gorge in the plateau, which continues to the south to Marienville and Clarion County. In its primitive state, the plateau and surrounding areas were covered with a dense pine and hemlock forest. The early timber industry removed the accessible pine, leaving most of the hemlock, which was of lesser value.

The postwar era saw the establishment of several large tanneries at Stoneham, Clarendon, Sheffield, and Brookston. Sheffield alone had three tanneries. Raw material for these tanneries, besides hides, was immense quantities of tanbark, which the bark-peeling crews obtained from the hemlock stands. An early practice was to drop the hemlock, peel its bark, and leave the rest of the tree to rot—essentially the same procedure used to obtain the buffalo hides that some of the tanneries processed.[70] Horton, Crary and Company, headquartered at Shef-field, was one of the largest tanneries in the area. It maintained several plank roads in the area of the Big Level west of Sheffield, where it owned several large tracts of land. Horton's road wound up the hill from Sheffield, and the Rockwell tannery's road followed Farnsworth Branch from North Clarendon. Both roads converged at the summit, on the lands of a retired Swedish bark peeler.[71]

One of the first oil prospectors in the area had been Henry Landsrath, an Oil City operator. Projecting lines between proven production and interpolating geological data, he drilled several trial wells near Balltown, Kane, and Sheffield in the early 1870s. All were dry. His last effort was on lot 668 in Cherry Grove township in 1879. Finding no oil at 2,000 feet and with no resources to drill further, he gave up.[72] His leases passed to Warren businessman Frederick Morck, who subleased them to Peter Grace and George Dimick, operating as the Jamestown Oil Company. Dimick, whose experience dated to the early days on Oil Creek, chanced to meet Landsrath, who told him that his next well, had he been able to drill it, would have been on lot 646, two lots north and two lots west of his last dry hole. Grace and Dimick located their first well nearby in December of 1881.[73]

Interest in the well was minimal at first, as there was a considerable amount

[70] Crum, 101; Carll, *Geological Report on Warren County and the Neighboring Oil Regions* (Harrisburg: Second Geological Survey of Pennsylvania, 1883), 161.

[71] Miller, *Petroleum Industry in Warren County,* 73.

[72] *Petroleum Age* 1 (June 1882), 243.

[73] *Ibid.;* Miller, *Petroleum Industry in Warren County,* 49. Some evidence exists that the 646 well was actually located on the southwest corner of lot 635. William O'Neil, a tank builder who worked on the 646 mystery, claims the well was not actually on lot 646, but 635 as noted. If true, the well site is currently owned by the Forest Service. Letter, William O'Neil to Edwin C. Bell, August 24, 1934. Letter in map case at Drake Well Library, Titusville, Pa.

of contemporaneous wildcatting in the Warren-Forest area. At Balltown, Berry & Grandin had drilled several small wells, at least one of which promised to pay its expenses. Below Sheffield, Magee & Horton drilled a fifty-barrel well on lot 396. At Foxburg on the Tionesta, the Darling and Blue Jay wells, the latter projected by perennial wildcatter Marcus Hulings, indicated the presence of oil there too. Operations in the Clarendon field also continued to trend southward, reaching Tiona in 1881. The Dew Drop area near Kinzua Village still attracted lease hunters. Still, opined the *Petroleum Age*, "there has been nothing discovered in Warren County, outside of the Tidioute section, calculated to cause apprehensions of immense and dangerous deposits of oil. A rock which is irregular in formation and 'habit,' is seldom, if ever, found to contain large bodies of any liquid or mineral product." The spotty distribution of the oil so far found, and the attendant dry holes, appeared to bear out this pronouncement.[74]

On January 11, first notice of the Grace & Dimick well was published in the *Derrick.* On March 10, the paper noted that the well was shut down and boarded up, and a guard had been posted. In early April, the well was still under guard with no information voluntarily given. However, the territory around the well was quickly leased by a number of companies, implying that some inside information had leaked out. Indeed, scout Si Hughes had crawled under the derrick and obtained samples of both sand and oil, determined that the well was successful, and notified his sponsor, the Anchor Oil Company. His reward was reported to be $10,000. Anchor leased the adjacent lot, 647, and began erecting a rig. The Mahoopany Oil Company did likewise on lot 611, and Davis & Murphy on 619, among a crowd of others.[75]

The well was finally opened on May 17. Scouts' estimates that morning rated the flow at a hundred barrels a day; then 150; by three o'clock, two hundred barrels; by six o'clock, five hundred barrels. By the next day, it was apparent that 646 was an enormous well. The market broke four cents that day on heavy trading, as 3,324,000 barrels changed hands.[76] Presumably those operators who had scouts in the field suffered little from the turn in the market.

As the Murphy and Mahoopany wells cracked the top of the sand and showed for large wells in late May, oil lease values skyrocketed. Lot 635, owned by Cadwallader, Johnson & Vandergrift (the same officers as the Anchor Oil

[74] *Petroleum Age* 1 (December 1881), 24; (April 1882), 183-184. Wells in these area described in *Derrick's Hand-Book* 1: 338 (Balltown), 335 and 341 (Sheffield), 331 (Blue Jay), 332 (Tiona), and 330 (Dew Drop).

[75] *Ibid.,* 344-347; Miller, *Petroleum Industry in Warren County,* 72.

[76] *Derrick's Hand-Book* 1, 347-349.

Company), was subdivided into five-acre lots and sold at $500 to $1,000 an acre, with a quarter royalty. Murphy sold seventy acres of lot 619 to the McCalmont Oil Company for $1,000 an acre in fee, which in turn subleased it to willing buyers for $300 an acre with a half royalty reserved. More than $2.7 million changed hands between May and July on Cherry Grove lease speculation. At the same time, the value of oil land in the Bradford district plummeted by more than one-third.[77]

The external effects of the Cherry Grove excitement were numerous and immediate. The twin villages of Farnsworth and Garfield rose quickly, less than a mile apart, on lots 636 and 646, respectively. By the middle of June, Garfield had fifteen hundred inhabitants. A narrow gauge railroad was quickly projected from Clarendon to Garfield, to run up Farnsworth Branch. The Warren and Farnsworth Valley Railroad, ironically, never hauled a barrel of oil, but handled a heavy freight and passenger demand. The plank roads of Rockwell and Horton & Crary to Cherry Grove, as the *Petroleum Age* noted, "[came] into first-class play, as there is an immense toll charged. Twenty cents for a single, and thirty cents for [a] double team, and two dollars a load for boilers and engines." At least five hundred teams used the plank roads daily. In that inflated economy, hiring a team and teamster cost an operator twenty dollars a day.[78]

Garfield and Farnsworth, originally nearly a mile apart, grew towards each other until they met. An observer described the scene there in early summer of 1882:

> Here is where the new stock of people have settled, making the woods and fields along both sides of the public highway, for several miles in length, appear as a nucleus of a young city. The buildings are by no means all of the substantial order, many being composed of tent material. . . The weather being fine, the shelter offered by the pleasant shade trees, which appear to smile in their dignity over the scene, has frequently been appropriated by those who are not supplied with an abundance of the wealth of the land.
>
> . . . The home life of the inhabitants is truly of the primitive style. In many instances all that constituted the dwelling-place of families was a few boards, elevated at one end by a pole between two trees, the other end of the boards resting on the ground. Here are women and children,

[77] *Ib id., Petroleum Age* 1 (June 1882), 244; Miller, *Petroleum Industry in Warren County,* 81.

[78] *Petroleum Age* 1 (June 1882), 265; (August 1882), 297.

> apparently enjoying their surroundings, all for the purpose of improving their financial conditions. Some have canvas tents, which are much more pleasant. Hundreds of these tents and slab shanties are labelled [*sic*] 'Bottling Works,' which is another name or title for whisky saloon. Small grocery stores are constructed on the same plan, having the solid earth for the ground floor and the heavens for the upper story. In the towns of Farnsworth and Garfield, which are rivals for superiority, some more substantial structures have been erected, but an air of limited duration and 'we'll have to get up and get shortly' seems to pervade everything and everybody.[79]

One of the more prevalent shelter types was the "brush camp," a collection of cut hemlock limbs arranged in a circle. The trunk ends faced inwards, and smaller branches were piled on top of the larger ones. The camp builders, usually strangers, gathered firewood and built a fire in the center of the circle. After a night's sleep, they went their separate ways. More than a hundred of these camps lined the road between Farnsworth and Garfield.[80] At the peak of the boom, the population of the plateau, in and out of doors, was estimated at over 15,000. More substantial lodging, such as the Cherry Grove House at Farnsworth (generally acknowledged to be the rowdier end of town) and the Jamestown House at Garfield lodged the better-heeled visitors, which included General George B. McClellan in September. The Jamestown House became the headquarters for the oil scouts for some time to come.[81]

When the other wells, started after the 646 mystery, began to come in as gushers in late June—eclipsing even the Grace & Dimick well—tankage and pipeage was quickly overwhelmed. Five competing pipelines vied for the production. The Union Pipe Line ran an eight-inch gathering line to 646, and the Standard-owned United ran a three-inch line to the Murphy well. As it quickly became apparent that the rapidly increasing production would outstrip even these facilities, the Standard line purchased two of its competitors, the Union and Warren pipelines, and hastily erected a large pumping station a mile south of Garfield at Vandergrift Corners. This station consisted of eight 90-horsepower boilers and two huge pumps, and took only thirty-five days to construct at a cost of more than a million dollars. It was reputed to be the largest in the United system.[82]

[79] *Petroleum Age* 1 (August 1882), 297-299.

[80] Crum, 102.

[81] Whiteshot, 71; Miller, *Petroleum Industry in Warren County,* 63, 74.

[82] Crum, 103; *Derrick's Hand-Book* 1, 348; Miller, *Petroleum Industry in Warren County,* 76-77.

Still, the pipelines could not handle all of the production. Tank builders stayed busy as the pipeline companies required four thousand barrels of tankage at each well to "settle" the crude. The output of the field grew exponentially. On June 22 the five producing wells flowed nine thousand barrels daily; by July 15, 14,722 barrels flowed from fifteen wells; by July 23, thirty-two wells produced upwards of 18,000 barrels daily. Scores of wells began flowing oil at more than a thousand barrels as soon as the sand was reached. Lot 635, which had been heavily subdivided, became the center of the action, as almost all the wells came in at gusher rates. There, the Clark & Goldsborough well came in at 1,200 barrels; Anchor, 900 barrels; Reed & Brenneman, 450; Nickle [*sic*] Oil Company, 1,000; C.H. Cramer, 1,700; and Coldren Brothers and Lecky, 1,800 barrels.[83] Much of it ran to waste. The Anchor Oil Company's well on 647 caught fire from a workman's lantern and burned for ten days, while flowing at a two thousand barrel rate.[84] Many other wells flowed onto the ground for lack of adequate tankage. The *Derrick's* reporter noted a "perfect stream" of oil running down Murphy hollow.[85]

The field peaked in late July and August and began to decline, as the wells at Cherry Grove showed a disconcerting tendency to quickly drop off in production. Wells that began at 1,500 or 1,800 barrels dropped to 100 or 250 barrels in just a few days. For example, the Sardine Oil Company's well on lot 635 came in at 2,000 barrels. The next day it made 1,128 barrels; the third day, 594 barrels, and the sixth day, just 274 barrels. From a high of over 40,000 barrels a day on the first of September, the production of the entire field (consisting of over two hundred producing wells) dropped precipitously to only 7,930 barrels daily by November. Shooting the wells heavily with nitroglycerine did not improve production more than temporarily. Operators who had gotten into the field late and paid premium rates for leases were lucky to cover their expenses. Nine-tenths of the operators who drilled at Cherry Grove emerged as heavy losers.[86]

Though Farnsworth and Garfield waned as quickly as had the oil, the city of Warren reaped the majority of lasting benefits accruing from the boom. Already profiting from the Glade and Clarendon developments, it became the supply and service center of the new field, located advantageously as it was on the river and railroad routes. All manner of supply and outfitting establishments boomed,

[83] Well gauges: *Derrick's Hand-Book* 1, 350.

[84] This early "wild well" was finally extinguished when an explosive projectile cut off the casing head and the flow was diverted. *Petroleum Age* (July 1882), 269.

[85] *Derrick's Hand-Book* 1, 349-351; waste described, 352.

[86] *Ibid.*, 350, 353-355; McLaurin, 196.

serving both oil men and oil wells; a petroleum exchange was established, and the Western Union telegraph office became one of the busiest in the system.[87]

By the spring of 1883, the magnitude of the overdevelopment became apparent. As of May, 426 wells had been drilled at Cherry Grove. Thirty-three were dry, seventy-four had been abandoned, and the remaining 319 wells produced a total 2,400 barrels daily. The total cost of leasing, drilling, completion, and production totaled at least $3,143,525; the producers realized just over $2 million on sales. Thus the net loss to producers was at least $1.3 million.[88] The biggest loser was United Pipe Lines. A month after the million-dollar pumping station at Vandergrift was built, the Standard company needed only one small line to transport the entire production of the field. The Warren and Farnsworth Valley Railroad arrived at Garfield too late for the party, but managed to survive by carrying tanbark and hemlock logs to the mills and tanneries.[89]

Cooper and Balltown

While the Cherry Grove excitement was in full swing, several wildcat wells, drilling just south of Warren County along the Tionesta River in Forest County, attracted the notice of the oil trade. As noted above, oil had previously been found in scattered locations in Forest County. The first well in the area was drilled in late October 1865 by the Forest County Petroleum Company, composed of New York capitalists, on the lands of Charles J. Fox, at Foxburg (near present-day Lynch), a mill seat on Tionesta Creek. The showing of oil at shallow depth did not warrant further development at the time. In 1876, Marcus Hulings also drilled at Foxburg on the river bank, using power from the mill's water wheel. Again oil was found, but not enough to keep Hulings from searching for more prolific territory northwest towards Bradford.[90] C.A. Schultz (a piano tuner) and F.M. Morck (a jeweler and watch repairman who had leased lot 646 to Grace and Dimick) obtained the lease on the Fox estate straddling Tionesta Creek and the Cooper farm tract on warrant 2991 directly to the north. Their Blue Jay well, named for the creek that runs into the Tionesta at Foxburg, was drilled in 1880 and also made a light showing.[91]

[87] Miller, *Petroleum Industry in Warren County*, 73-74.

[88] *Derrick's Hand-Book* 1, 380-361.

[89] Crum, 102.

[90] *Derrick's Hand-Book* 1, 53; *History of McKean, Elk, and Forest Counties*, 818-823.

[91] *Derrick's Hand-Book* 1, 331.

The Magee & Horton strike at Lower Sheffield, on a forty-five-degree line northeast, had recently found oil in a red sand more than three hundred feet below the Clarendon horizon. Encouraged, Schultz and Morck subdivided their Cooper territory, leasing lots on reasonable terms. John Mainwaring leased lot D of one hundred acres in the southwest corner of 2991, built a rig at the head of a ravine, and then abandoned the venture. He could hardly have found a worse time to drill, as Cherry Grove had profoundly depressed the oil market. Philip M. Shannon (formerly the burgess of Millerstown, today Chicora, during the Butler County boom in the early 1870s) had missed the Cherry Grove excitement, but instead took up the lot D lease and began drilling in the summer of 1882. Captain Haight, a veteran driller, contracted to drill the well.[92]

At 1,800 feet with no sign of oil, most of the interested parties conceded failure. Haight consented to drill deeper and spliced another drilling cable to the end of the first. Twenty feet deeper, Haight cracked the top of a white sand that quickly filled the well with oil. After they narrowly succeeded in plugging the well, Shannon operated it as a deliberate mystery, with an eye to manipulating the market. As the owners boarded up the derrick and posted armed sentinels, the scouts gathered to solve the mystery.[93]

Confident that they had a large well—it continued to flow despite several plugs and a hundred feet of bailings tamped into the hole—Shannon and his cohorts sat on the Cooper tract well for two months waiting for a rise in the market. When the market strengthened as Cherry Grove waned, they sold almost a million shares short, and proceeded to drill the plugs out of the well. Scout J.C. Tennent watched the telltale splice in the cable approach the same position it had been in when the tools first pierced the sand, then observed the gas emerging from the vent cupola on the tank house to estimate the flow. He concluded that the well was not as large as was thought. When he notified his principals in the exchanges, the market quickly advanced fifteen cents on the news, and Shannon and his associates had to cover their short sales.[94] The Shannon well cost its owners heavily in the market, but still stood as a fair producer. It opened a considerable amount of territory in Forest County, and operators retreating from

[92] *History of McKean, Forest, and Elk Counties*, 823-824.

[93] Tennent, *The Oil Scouts*, 19-23.

[94] *Ibid.* Here Tennent relates the story, widely retold and exaggerated, of being fired at by a Shannon well sentry. Lying prone behind a downed hemlock while observing the well, he accidentally snapped a branch, which drew the fire of the nearby guard. The bullet lodged in the tree two feet from his position. It did not part his hair, nor put a hole in the bunched fabric of his trouser knee, nor did Tennent return fire. It remains one of the colorful bits of lore that romanticized the era of the oil scouts.

Cherry Grove considered it promising acreage.

Meanwhile, similar events had been transpiring fifteen miles down the Tionesta at Balltown. In 1875, Judge John A. Proper of Tionesta and J.B. Agnew had formed the Balltown Oil Company, with Peter and David Berry, E.B. and J.L. Grandin, and W.T. Scheide as principals. With a lease of 4,000 acres of the "Balltown lands" (owned by the Pittsburgh & Forest County Oil and Lumber Company and consisting of warrants 4821, 4823, 4792, 3195, and 3197), they drilled a test well adjacent to the village on the river bank in the spring of 1876. Peter Berry, the guiding force of the company, had chosen the area because it was located directly between the Bradford and Edenburg (Clarion County) developments. Berry, who had learned the oil trade at Tidioute and Fagundus, salvaged the rig from an old well he had purchased in 1872 to drill the Balltown well. Though it ultimately made a show of oil, it created excitement only among its owners. The well was twenty-five miles distant from Sheffield, the nearest rail shipping point, over notoriously rough and treacherous roads. [95]

Over the next several years the Balltown Oil Company made two more tests, on Blood Run and Logan Run south of the Tionesta, both of which were dry. Returning to the banks of the Tionesta, Berry then drilled opposite the abandoned logging camp of Balltown, where he was rewarded with a hole full of black, tarry oil at a shallow depth. The company pumped a tank full of the thick oil before they found that no market existed for it. The showing, though, prompted the formation of another Tionesta company, May & Kelly, which leased part of the 4,000 acre Cook lands, including warrants 5236 and 5266 to the southwest of Balltown, in 1880. After Cook No. 1 on 5266 came in a dry hole, they consolidated with the Balltown Oil Company as the new operating company of May, Kelly & Grandin, and leased the balance of the Cook lands on warrants 5216, 5215, 5267, and 5235 in the spring of 1881. More dry holes followed. In May 1882, the company located their next attempt on Brush Camp Run on Warrant 5236 at the spot their late senior officer, H.H. May, had proposed before his death. The well, Grandin No. 3, reached the top of the sand in August.[96] The owners were present as the well made an impressive flow and decided to operate it as a mystery. Its location, distant from concurrent developments at Cherry Grove and Cooper, created logistical problems for the oil scouts, who nevertheless were compelled to watch the well. Berry—remembered by the scouts for his wild, flowing beard, his four-foot club, and his ready

[95] *History of McKean, Forest, and Elk Counties*, 820-821; *Petroleum Age* 4 (August 1885), 1052-1053.

[96] *History of McKean, Forest, and Elk Counties*, 821-822.

command of an impressive selection of blasphemous oaths—held off the scouts for several months. He opened the well in December only after tanks and pipeage had been provided, whereupon the well flowed over 1,000 barrels. For the scouts, this was vital news; Cherry Grove had glutted the market and this well appeared to mark a ten-mile extension of that prolific field. The resulting panic, to the delight of the "shorts," dropped the price of oil fourteen cents in the exchanges.[97]

The market furor caused by the news of Grandin No. 3 underscored the irrationality of the oil market in terms of actual production. Since September both daily production and stocks had declined, but the exchanges continued to fall victim to the machinations of the market bears. "Forest County . . . should have no greater effect than any spot of territory in the midst of the little wells of the McKean District. [But] every time a well touches the sand in that (Forest) locality it seems to command special attention at the hands of the Shorts," grumbled the *Petroleum Age* in November 1882. As an example, a strong well on the Cooper Tract, drilled by the Anchor Oil Company directly between two proven producers, caused an eleven-cent drop in prices, even though it could not possibly have missed. The uneasiness of the market since the debut of Cherry Grove underscored the fact that another field of that magnitude would wreak havoc for capital invested while prices were higher, and "there is nothing more timid at the hour of trial than capital."[98]

Fortunately for capital, Balltown and Cooper did not blow themselves out of proportion. As the majority of property at Balltown was controlled by a confederation of operators, the field's development proceeded in an orderly manner. The Cooper field's acreage was not so closely held, and many operators fresh from Cherry Grove tried their luck again there. The aforementioned Anchor well, the Murphy well, and the Clark & Foster well were some of the early strikes at Cooper. In late December 1882 the Reno Oil Company well on Cooper came in much stronger than expected, at 1,800 barrels, and caused a minor panic.[99]

The "disgusting practice" of mystifying wells continued in the Cooper Tract, where it reached its highest development—or lowest, depending upon point of view. A number of heavy speculators, some of whom had scouts in the field, purchased a promising well just before it reached the sand for the sole

[97] Tennent, 24-27; *Petroleum Age* 4 (August 1885), 1054-1055.

[98] *Petroleum Age* 1 (November 1882), 392-393.

[99] *Derrick's Hand-Book, 355-356.*

purpose of manipulating the market. The drillers were instructed to bring the Patterson-Leedom well in so as to make it appear light, to advance the market; then they were to break it loose as a gusher. As some of the scouts' principals were involved, those scouts were given a vacation; but with divided loyalty they gave indirect assistance to the other scouts. The operators used a variety of subterfuges to deceive the scouts, including surreptitiously dumping oil in the hole to stain the drilling cable, in order to create the appearance of a light, non-flowing well. However, the well unexpectedly came in dry, surprising both owners and scouts.[100] Like the Shannon well, the Patterson-Leedom well caught its owners short in an advancing market, underscoring the lesson that all wells are mysteries until they are completed.

Early 1883 saw the extension of both the Balltown and Cooper fields. The Grandin and Berry interests, operating as the Porcupine Oil Company, moved onto warrant 3194 in the area between Minister Run and Porcupine Run and began a long campaign of drilling successful wells.[101] The Cooper Tract development reached westward towards Balltown to the mouth of Fool's Creek, and northeast towards Sheffield and the Magee & Horton field south of town.[102] The Henry's Mills area also furnished some large wells and eventually connected with the Lower Sheffield pool. The operators in the Cooper field, mostly veterans of Cherry Grove, included Reed & Brenneman, Murphy & Davis, McCalmont Oil Company, and the Union Oil Company, which by purchasing established production had become the largest producer in the Oil Region.[103] In March, twenty-one wells on Cooper Tract produced 1,626 barrels daily. By April, 37 wells made 4,624 barrels. Like Cherry Grove, the wells quickly declined after coming in strongly. In comparison, six producers in the Balltown field made 1,060 barrels in April. Of the twenty wells drilled there, nine were completely dry, and five that showed oil did not pay their expenses. Likewise, in May, a third of the wells completed at Cooper were dry holes. Drilling in Forest County was considerably riskier than in Bradford.[104]

In contrast to Cherry Grove, Balltown proved to be a profitable enterprise for its operators. Through the middle of 1885 the field, consisting of 122 wells,

[100] Tennent, 33-41.

[101] *Derrick's Hand-Book* 1, 357-360.

[102] *History of McKean, Forest and Elk Counties*, 819-822.

[103] Williamson and Daum, 454-455. The majority stockholders of Union Oil Company, H.L. Taylor and John Satterfield, were also directors of the Tidewater Pipe Line, Standard's only competition for long-distance crude transportation.

[104] *Ibid.; Petroleum Age* 2 (April 1883), 469.

produced 1,781,185 barrels of oil worth $1,655,322. The wells, which cost an average of $2,500 each to drill, could have been sold for the customary price of $1,000 per daily barrel of production. In 1900, the field's production was 200 barrels per day, so if the field had been sold at that date—eighteen years after its development—it would have returned nearly its original investment.[105]

Wardwell

While Balltown and Cooper developments progressed, operators in the Glade-Clarendon field had extended the proven territory northwest along the Allegheny River. The oil found in these small, shallow wells closely resembled that of Clarendon; the oil was amber, high gravity and quality, and typically came from a well that produced three to five barrels daily when first drilled in. Therefore, it came as a pleasant surprise that, in the neighborhood of Wardwell's Ferry, five miles east of Glade and the same distance northeast of Stoneham, a number of wells started off with vigor. The Steelesmith well in August 1883 extended the territory, and Reed No. 2 started at 375 barrels in November. This was followed by the Wesley Chambers well, which opened at 250 barrels. Producers' interest in the new pool increased as J.A. Gartlan, also operating in the Cooper field, shut his well down on top of the sand on May 5, 1884, in the now-familiar pattern of a mystery. He opened the well several days later and brought in an 1,000-barrel gusher. If Gartlan had been playing for a break in the market, his timing could not have been better. His strike coincided with a wave of bank failures in New York, the repercussions of which struck hard on the exchanges. In two days, the panic had tossed the price of oil as high as 92 cents, and as low as 65 cents. On the Oil City exchange, sales amounted to 29 million barrels; the next day, 27 million barrels. This volume of certificate sales closely approximated the total of stocks above ground.[106]

Despite the hard economic times, the Wardwell development continued to grow in the summer of 1884, as a double row of derricks sprouted on either side of the Allegheny between Warren and Kinzua Village. The Gartlan well continued to flow strongly, and that summer saw a miniature Cherry Grove drama play itself out in the new gusher field. The Gartlan and Weible wells were the beacons for operators to invest in Mead and Glade township leases. By the middle of July, sixty-three wells produced 3,361 barrels. Through the next

[105] *Derrick's Hand-Book* 2, 178-179.

[106] *Derrick's Hand-Book* 2, 363-372. Wesley Chambers was the first president of the Bradford Oil Company. *Derrick's Hand-Book* 1, 651-652.

month, each day saw the completion of a well in the 500- to 1,000-barrel range. The field peaked in August at over ten thousand barrels of daily production, and then declined in the usual pattern, as nitroglycerine and sucker rods were brought into use. It had fallen to less than five thousand barrels by the beginning of September 1884.[107]

The Shut-Down Movement of 1884

Eighteen-eighty-four was a disastrous year for both the oil industry and the American business economy in general. The "Grant-Ward" panic, the failure of the Penn Bank of Pittsburgh (whose officers had been prominently associated with speculation on the oil exchanges and were duly prosecuted) and continuing low prices for oil made for a discouraging year in the oil business. For 1884, the average price per barrel of oil was $0.83. Additionally, net stocks of oil were at a record high; in August, pipe line reports indicated that there were 39,086,004 barrels of oil above ground yet to be refined. This represented a year and a half's worth of production from the entire industry.[108]

Since the early 1870s, small petroleum producers had banded together to protect their common interests, which were usually threatened by monopolies in transportation, purchasing, and refining. In 1872, this group, the Petroleum Producers Union, first imposed an embargo on sales to the South Improvement Company, a Rockefeller-led combination of railroads and refiners. The protective association also cut production and suspended drilling.[109] Following their victory in this "oil war of 1872," Pennsylvania passed a free pipeline bill due to Union's efforts. The organization's later activities, less successful, included several "shut-down" movements, initiated when oil prices were low and stocks high. The last movement to "stop the drill" had been in the Bradford field in 1879, when a lack of storage left wells pumping oil onto the ground. The attitude facing a mutual-benefit combination of producers at Bradford was summed by an opposing group of producers: "Whereas, the shortest way to two dollar oil is through 25-cent oil; Therefore be it, Resolved, that we favor the pushing of the drill as rapidly and diligently as possible until the goal of 25-cent oil is reached."[110] This sentiment, made only partly in jest, underscores the perennial willingness of many producers to drill for and pump oil regardless of the market.

[107] *Ibid.*, 373; *Petroleum Age* 2 (September 1883), 530.

[108] *Derrick's Hand-Book* 1, 711, 809.

[109] Miller, *Petroleum Industry in Warren County,* 40-41; Williamson and Daum, 352.

[110] *Derrick's Hand-Book* 1, 314.

The Producer's Association met at Bradford on June 12, 1884, and circulated a pledge for a six-month shutdown as the Wardwell pool began to boom. The *Derrick* predicted success as "hundreds of producers are signing the pledge, including the big companies." By the middle of August, new operations had come to a virtual halt in the Regions, and more wells shut down daily, as the Producer's Association counted over seven hundred firms and individuals who had signed the shut-down pledge. The association also published a list of those producers unwilling to sign the pledge.[111] These recalcitrant operators included most of the Wardwell operators and T.W. Phillips, one of the largest operators in the Butler region. A new pool he opened in August on Thorn Creek, south of Butler and some of the most southerly wildcatting to that date, favored him with the largest gushers yet seen. The Armstrong, Phillips, and Christie wells, just yards from each other, began flowing more oil in an hour than many famous gushers had in an entire day. The Phillips well, the first in the pool, flowed 150 barrels an hour from three pay streaks. The second well, the Christie, flowed almost 300 barrels an hour—five thousand barrels its first day—and was acclaimed as the biggest well in history to that date. The Armstrong well, which appeared to be a dry hole until it was shot, responded with a flow of an estimated 500 barrels an hour, but could not be accurately gauged since it flowed wild for several hours. These 5,000 to 10,000 barrel wells had a predictably demoralizing effect on the oil market, which dropped into the sixty-cent range in October.[112]

The shut-down movement lost its momentum, as prices rose after the Thorn Creek pool waned. Still, the operators, never before known for their cohesiveness, in large part resisted the urge to join their colleagues in the gusher fields and stuck to their pledges. During the period from September 1884 through February 1885, fewer wells were completed than at any other time since before the Bradford field began producing in 1875. The "stop the drill" movement, then, was a qualified success.[113]

Kane, 1885

The last field developed in the region during this notorious era was in wildcat territory, where Warren, Forest, Elk, and McKean counties come together at a point on the headwaters of the Tionesta west of Kane. In this area, F.J. Clemenger, a veteran producer from the days of the Pithole boom in 1865, leased one thousand acres of Elk County warrant 3788 in 1879. Marcus Hulings

[111] *Ibid.*, 372-374.

[112] *Ibid.*, 374-380, 742, 791.

[113] *Ibid.*

had just located the Guffey field on the Kinzua, and Clemenger extended Hulings' line from the Bradford field through the Kinzua Creek development to a point southwest of Kane. His first well, Roy & Archer No. 1 on the center of warrant 3788, was drilled to the depth of 2,188 feet in early 1880, considerably deeper than expected to be necessary for the Bradford Third Sand. The well produced gas, but no oil. So did their next well, to the extent that the gas pressure was used directly in the cylinder of the steam engine to drill the third well. The showing of oil in the third well, completed in September 1881, was sufficient to interest Joseph P. Cappeau, scouting for the Forest Oil Company, into taking a lease on warrant 3767 northwest of the gas wells.[114]

Cappeau, who at age 19 had been the youngest oil scout, at 25 was now one of the youngest operators. His partner, Joe Craig, was a broker at the Pittsburgh Oil Exchange. Both had made money on the rise in the market following the decline of Thorn Creek in early 1885, and now invested in some wells of their own. Their first well, located 225 rods from the east line of the warrant and 76 rods from the south line, started drilling in early August and reached the sand on November 11. The well flowed even after the drillers inserted two plugs.[115]

At the time, they believed that they had struck the Bradford Third Sand, as it was a dark brown color similar to that in the Bradford and Guffey fields. In a now-familiar pattern, the oil market broke twenty-five cents on the news of a flowing well in entirely new oil territory. By first of December there were fifteen wells drilling and seventeen new rigs being built in the new pool. However, wells on surrounding leases failed to find oil, and several did not even find the same sand formation. Four straight dry holes braced the market somewhat. As the development of the field progressed, it became apparent that Craig & Cappeau had center-punched the pool rather precisely, as at no point on their lease, it seemed, could a dry hole be found. To the north, the Union Oil Company on lot 425, the Kane Oil Company on 426, and Coast & Thyng on 420 all held good territory. To the south of the Craig and Cappeau lease, warrant 3775 had been subdivided into twenty lots; Reed & Brenneman, E.H. Jennings, and the Kane Oil Company were among the lessees there.[116] The name of the oil town that grew on the north end of warrant 3767, JoJo, was a combination of the first names of the fortunate operators. The James Brothers logging interests extended a railroad from Kane to the new boom town.

The Kane field was exploited with noteworthy speed. By April, Craig and Cappeau and Union Oil Company each had twenty-three wells producing or

[114] *Petroleum Age* 4 (December 1885), 1187-1190. The Roy & Archer wells were commercially successful gas wells and supplied Bradford and much of McKean County with commercial gas service.

[115] *Ibid.;* also *Petroleum Age* 5 (January 1886), 1224.

[116] *Petroleum Age* 5 (April 1886), 1292 and map.

underway, and twenty-nine wells produced 2655 barrels. For May, the daily gauge increased to 3,858 barrels. The most prolific wells were found on the dividing line between lots 425 and 426, where some of Union's wells came in at 300 barrels each.[117]

As geologists reviewed the drilling data, it became apparent that the Kane field had tapped a new sand. The Kane Sand, at 2,200 to 2,500 feet below terrain, lay a good bit deeper than the Bradford sand horizon. The geologists of the Second Pennsylvania Survey could have given the Kane producers more assistance, had they been allowed. In this era, however, petroleum geology was little understood and generally scorned by the producers, who noted that geology had yet to fill an oil tank. Pennsylvania's state geologists, particularly J. Peter Lesley, John Carll, and Charles Ashburner, had made many important contributions to petroleum geology, including the first instance of subsurface contour mapping (by Carll). A former member of the Pennsylvania survey, Dr. I.C. White, was at the time laying out an enormous leasing program for J.M. Guffey in West Virginia which, had it been carried out, would have secured a significant portion of the future production of that state for Guffey.[118] As it was, however, the secretiveness, rumors, and disinformation prevalent in the speculative era hindered scientific examination of local stratigraphy and infuriated professional geologists. Lesley wrote in 1885:

> . . . The geologist can learn nothing when new wells, both productive and unproductive, are guarded against investigation, and what is said of them is more probably false than true. Pennsylvania may be vain of her possession of this most wonderful treasure; but she cannot be proud of the utter demoralization of the crowded population which scrambles for it in so unmanly and thriftless a manner. The next generation will gather from our oil history, with angry astonishment, a lesson of warning in political economy, only useless because coming too late . . . When the reservoirs are exhausted there will be an end of it. The discovery of a few more pools of two or three million barrels each can make little difference in the general result; they will enrich a few gamblers; and only such gamblers as can corner the market.[119]

[117] *Ibid.*, 1292-1293.

[118] Randall, op. cit., 50-55; Derrick's *Hand-Book* 1, 851.

[119] J.P. Lesley, foreword to J.F. Carll, *Geological Report on Warren County and the Neighboring Oil Regions* (Harrisburg: Second Geological Survey of Pennsylvania, 1883), xiv.

5. Stabilization, 1886-1902

Changing Trends in Production

While Pennsylvania continued to pour out the overwhelming majority of the national crude supply, both West Virginia and southeastern Ohio—long noted for petroleum seeps and "burning springs"—had produced commercial quantities of oil as early as 1860. However, only the shallowest deposits were accessible to the drilling technology that existed through the 1870s. In 1883, some attention focused on the Macksburg field in southeastern Ohio, enough for some of the oil scouts to evaluate it for the oil trade. The field made noteworthy production well into the following year.[120] In Pennsylvania, strikes in southern Butler, Allegheny, Washington, and Greene counties in deep sands (actually the same sands as in the Venango district, but lying much deeper) showed that the trend of production lay to the south. One by one the erstwhile Bradford and Warren-Forest operators took leases in southwestern Pennsylvania. As early as 1885, well-known Oil Region operators such as the Union Oil Company, J.M. Guffey, and John McKeown began operations at Washington. [121]

After the lubricating oil fields at Volcano had been thoroughly exploited by the late 1870s, West Virginia's production dropped to just a few thousand barrels a year in the early 1880s. By 1885, several operators were willing to again wildcat the territory, which now looked much more promising. By this time, the technology had been developed to drill to that state's deeper oil horizons through the soft Permian and Carboniferous formations that tended to cave in the well, and Pennsylvania capital was finally willing to invest outside that state. In 1889 West Virginia began its second oil boom, fueled by simultaneous discoveries in widely scattered areas.[122]

Still, these new fields were not greatly distant from the birthplace of the industry. The truly notable shift in production trends was the discovery of oil in 1885 in the Trenton Limestone formation at Lima in northwestern Ohio. Though gas had been proven to exist in the area, oil was not known to accompany it until a drilling gas well struck a deposit of thick, sulfurous crude. It could not be

[120] *Derrick's Hand-Book* 1: 356, 367-372 *passim.*

[121] *Ibid.*; 434.

[122] Eugene Thoenen, *History of the Oil and Gas Industry in West Virginia* (Charleston: Education Foundation, 1964), 197-207.

refined into illuminating oil using known methods, as the sulfur was difficult to remove and rendered the oil unfit for burning in lamps.[123] Because of its inferior quality, refineries paid only $0.15 per barrel; its primary use was as fuel oil, a market that the rapidly increasing production encouraged. By the end of the 1880s, Standard conquered the sulfur problem with the Frasch distillation process and refined the Lima oil into an acceptable illuminating product, while continuing to pay a pittance for the crude.[124]

The net result of these developments was that petroleum became more of a national industry, rather than a regional one centered in northwestern Pennsylvania. Geologist J. Peter Lesley was correct when he noted that Pennsylvania's resources were limited and production would surely decline. The state reached an all-time high in production in 1891 and fell steadily thereafter.[125]

Pennsylvania's last great gusher pool was discovered at McDonald, southwest of Pittsburgh, in 1890. Its production grew more slowly than Cherry Grove's, but reached a much higher daily total (83,000 barrels) in November 1891. It sustained its production through 1894. The McDonald field, and its sibling competitive field at Sistersville, West Virginia—the two fields vied for the honors of top daily producer for several months in 1891 and 1892—decisively shifted the headquarters of the Pennsylvania oil campaign to the "Southwest," as the Oil Region's newspapers and journals termed any producing area south of Butler.[126] The Lima field, which extended into Indiana in the 1890s, served to accentuate this geographic shift.

Standard Oil's Role

The all-powerful Standard Oil Company was involved primarily in refining, marketing, and transportation until the mid-1880s, and was little involved with development and production of the Middle Field.[127] By the late 1870s Standard

[123] Williamson and Daum, 590-592.

[124] *Ibid.*, 599-600, 616-619.

[125] State-by-state production figures: Whiteshot, 800.

[126] *Derrick's Hand-Book* 1, 527-560 *passim.*

[127] A knowledge of the basic history of Standard Oil is absolutely essential to understanding the evolution of the nineteenth century petroleum history; but space does not permit its adequate treatment here. There does not seem to be a brief history of the corporation other than Gilbert Montague's *The Rise and Progress of the Standard Oil Company,* which was authorized by Standard. Ida Tarbell's *The History of the Standard Oil Company,* 2 vols. (New York: McClure-Phillips and Company, 1904) remains one of the best contemporary accounts of the corporation.

had successfully integrated horizontally throughout the entire petroleum refining industry, and by 1880 also dominated the pipeline network. When the shut-down movements threatened its crude supplies in 1884 and again in 1887, Standard turned its attention to production. It did this first in the Lima field, where producing leases could be bought cheaply, since the sulfur-laden oil brought little return on investment. Thus, by the late 1880s, Standard was vertically integrated throughout the Midwest, from production and transportation to refining and marketing.

In 1889 Standard moved into the production business in the Appalachian field with the formation of the South Penn Oil Company. Its first president, Noah Clark, had a long association with Standard, first as a purchasing agent for a Cleveland refinery subsequently swallowed by Rockefeller. Clark became a producer in the Bradford field as Clark & Foster, previously mentioned in connection with the Cooper Tract development. Clark & Foster's producing leases became the nucleus of Standard's Appalachian field production. Many smaller leases with established production were acquired in this way. Other properties merged into South Penn included the Anchor Oil Company in 1890 and the Union Oil Company in 1892. Two other producing interests that allied with Standard, but were not absorbed, were the Carter Oil Company in 1895 and the Forest Oil Company at about the same time. As well as buying established production, Standard (through South Penn) commenced a leasing and exploration program of a magnitude to be expected of an organization with practically unlimited resources. In this manner, Standard came to control about one-quarter of Pennsylvania's oil production. South Penn's descendant, Pennzoil, is still the largest producer of crude oil within the Forest boundaries.[128]

By 1895 Standard was well established in the production area of the petroleum business in addition to their total domination of refining and transportation. That year the Joseph Seep Agency, Standard's purchasing arm, announced that henceforth they would issue daily bids for crude at prices that were not necessarily tied to the open market quotations on exchange. Since Standard was by far the dominant buyer of crude, this action effectively ended the era of speculation on the crude exchanges, in keeping with Standard's efforts to rationalize the industry during its boisterous growth phase. Few in the business lamented the passing of this aspect of the region's petroleum industry. The last oil certificate was exchanged in 1908.[129]

[128] Whiteshot, 187; Crum, 339; *Derrick's Hand-Book* 2, 218.

[129] Boyle, introduction to Tennent, *The Oil Scouts,* 8.

Local Developments: Deerlick, Watson-Duhring, Klondike

Several noteworthy and productive fields were discovered adjacent to older proven areas in the Middle Field after the momentum of the industry had decisively shifted south. In January 1890, J.M. Clapp found a small pool on Deerlick Run northeast of Sheffield on lot 169. The discovery well flowed 350 barrels a day, and Clapp sunk three more wells in quick succession. Some of the wells were quite productive, flowing up to fifty barrels an hour. A rush followed to develop the pool, which was quickly defined on all sides by dry holes. Horton & Crary found oil on lot 170 but a dry hole on lot 196. At its peak in March 1890, the pool produced 3,570 barrels daily, and by April, there were thirty-one producing wells at Deerlick. Fortunately for producers, oil was selling for more than a dollar a barrel due to dwindling stocks, and the pool's productivity did not adversely affect the market. [130]

By 1890, the old Cooper field had been extended northwest to Martin, where several good wells were drilled by the Sheffield Syndicate. The Cooper field was also extended in a southward direction along Blue Jay Creek in the vicinity of Watson Farm. This development became known as the Watson-Duhring field. Later the Cheseborough Company obtained producing leases in this field as a supply of petrolatum for their "Vaseline" product and as a base for other cosmetics.[131]

The largest new development in the Middle Field during the 1890s was southeast of Kinzua at Watsonville beginning in 1896, where operator L.E. Mallory drilled a 200-barrel well on warrant 5572 in August. Mallory, a second-generation oil man, began his career on Oil Creek dressing tools for his father. He operated at Pithole and Pleasantville in the 1860s, Clarion and Butler in the 1870s, and Lima in the 1880s, consistently drilling in the early phase of each field's developments.[132]

Mallory & Company's second well on the adjacent Post lot started at 125 barrels in September. The new pool topped one thousand barrels daily production in October. The Devonian Oil Company, which had been a prominent company at McDonald and in West Virginia, drilled on lot 7 and found several productive wells. [133]

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[130] *Derrick's Hand-Book* 1, 502-508.

[131] *Ibid.*, 508,; Ingham et al., *Sheffield Quadrangle*, 4-5; Woman's Club of Marienville (Pa.), Comp., "History of Marienville, 1832-1976" (Tionesta: Forest Press, 1976), 96.

[132] *Derrick's Hand-Book* 1, 616-681.

[133] *Ibid.*, 616-622.

By late fall there were thirty-three producing wells in the Watsonville pool with an aggregate output of 2,200 barrels daily. The field continued developing steadily for the next several years, occasionally furnishing very prolific wells. L.E. Mallory developed Lot 6 in the spring of 1897, and Lot 17 that summer. Also in 1897 Devonian drilled on the Haffey lot, and South Penn Oil Company joined the development on lot 4910, where its second well caught fire from the forge and destroyed the rig.[134]

As eventually developed, the area around Watsonville, now known as the Klondike field, furnished oil from a variety of producing sands contained in small pools. The list below details the eight pools of the Klondike Field, with their discovery dates and productive formations:

Watsonville Pool. Discovered in 1896 by L.E. Mallory and Company on Warrant 5572, Devonian Lot 8. Wells in Watsonville Sand. This is the largest pool in the Klondike Field.

Swamp Angel Pool. February 1896. Seven wells in the Bradford Second sand.

West Watsonville Pool. Discovered March 1896; oil in the Watsonville sand.

Bucklick Pool. October 1896; the discovery well was Fogle No.1 in the Clarendon sand.

Mallory Pool. Opened in 1900 with Van Scoy Mallory and Company's Wilkeson No. 1 on Warrant 3705. The Wilkeson well's initial production was 100 barrels per hour from the Watsonville sand.

Jungle Pool. Discovered in November 1908 with production from the Dewdrop sand.

Sugar Run Pool. Discovered in September 1910; first well was L.E. Mallory's No. 1 Hemlock on Warrant 3705, with oil in the Dewdrop sand.

Pigeon Run Pool. Discovered in 1912. Gas in Kinzua sand and oil in Dewdrop.[135]

The nineteenth century closed on the Middle Field with its prospects much in doubt. The tide of production had decisively shifted to the south, and production in the established pools continued to decline.

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[134] *Ibid.;* 637-640. Number 2 came in May 14 at 25 barrels an hour; No. 3, 12 barrels an hour. Other Lot 6 wells: Nos. 7 and 8, 500 and 400 barrels a day; No. 12, Oct. 1, 25 barrels an hour. No 15, "on the edge" of the pool, produced 150 barrels a day. See *Derrick's Hand-Book* 1897 chronology.

[135] Lytle, *Kinzua Quadrangle*, 26-38.

6. Production, 1903-1945

National Patterns of Exploration and Production

The turn of the century marked a turning point in both the production and marketing of Pennsylvania oil. As new discoveries of oil in the Southwest and West swelled stocks, new uses for the abundant but lower quality oil produced there were devised. Fuel oil became an important market for heavy-grade crudes, as western railroads distant from inexpensive coal supplies began to adopt it for use as steam fuel.[136]

Petroleum production from the western states was another hallmark of the new century. The Spindletop field in eastern Texas was discovered in 1901 in a wholly different kind of geological formation—the salt dome—and was tapped using new drilling methods, characterized by rotary tools that are recognizable predecessors of modern rotary drilling technology. Though exploration in the Appalachian field continued southward through central West Virginia and eastern Kentucky, the real trend was far to the south and west. Between 1897 and 1904, a number of significant strikes were made in eastern Texas, Louisiana, Kansas, Oklahoma, and Illinois. The Sour Lake, Batson, Humble, and Glenn fields became the newest sensations in the industry, much as Bradford, Cherry Grove, and Sistersville had been in years past. In 1904, production of oil from west of the Mississippi River was larger than that east of it for the first time, a differential that continued to widen throughout the pre-World War II years.[137]

The other side of this situation was the effective stabilization of the high-grade crude market. In 1908, the price of Pennsylvania crude was $1.79, unchanged for the entire year. This stable market promoted a small degree of development in Pennsylvania, characterized by drilling over previously defined territory but especially by secondary recovery, a concept that assumed primary importance in a region no longer in the forefront of the industry.[138]

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[136] The Pennsylvania Railroad explored the idea of petroleum fuel for steam locomotives as early as 1886. While considered a promising alternative, the fuel was uneconomic in a coal-rich region. James A. Clark, *The Chronological History of the Petroleum and Natural Gas Industries* (Houston: Clark Book Co., 1963), 60.

[137] *The Oil City Derrick's Statistical Abstract of the Petroleum Industry* (Oil City: Derrick Publishing Co., 1916), 39.

138 *Ibid.*, 42. The growing significance of the Appalachian field after the turn of the century can be noted in the increasingly scant mention of developments there in the *Derrick's* publications, which became "statistical reviews" after 1900.

New Pools: Lewis Run, Marshburg, and Queen

An extension to the Bradford field was discovered at Lewis Run, due south of Bradford, in 1909. The producing sand at this locality was found at a level more than one hundred feet below the Bradford Third Sand. Initial production in the 1,800-acre pool ranged from one-half to eight barrels a day, making it a pool of small importance.[139] Similarly, a very small pool was discovered at Marshburg in 1929 by Mallory & Pringle in the Bradford Second sand. Their eight-year drilling program defined a small pool of about 235 acres on warrants 3414 and 3437. By 1940 there were 56 producers in the field; the long-lived wells ranged in initial production from two to eight barrels daily.[140] The field still produces with central powers.

The Queen pool, on the Siggins Farm four miles south of Tidioute on Red House Hill, was opened by Triumph field producer Charles Carnahan in early 1922, when he was searching for gas for his lease to the northwest. The Queen sand, primarily a gas producing formation, was well developed south of the prospecting area. Carnahan found oil as well as gas—100 barrels daily production, the biggest strike in years. Other operators, including A.V. Clinger and Jennings Brothers & Hertzel, leased and drilled and the field soon took on boom dimensions, with 500-barrel wells and a maximum production of 5,500 barrels gauged from the pool. The field proved small and quickly faded.[141]

Secondary Recovery

The production from these new fields did not in any way compensate for the continuing decline in production from the established fields. The production of Pennsylvania oil continued to decline, reaching a low in 1906. The chief problem was, as Lesley and Carll had accurately predicted, the wasteful production practices characteristic of the nineteenth-century boom ethic. In all of the declining fields, significant reserves of petroleum remained. However, the reservoir pressure had been depleted, which left no propellant to move the petroleum out of the sands. Producers began to search for methods to restore pressure to their gas-depleted reservoirs.

[139] Fettke, *Bradford Oil Field*, 281.

[140] Lytle, *Crude Oil Reserves of Pennsylvania*, 186; Fettke, *Music Mountain Pool*, 31.

[141] Miller, *Petroleum Industry in Warren County*, 101.

Water Flooding

As early as 1880, John F. Carll observed that when groundwater entered a producing formation either by accident or through intentionally pulled casings, the flooding of the sand often had a beneficial effect on surrounding wells for a certain period.[142] Attentive operators noticed it too, but a Pennsylvania law forbade intentionally flooding oil sands (the rule was directed towards preventing economic blackmail of operators by their neighboring producers). By 1906, the Bradford field's production had "mysteriously" begun to rise and it was general knowledge that some operators selectively and systematically pulled the casings of wells and allowed water to enter the producing formation. This early system was known as a "circle flood," since the method enhanced recovery in a radial pattern. At first, this practice led to a great deal of waste and uncontrolled flooding. For example, the Deerlick field was waterflooded in the early twenties by pulling casings, and though production in some wells increased to forty barrels a day, the flood pattern got out of control and entirely watered out the field. Still, by the 1920s waterflooding had proven its promise and was becoming a science.[143]

Modifications to waterflooding practice came in 1922 as the Forest Oil Company developed the "line flood," a method that consisted of two rows of oil wells evenly spaced between a row of water-intake wells. Wells were spaced 200 feet apart and the rows 100 to 130 feet apart. As the oil wells were watered out, usually within a period of three years, they were converted to intake wells and a new row of producing wells were drilled.[144]

By 1928 a newer and more successful process eclipsed the line flood. The entire lease was laid out into squares, water intakes were drilled at the intersections, and a producing well was located at the center of each square. This "five-spot" flood quickly became the standard method for waterflooding adopted in the Bradford field. Operators made various improvements to the system, including pressure flooding and a variant seven-spot flood, but all are forms of this most successful method. Pennsylvania production again rose quickly—so quickly that Bradford broke the market for lube stocks in 1930, proving again the association between depression and overproduction. Indeed, the Bradford field was the only Appalachian field that was subject to prorated production.

[142] J.F. Carll, *The Geology of the Oil Regions of Warren, Venango, Clarion, and Butler Counties*, Report III (Harrisburg: Second Pennsylvania Survey, 1880), 263.

[143] Fettke, *Bradford Oil Field*, 7-8; Lytle, *Crude Oil Reserves of Pennsylvania*, 228.

[144] Fettke, 8-9.

Pennsylvania's second production peak occurred in 1937 at 10,930,799 barrels as the Bradford field came back to life through waterflooding. In many cases, secondary methods boosted production rates higher than they had been under natural pressure when the field was developed.[145]

The Bradford Sand horizons proved to be particularly conducive to waterflooding operations since the sandstone is, in comparison to other producing sands, very permeable. The Clarendon and Tiona fields, similarly, are amenable to waterflooding. However, when waterflooding was attempted in other sands in the Middle District, the results were often discouraging.[146]

Gas Drive

As early as 1869 some producers in the Triumph-Tidioute field installed low-pressure beam-driven vacuum pumps and connected them to their wells' casing heads, the theory behind the practice being that the vacuum would suck the petroleum out of the rock. Though this is not quite precisely what happened, production did increase and gas pump usage spread slowly through the Appalachian field. This technology was the first application of secondary recovery techniques.

In 1888, a Venango County producer named J.D. Dinsmoor noticed that the production of his established lease increased significantly when a gas well was drilled on a neighboring lease. He suspected that the gas, produced from a deeper formation, was entering the same producing formation his wells tapped. His suspicions were confirmed when the new well was packed at the level of the gas sand and his wells declined to their former productive level. Deducing that gas could be mechanically reintroduced into a producing formation, he purchased a number of unproductive but inexpensive leases near St. Marys, West Virginia to test his theory. He installed a newly-developed compressor (the Russell Gas Pump, manufactured in Noblestown, Pennsylvania), coupled to a gas engine, to draw gas from the casingheads of several wells. The compressed gas was then tubed down a centrally-located well, called a "blowback." The shallow sand in West Virginia proved conducive to this method, and Dinsmoor, who did not patent the process, hid the installations under brush heaps to disguise the process while he accumulated more leases.[147]

[145] *Ibid.*, Lytle, *Secondary Recovery Operations in Pennsylvania to January 1, 1954* (Harrisburg: Topographic and Geologic Survey, 1955), 1; Tait, 68.

[146] Lytle, *Crude Oil Reserves of Pennsylvania*, 225-229. For instance, the Dew Drop Sand, less permeable, is not amenable to waterflooding.

[147] "Petroleum Panorama," D22-D23; Testimony of James D. Dinsmoor, *Petroleum Patents Company v. Walter and Frederick Squires*, eq. 141; Defendant's Proofs, vol. 1 (U.S. District Court, Southern District of Ohio, 1920), 68-75; Philip W. Ross, "Makin' Hole, Pumpin' Oil: An Oral History of a West Virginia Oil Field," Technical Report No. 9 (Morgantown, W.Va.: Institute for the History of Technology and Industrial Archaeology, 1994), 2.

A variant of this system was the Smith-Dunn or Marietta process, which used compressed air to replace the gas. This process apparently rose independently of the Dinsmoor gas drive process. It was first used in the Macksburg, Ohio field in 1903 in a shallow sand pool where the gas pressure was depleted. This process was used in areas where the original gas pressure was entirely lacking, as in the oldest developed fields. Natural gas-powered air compressors from 20 to 100 horsepower are used in the secondary recovery process with pressures between 40 and 300 pounds per square inch. [148] The apparatus for gas drive and air drive are quite similar.

Gas drive became a widely-used method for oil recovery by the teens, although not as extensively as water flooding. In northern Pennsylvania, it was tried in the fields that did not respond to water flooding. Its widest use was in the Cooper, Balltown, and Tidioute fields, where it was used successfully through the World War II era. It was often used on leases where natural gasoline was already being produced, since the necessary equipment was already in place.[149]

Natural Gasoline Production

Early shippers of natural gas noticed that low places in their pipelines collected a combination of condensed water and light-gravity gasoline that condensed from the petroleum vapors and gas. As this created a dangerous situation, especially if it entered the compressors, the gasoline was separated in "drips," or shunts off the main gas line, and then drained or burned.

As internal combustion engines began to assume more importance after the turn of the century, gas producers realized that a new market now existed for their former waste product. Oil producers whose wells produced significant amounts of casinghead gas (so called because it rose from the well between the casing and the tubing) were also eager for a method for increasing returns from declining leases.

In 1904 Anthony Fasenmeyer of Tidioute, Pennsylvania, produced gasoline

[148] The process was first used on the Wood farm of the Cumberland Oil Co. near Chesterhill, Ohio, by I.L. Dunn in August 1911. J.O. Lewis, "Methods for Increasing the Recovery From Oil Sands," U.S. Bureau of Mines Bulletin 148 (Washington: GPO, 1917), 37.

[149] Lytle, *Crude Oil Reserves of Pennsylvania*, 150-151, 238.

by conducting compressed gas through a coil of pipe submerged in a water tank. The condensate then dripped into a wooden barrel. With what must have been significant evaporational losses, he still produced four thousand gallons of gasoline the first year in this manner, for which he received ten cents a gallon. The Tompsett Brothers (also of Tidioute) were among the first producers of "casinghead gasoline," and claimed precedence over Fasenmeyer for making a commercial venture of the new product.[150]

As the commercial viability of the new process now seemed assured, manufacturers and producers turned attention to perfecting the process. The earliest systems used low-pressure gas pumps to compress the gas. Later methods used higher pressure and then split-stage (low pressure and high pressure) compressors.[151] Among the patents issued for apparatus to manufacture gasoline were Dennis Hastings and W. Brink (No. 867,505, 1907) and John L. Gray (No. 993,976, 1909) The Bessemer Gas Engine Company specialized in manufacturing complete outfits for producing gasoline on-lease, using the Gray's patent process.[152] A simplified description of the system follows.

Gas is gathered by lines from several wells at the casing heads. It enters the low-stage compressor, is compressed to about fifty pounds pressure, and enters the low-stage cooling coils. These coils may be cooled in air or in a trough of water. Condensate is conducted to pressurized accumulator tanks, and the partially-stripped gas is conducted to the high-stage compressor. At approximately two hundred pounds pressure, the gas is then cooled in the high-stage cooling coils. The stripped gas is then conducted to a gas distribution facility, used on the lease, or returned to the field. The condensate from the high-stage coils is conducted to the accumulator tanks, where the gasoline is separated from water condensate by gravity. It is then stored and marketed.[153]

A variety of different systems evolved, differing markedly in configuration and capacity. Casinghead gas differed from locale to locale in the relative amount of volatile vapors, or petroleum distillates, contained in the gas. Fields that produced rich vapor-laden gas, or "wet" gas, favored the establishment of natural gasoline operations. In the Appalachian field, the process was concentrated in two regions: the vicinity of the Sistersville field in West Virginia and in

[150] Lewis, 9.

[151] *Ibid.* The earliest high-pressure system on record was constructed in the Balltown field at Mayburg by William Richards of Warren. He used up to 400 pounds of pressure before determining that 250 pounds was most effective. This became a relatively standard pressure.

[152] Zook, *The Bessemer Manual of Gasoline Recovery,* 12.

[153] *Ibid.*, 12-13.

northwestern Pennsylvania, where it was restricted to Butler, Warren, McKean, and Forest counties. The typical Pennsylvania gasoline plant was quite small and averaged only 200 gallons of product daily. The Venango Third Sand, the Bradford Third Sand, and the Balltown and Cooper sands were the most productive of wet gas in the region. In the Tidioute field, casinghead gas was found to be extraordinarily wet, consisting almost entirely of liquid hydrocarbon vapor and very little methane. There the process required only twelve pounds of pressure to draw the gas out of the sand, and no compression before condensation. In this field gasoline could be manufactured quite cheaply, and a gas pump was often integrated into the central pumping power.[154]

Forest County was the site of larger operations, chiefly in the Balltown and Cooper fields, where A.V. Clinger and the Forest Chemical Company operated plants at Hastings, Balltown, and Mayburg. The sites of these plants are still discernible, identifiable by the concrete engine and compressor pads.

The natural gasoline industry grew rapidly in the teens and peaked in the twenties as the product found a ready market at the regional refineries, where it was blended with refined gasoline to improve its fast-start qualities. Since natural gasoline is low in octane, however, it lost popularity as newer cars, with high-compression engines that were less tolerant of low-octane gasoline, replaced older vehicles with less exacting fuel requirements. By World War II, the process had largely faded.[155] Natural gasoline production in Pennsylvania is now limited to that incidental to natural gas pumping and stripping operations.

Coda: Music Mountain

The Music Mountain field in McKean County, on the old Bingham lands adjacent to the Lewis Run field, was the last flush field developed in the region, and certainly one of few fields developed with concern to measured production and conservation. The initial well, the Niagara Oil Corporation's Music Mountain No. 1 on the southwest corner of warrant 2276, came in on August 24, 1937 at an enormous rate, gauged at 44 barrels an hour. The wildcat gusher caught Niagara by surprise. The drilling contractor, E.A. Williams & Sons, did not succeed in capping the well until the next day. Every available employee rushed to the new field to build tanks, improve the road, and lay pipeline. The well

[154] Lewis, 13. The demonstration central power lease at the Drake Well Museum, salvaged from the Tidioute field, incorporates a Grettenberger gas pump for gasoline recovery.

[155] "Petroleum Panorama," D36-D37.

flowed every 18 minutes after being shut in, and its maximum flow was gauged at two barrels a minute. Afterwards Williams leased a parcel of warrant 3436 and brought in several wells there.[156]

The Sliverville Sand, the producing formation in the Music Mountain field, is known as a "shoestring" sand, with the meaning of the name readily apparent when viewing a map of the pool. It is only eight hundred to two thousand feet wide at its widest point but four miles long, stretching in a northeast-to-southwest direction. It lies at a depth of 1,635 feet in the discovery well, about 90 feet below the Bradford Second sand horizon and 250 feet from the top of the Bradford Third sand. It is unlike either of those two sands in composition, being a loose, coarse-grained white sand that is more like the Clarendon series than the Bradford sands. The area around the Music Mountain strike had been unproductive in the Bradford horizons, and the sparse drilling there during the nineteenth century had missed the narrow field. As a result, the Bradford region's secondary recovery operators enviously watched Niagara bring in the first flowing wells in forty years.[157]

The development of Music Mountain took on a much different pattern when compared to the earlier reckless development so lamented by Pennsylvania's first generation of geologists. Due to both the lingering depression and enhanced production from waterflooding in the Bradford field, prices were at a low while stocks were abundant—just as in 1882 when Cherry Grove broke the market. The Music Mountain operators, however, had no intention of cutting their own throats. Four of the seven operators in the field were waterflood operators with extensive producing interests in the Bradford field, and all governed themselves with restraint while developing their new production.[158]

The Minard Run Oil Company, the successor to the Emery Oil Company, developed their lease unhurriedly on warrant 2265 directly south of Niagara's operations. Their first flowing well (their second attempt; their first well was dry) came in on October 25, 1937, at a rate similar to that of the Niagara's well. The Healey Petroleum Company leased four tracts of the Bingham lands on warrants 3437, 2277, and northern 2276 in January 1938. Their first efforts yielded only dry holes, but later operations were successful. To allay fears of

[156] Fettke, *Music Mountain Pool*, "'Sliverville' Sand Yields Second Gusher; Drilling to Continue," *Producers' Monthly* 2 (November 1937); "Production, Drilling, Geology, Reserves of Music Mountain," *Producers' Monthly* 3 (July 1939), 14-20.

[157] Fettke, *Music Mountain Pool*, 29-30; Map, *Producers Monthly* 1 (June 1938), 16.

[158] Fettke, *Music Mountain Pool*, 30.

heavy production and a bearish influence on crude prices, the operators choked off their production and allowed their wells to flow only at an extremely conservative rate. At no time did the field's daily production exceed 2,200 barrels during the early phase of development in early 1937 and 1938, despite wells capable of flowing 500 barrels an hour. Production rose after federal prorationing restrictions were lifted in 1939. In 1940, a full two years after initial development, the field briefly produced almost 7,000 barrels daily, but in general the producers were careful to keep unneeded crude in the ground and out of the market.[159]

The producers took additional farsighted conservation measures. Very little of the gas from the field was marketed. Some of the producers piped it to their other leases to the east in the Bradford field proper, but most operators built gas-recycling plants to maintain the field's reservoir pressure as long as possible. Additional new technologies, including a bottom-hole choke that reduced the gas-to-oil production ratio and "lubricators," drilling devices that allowed tools to be drawn from a well under pressure, provided a sensible contrast to the wasteful practices of fifty years earlier, when the lifeblood of the reservoir was allowed to hiss uselessly into the atmosphere.[160]

By 1940's end, 292 wells had been drilled in search of the Sliverville sand. Of these, 220 were productive, 14 produced gas, and 68 missed the target formation. Some wells drilled for the Sliverville were productive in the Bradford zone. Niagara and Minard Run were the big winners, each with several of the biggest flowing wells ever tapped in the region. [161] No pool developed since has been nearly as productive.

[159] *Ibid.*; "Production, Drilling, Geology, Reserves of Music Mountain," 16-18.

[160] *Idim.*

[161] Fettke, *Music Mountain Pool*, 31.

7. Central Power Systems

Evolution of Pumping Technology

From the time of the earliest petroleum developments in the Oil Creek valley until the end of the nineteenth century, the task of producing oil from non-flowing wells was performed with essentially the same equipment used to drill the well. Instead of lifting and dropping the drilling tools, the rig's walking beam drove a valve pump in the bottom of the well. The pump was connected to the walking beam by "sucker rods," long wooden (usually hickory or ash) rods with iron male and female (box and pin) screw connectors riveted on either end. The steam engine that had been used to drill the well also pumped it. This "standard" drilling and pumping rig remained the production method of choice for deep-sand wells and other wells that were sparsely scattered over a wide area.

However, unless the well flowed of its own pressure, the petroleum producer faced the neccessity of employing a pumper to operate the well. The pumper kept up the steam in the boiler, maintained and ran the engine, and made repairs to the rig. The expense ensuing from stationing a pumper at each well, a necessity with the contemporary technology, was the earliest economic limit on oil production. On Oil Creek, wells were quickly abandoned that ceased to flow or pump strongly, as it made more sense for the producer to drill another well. The life of an oil well was usually measured in months, rather than years.[162] Cost accounting from the era indicated that operating a 30-barrel well for six months in a $2-per-barrel market, using coal or wood for fuel, resulted in net losses of $1,507 and $1,043, respectively. If the boiler was fired by gas from the well, however, it paid its expenses and a $504 profit. A well that produced less than thirty barrels would be uneconomic to operate with any fuel unless the price of oil rose by a commensurate amount.[163]

The oil market, then, favored the producer with either flowing wells or highly productive pumping wells. The problem was that few wells in the Pennsylvania field produced this way for more than a brief period. The amazing

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[162] John Ponton, "A Crisis in the Oil Region" (1867), quoted in Whiteshot, 385.

[163] *Ibid.*

feature of nineteenth-century oil production in the Appalachian field was that more or less constantly, a new field was being exploited whose flush production supplied enough petroleum to meet growing demands. It was these new fields that set prices, to the detriment of the small operator in an established field who could not afford to drill new production elsewhere.

Equally problematic in the early era was transportation of crude to market, a cost that usually exceeded the value of the oil itself. This aspect of crude production was quickly rationalized with the introduction of pipe lines in the mid-1860s, eliminating the barrel and the teamster. Industry observers questioned why production could not be rationalized and economized, too.[164]

Since some grades of crude oil were more valuable than others, oil of superior quality was more likely to be produced from an otherwise uneconomic well than was oil more suited for illuminating fluids. At Franklin in Venango County, for instance, the crude petroleum was of very low gravity and ideally suited for lubricating purposes. A similar grade of oil was found in the Oil Spring, Gale's Fork, Mount Farm, and Volcano anticlinal pools in northwestern West Virginia. In these pools the wells quickly declined to a fraction of a barrel production per day, but supported a specialty lubricating oil industry at nearby Parkersburg. Since these pools represented the only regional supply of lubricating oil, demand prompted continued production, and at the Oil Spring pool near Petroleum, West Virginia, was recorded the earliest use of a multiple-well pumping system, in 1863. The Oil Spring wells were drilled by Ford & Handlin, who "commenced the use of appliances now known to all operators . . . the application of power to pumping thirteen wells at the same time." A contemporary observer noted their operation:

> Eleven wells were working at the date of the writer's visit, all operated by a rude but effective as well as novel system of mechanism, driven by a single engine of fifteen horse-power, with ample power to spare for the working of many more wells. It is called a "telegraph," its continuous line of rough scantling, suspended by iron hangers between duplicate telegraph-like poles, being somewhat suggestive of such a name. The entire system, connecting the different wells throughout the narrow valley and in the ravines that make into it, requires more than half a mile in length of this telegraphing and is operated by an alternating horizontal motion—forward perhaps twenty inches and back the same—which keep in continuous action all of the pumps at the same time. . . . Nearly all the labor required is in running the engine and obtaining fuel for it, boring wells, making fixtures, and barrelling the oil.[165]

[164] William Wright, *The Oil Regions of Pennsylvania, Showing Where Oil is Found; How It is Obtained, and at What Cost* (New York; Harper & Brothers, 1865).

By 1871, nearby Volcano operator William Cooper Stiles, Jr., had introduced another unique system for multiple well pumping. Reportedly inspired by contemporary factory rope power transmissions, his system consisted of a long loop of wire rope which passed over two positioning pulleys and a band wheel at each well in the system. When the well was to be pumped, the pumper placed the pitman over the crank pin. A steam engine belted to a large-diameter band wheel, concentric with a smaller-diameter rope pulley, provided the power to the cable loop.[166]

> . . . An endless wire cable is set in motion by a large wheel at the power house and is carried around the counter of a band wheel at the several wells by means of angle wheels, which are small grooved wheels set on movable frames, so the rope can be run under this counter wheel on any angle from which it may come. This system of pumping also enables the pumper to pull the tubing and rods, the same as with steam, thus making a well that only pumps a quarter of a barrel a day a paying well. Stiles . . . has two leases running with this power, one with 45 wells and the other with 33 wells.[167]

This pumping system, described twenty-seven years after its implementation, survived well into the twentieth century. Inexplicably, the technology did not transfer to the Pennsylvania fields, but remained a regional curiosity for over a hundred years.

The direct ancestor of the central power system eventually adopted in

[165] "Charles W. Brockunier," *Derrick's Hand-Book* 1, 1004; J.R. Dodge, "West Virginia," in U.S. Congress, House of Representatives, *Report of the Commissioner of Agriculture for the Year 1863*, 38th Cong., first sess., Vol. 15, Ex. Doc. 91 (Washington: GPO, 1864), 72. Dodge later published his impressions of the oil industry in 1865 in *The Oil-Regions of Pennsylvania, West Virginia, and Ohio*. J.H.A. Bone, in *Petroleum and Petroleum Wells: A Complete Guide Book and Description of the Oil Regions* (Philadelphia: J.B. Lippincott, 1865), also mentions the Oil Spring wells, noting fifteen wells pumped with one engine but without further detail. Local West Virginia writers have speculated that the Oil Spring wells predate the Drake Well. Though it is possible that these wells did indeed produce petroleum as early as 1857, there is no evidence that they were drilled. See David L. McKain and Bernard Allen, *Where It All Began* (Parkersburg, W.Va., David L. McKain, 1994).

[166] *Derrick's Hand-Book* 1, 164; entry from December 21, 1871. Also "William Cooper Stiles, Jr., Esq.," *Petroleum Monthly* 2 (October 1872), 270-272.

[167] "William Cooper Stiles, Jr.," *Derrick's Hand-Book* 2, 594-595. The article states that Stiles altruistically declined to patent his invention, and a search of patent records bears this out.

Pennsylvania was the "jerker" system, devised in the Oil Springs shallow field in Lambton County, Ontario, Canada at about the same time as the West Virginia "telegraph" system.[168] John Henry Fairbank, an early Oil Springs producer, receives the credit for introducing the system to the Canadian field. A double row of reciprocating wooden rods, driven by twin cranks and pitmans, comprise the main power transmission system. Horizontal iron wheels, called "field wheels" or "spiders," change the direction of the main jerker lines. Individual wells connect to the main transmission system by a single line, which connects to the walking beam of the well by a pulley and chain or a pivoting right-angle lever, which translates the horizontal motion to vertical motion. Wooden poles suspend the rods above the ground on wire hangers. In order to balance the system, opposing wells counterbalance each other on either side of a field wheel; the downstroke on one well assists the upstroke of its opposite. Thus the only power necessary, assuming the system is balanced, is that to overcome inertia and friction.[169] The earliest such systems used lightweight wooden rods, which were possible as the system worked only under tension, never in compression (again, assuming a balanced system). The original system, with minor changes, is still in use on several hundred wells in the Oil Springs-Petrolia field.[170]

A very similar system appears in United States Patent Office records as the subject of an application made May 28, 1879. Edward D. Yates of Philadelphia patented an "Apparatus for Pumping Oil Wells" for the purpose of "economizing the power requisite to pump non-flowing oil-wells." Yates' system mimicked Fairbanks' especially in the horizontal "oscillating wheel" that was simultaneously pulled and pushed by twin cranks and pitmans. The only portion of Yates' "invention" that appeared to be truly new were the iron connecting rods and hold-up rockers that elevated the rods off the ground. The push-pull power underwent numerous refinements and was available in supply catalogs well into the twentieth century. [171]

Two years earlier, Waldemar Plockross of Fagundus patented a pumping

[168] Fairbank's claim that the jerker was the first such system, in 1863, is difficult to substantiate. A schematic drawing in Diane Newell and Ralph Greenhill, *Survivals: Aspects of Industrial Archaeology in Ontario* (Toronto: Boston Mills Press, 1989), circa 1870, shows an oil lease pumped by the jerker system. Newell and Greenhill cite Fairbank in *Report of the Royal Commission on the Mineral Resources of Ontario* (Toronto, 1890); Fairbanks testified in 1889 that he devised the jerker line "about twenty-five years ago ... I think that was in 1863." He also states that he did not think the rig could be patented.

[169] Newell and Greenhill, 128-131; Wanda Pratt and Phil Morningstar, "Early Development of Oil Technology" (Petrolia, Ont.: Oil Museum of Canada, 1987), 12.

[170] Newell and Greenhill, 131.

[171] United States Patent Office, Patent No. 226,948, April 27, 1880. *Derrick's Hand-Book* advertised two push-pull powers in 1898, the "Merrill," manufactured in Toledo, Ohio (xli), and the "A.B.C." manufactured by the Adams Brothers Company in Findlay, Ohio (cxv).

jack remarkably similar to ones still in use. It consisted of "a suitably braced right-angled lever, which swings on a pivot between stationary posts, and is connected at the end of its horizontal arm with the pump rod; and at the lower end of its vertical arm, by means of rods, with any convenient motive power." Unfortunately, Plockross did not further describe the power source.[172]

Carll described an early central power, apparently based on the Yates push-pull system, in his 1885 annual report of the Second Pennsylvania Survey. He noted that in the older, established districts many of the wells were now pumped in clusters by the "sucker-rod system":

> The method of pumping wells by "sucker-rod" connection is this: A wheel eight or ten feet in diameter is placed in a horizontal position at the "engine well," and by a pitman caused to have an oscillating motion of about one foot. From a pivotal point on the rim of the wheel a line of connected rods (old sucker rods were first used, and hence the name), is run to the well to be pumped, and joined to the pumping gear. The rods are suspended by cords from standards erected at intervals along the line, and swing freely without friction. When the propelling well is made to oscillate, an up and down motion is communicated to the pump-rod in the well. Several wells can be attached to the same wheel, and the rods may branch off in any direction. By a system of balancing—that is, connecting the wells in pairs, so that one shall be on the up stroke while its auxiliary is on the down stroke, four or five wells can be pumped with about the same power required for one alone.[173]

Carll noted that central power pumping promoted development of established areas, especially in shallow territory, where several wells of small yield could be drilled and made profitable producers when connected to the pumping system.

Other than Carll's account, few records can be found of earlier Pennsylvania central power systems; the expense of setting up such a system would likely negate any benefits it would have accrued. Additionally, generally high prices for oil prevailed during the 1870s. What passed for central power in this era, instead, was a growing tendency to use a single boiler to power a number of steam engines at the pumping wells. Such systems had became common in the

[172] Patent No. 189,955, April 24, 1877.

[173] Carll, *Report of the Geological Survey of Pennsylvania, 1885* (Harrisburg: Second Geological Survey of Pennsylvania, 1885).

Bradford field by 1880.[174]

In the early 1880s oil prices fell precipitously with the peak of Bradford production, the onset of the Cherry Grove boom, and the subsequent speculative craze. Marginally productive wells returned even less profit than before. This new era of low prices, then, created the conditions which made central power systems necessary.

George Allen, a producer of lubricating oil at Franklin, held an interest in a small refinery which burned in the summer of 1884. Also consumed in the fire was the pumping rig connected to their wells. When Allen discovered what its replacement cost would be, he designed and put into use a system that was inexpensive to both install and operate. Over the next several years he patented the elements of his "Device for Converting Motion in Oil Pumping Apparatus," more simply known as the pumping power. The primary feature of Allen's patent rig was a bevel-gear-and-pinion-driven vertical shaft, on which was mounted a modified crank, disc, or eccentric. This eccentric provided a reciprocating motion to the rods similar to that imparted by the push-pull power.[175] It was also inexpensive—$200 to $350—compared to $2,000 and more for the earlier push-pull systems. The Oil Well Supply Company featured Allen's patent pumping power in its illustrated catalog.[176] This is the core design and basic configuration of the most popular and widespread type of pumping power used in the Pennsylvania oil fields. Variations on the basic elements include the frame design, which could be constructed of cast iron, structural steel, or wood; the number, combination, and position of the discs and/or eccentrics; and the reduction gearing. A great variety of pumping powers were designed and marketed during the turn-of-the-century era. The most popular ones were sold by the large supply houses: Reid, Bessemer, Paova, Pyramid, and Iron King are among the many designs. Scattered examples of these powers continue in use today. Allen received a royalty on each power manufactured that was based on his design, and vigorously defended his patents in court.[177]

The next innovation in pumping power was George Grimes' bandwheel power in 1897. Grimes made two significant improvements to Allen's design. Firstly, his improved eccentric was now composed of a rotating eccentric plate

[174] *Ibid.;* Crum, 131.

[175] Patent Nos. 313,907 (March 17, 1885), 326,008 (Sept. 8, 1885), 328-099 (Oct. 13, 1885).

[176] Oil Well Supply Company *Illustrated Catalog,* 1892 (Pittsburgh: Oil Well Supply Co., 1892).

[177] *Derrick's Hand-Book* 2, 523-524; P.H. Curry, "Economical Operation of Small Wells, *"Oil and Gas Journal* (April 10, 1930), 81. One locally-manufactured power was noted in the literature: the "Little Giant," manufactured by J. Hill & Son of Warren *(Derrick's Hand-Book* 1, xlvi).

and a new annular slip ring, perforated to attach the yoke and clevis of the connecting rods. This allowed a straight pull on the rods, which previously had to angle downward somewhat from the eccentric to hold it in place. His other innovation dispensed with the bevel gearing, and instead used a large-diameter (twelve to sixteen feet) horizontal bandwheel, similar in construction to a standard drilling rig bandwheel, with the eccentrics mounted above the wheel. The ball-bearing-mounted hub, or "rotary sleeve," rested on a large tapered steel spindle. The system required a large wooden or masonry foundation and three radial guy rods to anchor it firmly in position.[178] The advantage of this bandwheel power was that it could pull a larger number of wells than most of the bevel-geared powers. The bandwheel also acts as a flywheel, adding to the torque available to pull the surface rods. By 1898, Grimes was marketing his "Mascot" pumping power, along with a geared variant using the same eccentric and bearing design.[179] More expensive than a geared power, the bandwheel power was used most often in well-capitalized operations where its additional capacity could be used to advantage. To a producer, it made little sense to employ more expensive machinery where its capacity could not be fully utilized.

Further improvements were made to the bandwheel power in a 1913 patent by Wilbur O. Platt, president of the Joseph Reid Gas Engine Company. The improved bandwheel power had underslung eccentrics and was built largely from steel, with a steel rim and a combination of steel rod and angle-brace steel spokes. Angle-brace spokes ran from a common point on the rim to opposing sides of the bandwheel hub flange to triangulate the circumferential strains. This arrangement allowed for relatively lightweight construction, as did the underslung eccentrics, which reduced the amount of necessary foundation and bracing.[180] The underpull bandwheel power was especially suited for installations on a level lease since the surface rods emerged from the power house at ankle height. It could be shipped in a compact package and quickly assembled, and soon became the signature of a state-of-the-art pumping system.[181]

By the first decades of the twentieth century, then, a multiplicity of well-pumping devices had been invented and put into general use. The designs went through continual modification and updating with practical use, the innovations traceable by their appearance in supply catalogs and trade journals over the

[178] Patent Nos. 562,602 (June 23, 1896) and 590,482 (September 21, 1897).

[179] Grimes' Mascot Power was advertised in *Derrick's Hand-Book* 1, lxvii, and also in National Supply Co.'s catalog of 1906.

[180] Patent No. 1,072,028, September 2, 1913.

[181] George, 73-74; Curry, 81.

years. For example, the push-pull power evolved into an all-metal design and was offered in the National Supply Company's catalog of 1906 as the "National Pumping Power." Various iterations of the geared power acquired direct drive mechanisms, recirculating pressure lubrication systems, enclosed crankcases, and worm-gear drives. New pumping powers were advertised for sale through the World War II era in the supply catalogs.[182]

Prime Movers

Before the early 1890s, practically all motive power was supplied by steam engines. These engines were ubiquitous in the oil fields and the producers usually had several already on the lease. Illustrations of oil field machinery in the late 1890s show steam engines connected to geared powers.[183] Steam engines required considerable expenditure for labor, and if the wells required round-the-clock pumping, two pumpers had to be employed. Additionally, there was a constant danger of fire and explosion from natural gas coming in contact with the fire under a boiler.[184]

The major labor-saving innovation in motive power came in the early 1890s with the introduction of a practical gas engine for oilfield duty. Joseph Reid, an itinerant Scottish machinist who settled in Oil City, is usually accorded the honor of manufacturing the earliest practical gas engine. The first such internal combustion engine for pumping purposes was installed on the Rynd Farm lease on Oil Creek in May of 1895. Though the earliest gas engines required frequent maintenance, the simplicity of construction (some had as few as six moving parts) and cheapness of operation—the well supplied its own fuel as casinghead gas—led to their widespread adoption after the turn of the century.[185]

Space here does not permit a discussion of the bewildering variety of gas engines designed for oil field duty during this era. Some, especially those carried by the supply houses, are much more common than others. They generally fall into two types. The most durable and popular type has proven to be the patent two-cycle gas engine, best represented by the Joseph Reid Gas Engine Company

[182] National Supply Co., *Catalogue No. 14: Oil and Gas Well Supplies* (Toledo, O.: 1906); see early issues of *Producer's Monthly, Oil and Gas Journal*, etc. for advertisements of contemporary equipment. Also see Lester Uren, Petroleum Production Engineering: Oil Field Exploitation (New York: McGraw - Hill, 1939), 317-322.

[183] Advertisement for Iron King Power, *Derrick's Hand-Book* 1, lxviii.

[184] Curry, 81.

[185] *Ibid.*, Crum, 126.

(Oil City, Pa.) the Bessemer Gas Engine Company (Grove City, Pa.), and the Bovaird & Seyfang Company (Bradford, Pa.). Four-cycle engines, such as the Evans (Butler, Pa.), are similar but more mechanically complex. Scattered examples of each of these types of engines continue in daily use in the Appalachian fields.[186]

In response to the high initial cost of purchasing a patent gas engine, a hybrid type of prime mover was also developed. These derivative engines, commonly called "half-breeds," employ a gas cylinder and piston mounted to a steam engine bed, crank, and flywheels. This way, a producer wishing to update his system could convert an engine that he likely already had available, and had only to invest in the new cylinder and plumbing. Several of the major manufacturers, including Bessemer and Bovaird & Seyfang, manufactured gas cylinders for steam engine conversion. So did quite a few smaller local machine shops.[187] Since this innovation represents a technology in transition as well as an earlier era of machinery, these "half-breeds" have more historical significance than patent gas engines.

The ignition systems for both types of engines varied. Most early gas engines used a "hot-tube" ignition, similar to a glow plug on a diesel engine, whereby a gas flame heated a hollow nickel-alloy plug to a red heat. This plug, threaded into the cylinder head, ignited the gas-air mixture at maximum compression.[188]

Many of the later-design gas engines used a spark plug and magneto ignition system, which was mechanically more complex than a hot tube but afforded much better control of ignition timing. Additionally, they were safer for the operator, reduced the hazard of fire, saved fuel, and eliminated the lengthy hot tube preheat period. In large or modern installations, this system supplanted hot-tube ignition by the early 1920s; but in areas where the power installation was remote—or the operator simply disliked the complexity of the magneto and spark system—hot tube ignition persisted for a remarkably long period. In many installations using half-breed engines, provision for spark ignition was never

[186] An outstanding resource for interpreting the evolution and significance of the gas engine is located south of the Allegheny National Forest at the Coolspring Power Museum, near Brookville in Jefferson County. The museum, dedicated solely to interpreting and preserving gas engines, has over 200 working exhibits and is staffed by knowledgeable persons who are available to assist in evaluating the significance of particular engines.

[187] The fieldwork for this survey noted several gas cylinders on steam engine frames ("half-breeds") over a broad area of the ANF.

[188] Ellis M. Wellman, "Hot Tube Ignition," *Bores & Strokes* 6, Fall 1993. *Bores & Strokes* is the quarterly journal of the Coolspring Power Museum.

available, and in some cases, spark-ignited engines were retrofitted for hot-tube ignition. James Billstone, an independent Kinzua operator who ran a large local oil and gas operation for nearly eighty years, converted many of his spark-ignited engines back to hot-tube ignition. Operating in an environment where moisture, extremes of heat and cold, and even wildlife are hostile to electrical components, the simplicity and reliability of the older ignition system prolonged its use in the oil fields long after it was superseded elsewhere.[189]

"Air Leases"

A rather unique pumping system originated in the Bradford field in the late 1890s, patterned after the single boiler/multiple engine setup in the late 1870s and early 1880s. With the introduction of powerful air compressors, some operators began using compressed air instead of steam in their engines. Although not practical for extensive or distant pumping, the system became established and evolved into a component pumping system at each well, consisting of a steam engine on which is mounted a spur gear-driven crank and a winding drum; the crank drives the pitman and walking beam, and the drum is used for pulling rods and tubing. A mast made of casing replaces the derrick. This system is known as a Barcroft pumping rig in the literature, and locally as a "Blaisdell" jack or "cog engine."[190]

This all-metal system became popular in the Bradford area for a practical reason: the pumping rig could not be destroyed by fire, a constant threat and a very real problem during this era. Where old-growth timber (in this area, mainly hemlock) had been recently removed, loggers left large amounts of slash lying that fueled annual forest fires. Tens of thousands of acres of timber and oil land burned annually, and with it scores of wooden rigs. Quite likely the first compressed air systems replaced rigs destroyed by fire.[191] In many areas this system was superseded by the rod line central power, but the Barcroft rig found extensive application in the southern McKean and Elk County area, and especially in the Kane field. A number of these "air leases," as they are called locally, were recorded in the Ridgway district of the Allegheny National Forest by researchers in the 1980s, and at least one such system operated until October 1993. Since these systems use steam engines that first saw service in the initial development

[189] *Ibid.*

[190] Lewis, "Methods for Increasing Recovery from Oil Sands," Plate IV-A facing page 41; Curry, 81.

[191] Curry, 81; *Petroleum Gazette* I (June 17, 1897), 3. During this era, the *Derrick's Hand-Book* carries several accounts of forest fires in the region destroying producing rigs.

of the region, Barcroft rigs are highly significant.[192]

A further refinement of compressed air power was the development of the "air head" mechanism, which was introduced by R.J. Hoffman and E.H. Hollingshead in 1904. Here the piston rod of the vertical cylinder, mounted to the casing head, is positioned directly over the well and connects to the sucker rods. When the piston reaches the top of its stroke, a trip valve exhausts the cylinder, and the piston drops by the weight of the sucker rods. The mechanically simple device dispenses with the power-robbing conversion of reciprocating motion to rotary motion and then back to reciprocating motion, as is necessary with beam pumping.[193] This pumping device was manufactured and marketed by Bovaird & Company in Bradford. Some are still in use in the region.[194]

Rod Line Central Powers: Engineering Considerations

The first decision a producer desiring to install a central power on his lease had to make was where to site the power. This involves a fundamental principle of mechanics, in which the goal is a point at which all resultant forces equal zero; in practical terms, this meant that the loads had to be set so that the power requirements were nearly constant throughout a complete revolution of the eccentrics. The variables the producer had to consider in this equation included the distance from the power to each well, the depth of each well, the weight of the oil being lifted, the reciprocating mass of the surface and sucker rods, and the frictional losses in the surface transmission equipment. Thus considerably more planning went into the siting of the powerhouse than simply finding a central location.[195]

The next most important decision a producer had to make was what type of pumping power to use. His usual choice was between a geared power and a bandwheel power. A bandwheel power was more flexible in use; it could be used in relatively level to very hilly terrain, and even installed at an angle parallel to the slope of the hill. It could drive a large number of wells. It was also more expensive and required a larger building than a geared power, and used more belting, which was no small expense. Though it could pump fewer wells, a

[192] Susan J. Beates, "Steam Engine Drilling Catalogue" (Titusville, Pa.: Unpublished manuscript in Drake Well Archives, 1984); Personal communication, "Skip" McKenna, JoJo field near Kane, Pa., Feb. 16, 1994. Rutsch also underscores the significance of these systems.

[193] Patent No. 773,501, October 25, 1904.

[194] Personal communication, Victor Peterson, Kushequa, Pa., August 5, 1993.

[195] Lester C. Uren, "Multiple Pumping of Oil Wells," *National Petroleum News* (reprint from 1927), 19-20.

geared power was less expensive, was rugged, simple, and reliable, and since geared powers were available in a variety of sizes, could be tailored in size for the application at hand.[196] A small lease with ten or fewer wells could be suitably equipped with a small geared disc power and a ten- or fifteen-horsepower half-breed engine with a minimal capital outlay.

With a vast selection of components and hundreds of possible combinations of machinery, a standard central power pumping outfit never became established. The configuration of a central power reflected the financial wherewithal of the producing company, the preferences of the producer, the topographic characteristics of the lease, and often the sales skills of the local supply house salesman. These variables account for the fact that few central power installations resemble each other more than superficially. The exception to this rule is where a well-capitalized operating company built a number of powers from standard plans, as the South Penn Oil Company did in many of their early intallations. Some of these powers were architecturally distinguished, well-built, and comfortable, with poured concrete floors and finished interiors.[197]

The majority of powerhouses were simply functional responses to the engineering problem at hand. The structure housed the engine and power, and usually contained a well-stocked tool bench, a supply of spare engine parts, pipe joints, and other odds and ends necessary to keep the machinery in working condition. The pumper often personalized and decorated the interior with calendars, pinups, and favorite advertisements, and provided a chair and a gas stove for his comfort when the weather required him to stay inside the powerhouse.

The shacklework that extended in every direction from the powerhouse reflected the engineering skill and ingenuity of the system's designer. [198] In broadest terms, the rod lines extended horizontally from the eccentric to the well. The manner in which each line was suspended, supported, or changed direction required a unique solution for each well. In cases where the terrain was nearly level, a series of "friction post" supports—short lengths of 2-inch tubing driven into the ground topped by a wooden block (called a "doll head"), with one end milled for insertion in the end of the tube—adequately carried the line. The frictional losses from such a system made friction posts inferior to a simple pendulum arrangement whereby the rod lines were suspended from a structure.

[196] Uren, 17-18.

[197] This survey identified three such powers: two in the Tiona field and one at Cooper Tract. They range from moderately to severely deteriorated in condition.

[198] See George for illustrations.

These took on a variety of forms, the most prevalent being a tripod or tetrapod made of wood or, more often, ubiquitous secondhand 2-inch tubing. The legs were joined by a bolt, from which was suspended a hook fashioned from a salvaged rod. The rod line swung freely from this pendulum. If, however, the rods deviated from a straight line, a loss in the length of stroke transmitted would result, as a pendulum arrangement permitted significant lateral motion.[199]

When terrain required a vertical change in direction, a pivoting swing post, "rocker," "hold-up," or "hold-down" was used.[200] Performing similar functions, these devices were usually hinged on the lower end and anchored to reciprocate back and forth. A swing post or "hold-up" held the line off the ground at a high point in the terrain, such as the crossing of a ridge or the descent of a slope from a level; a hold-down or a well-anchored swing post performed the same function at the low points of the line, such as at the bottom of a gully. These devices ranged in cost from patent designs and castings ordered from supply catalogs to wholly site-built devices built from timber or secondhand tubing and casing.

To effect a horizontal change in direction, a device known as a "hold-out," "butterfly," or swing was used. A vertical post or support (often a tree) provided a pivot point for a triangular braced frame, from which extended lines in the different directions. This arrangement was often quite elaborate and provided a point remote from the powerhouse at which to connect or disconnect additional wells, as lines could be attached to the oscillating corners.[201]

The pumping jacks are of several designs that perform the same function: they translate the horizontal reciprocating motion of the surface rods to a vertical reciprocating motion of the sucker rods. There were two main kinds of jacks: direct pull, represented by the Jones & Hammond and Norris jacks; and indirect pull, represented by the Oklahoma pattern jack. Both used a pivoting triangular frame or "knee" as their main mechanical members. The direct-pull type was attached to the polished rod (the pumping rod emerging from the wellhead), while the indirect-pull type operated a pitman and beam, which then provided the lift. Supply company catalogs identify a number of different indirect-lift jacks available during the 1900-1920 era, all of which have been noted as extant in the region: The common Oklahoma jack, the O.K. jack, the Paova jack, and the Maloney jack. All of these jacks bear a superficial resemblance to each other,

[199] *Ibid.*, 22. These devices are locally known as "straddlebugs." Other common types of pendulum supports include a two-post pendulum and a single-post pendulum.

[200] See Appendix.

[201] Uren, 22-24.

the primary differences being in the castings and materials for the knee and the beam, and the severity of intended duty. Producers often purchased the castings for the jacks and used salvage tubing or lumber to build frames and beams.[202]

The direct-pull jacks, which were manufactured by Jones & Hammond, Hudson, Simplex (all available regionally in the large supply houses and by catalog), and Norris (available locally, from a machine shop at Tiona) are further differentiated into upper connection and lower connection jacks, according to the way the rod line arrived at the jack at either a high or low angle, depending on the terrain. Except for the Hudson jack, all of these direct-pull jacks incorporated a tangential arc to give the polished rod a straight lift, reducing lateral strains on the rod and stuffing box. The most popular jack in the region seems to have been the structural steel Oklahoma pattern jack, even though it was not as mechanically efficient as the Jones or Norris jacks.[203]

The ubiquity of the central power system in the northeastern Pennsylvania oil fields in the early part of the century can be noted in contemporary technical literature, particularly in the Pennsylvania Geologic and Topographic Survey publications. Lytle notes the use of rod lines and central powers in nearly every field in the region in 1945.[204] In the Bradford field, Fettke observed in 1938 that the most common pumping setup used a double-eccentric band wheel power and Oklahoma pattern pumping jacks. As many as 30 to 40 wells were connected to a power, but only 16 to 20 were pumped at one time.[205] On leases with lower well density, smaller installations prevailed. Another regional observer generalizes that the large corporate producers in the Bradford field favored massive direct-driven gear powers with double-underslung eccentrics; the small independents employed compact belt-driven geared powers, and the larger independents characteristically used bandwheel powers.[206]

Even though production had settled to predictable levels, the oil fields continued to decline and many became uneconomic to operate, or were watered out from secondary recovery activity. Most of these leases have been abandoned and scrapped. Since World War II the more profitable fields have been updated with

[202] *Producers Monthly* 4 (April 1941), 16.[196] Uren, 17-18.

[203] See oilfield supply catalogs from the turn of the century to World War II for examples. There were a number of jacks, similar to both the Oklahoma and Jones jacks, that could be built on the lease from salvage parts attached to patent fittings. Some examples are the Paova, O.K., and Maloney jacks (indirect pull, available through Oil Well Supply Company catalog, 1916).

[204] See generally Lytle, *Crude Oil Reserves of Pennsylvania,* in the "remarks" field of each entry.

[205] Fettke, *Bradford Oil Field,* 424.

[206] E. Patrick Munday, "The Restoration of an Oil Lease to Production Status" (Thesis, Rensselaer Polytechnic Institute, December 1981), 7.

new equipment, mainly gasoline or electric-powered unit pumping jacks. Many of the pumpers were happy for the change, since work on a central power lease was hard and often dangerous: "It just didn't seem as bad, to push the button and start—it was a little safer," a former central power pumper has commented.[207] The result has been the virtual extinction of an entire industrial process, but one which still has vestigial operations in the region. Furthermore, because this process was so widespread, there still exists relatively abundant archeological evidence of its activities. This is fortunate, because little historical investigation of this process has been performed to date.

Obsolescence and Technological Persistence

By the first decade of the century, most of the oilfield supply houses had introduced "unit" pumpers, a combination of a gas or gasoline engine coupled to a small cast iron walking beam. The compact, unitized arrangement and low price was advantageous to producers whose wells were either few in number or widely scattered. Some of the best examples of these early unit pumpers are those made by the Oil Well Supply Company, the American Railway Appliance Company, and the Myrick Machine Company of Olean, New York. These early pumping jacks are now in demand among gas engine collectors, and replacement parts are being remanufactured for them.[208]

These early, relatively heavy units were superseded by more lightweight units constructed of structural steel instead of cast iron. To aid in pumping and engine efficiency, most of these unit jacks have iron or concrete counterbalances on the pitman end of the walking beam, and are known as "beam-balanced units."[209] These jacks employ a variety of power sources. Many are pumped with small Wisconsin or Briggs & Stratton gasoline engines. Many producers use electric motors if their wells are located near electric service. Electrically-operated wells, which can operate on timers and thus require very little supervision, are the logical development of the central power concept. Some of these unit pumping jacks, such as the common Jensen jack, are up to fifty years old now and soon must be considered as historic machinery.

[207] Ross, "Makin' Hole, Pumpin' Oil," 13.

[208] For example, ignition parts for the Myrick Eclipse jack (see Rutsch's typology for illustration) are now being remanufactured by the Burns and Horner Gas Engine Company of Dayton, Ohio (advertising pamphlet). Early unit jacks may be seen at regional gas engine shows and at both the Coolspring Power Museum and the Drake Well Museum.

[209] Other varieities are crank-balanced and air-balanced units, which are much more common outside the Appalachian field. Newer beam-balanced units also have crank counterweights.

Replacement of rod-line jack plants with unit pumpers has been continuous since their introduction. The writer knows of no source for new parts for shackle systems, and used and salvage parts are certainly nearing the end of their service life on the remaining systems in use. The likely operator of a central power system still in use is a marginal operator who either lacks the resources to upgrade the system, or does not consider the wells productive enough to justify the capital expense. In a stringent regulatory climate and a poor oil market ($14 per barrel as of this writing), few producers are willing to upgrade more than the law requires. This atmosphere is not conducive to preserving these systems; more often, it is leading to abandonment and salvage.[210]

In some cases, the operator still uses a central power simply because he enjoys the old machinery, and the expense and labor that go into maintaining the system can be justified on this basis. These individuals are the best avenue to preserving and interpreting the engineering heritage of the region's oil fields.

There is a rich social and cultural heritage to be documented in the oil fields as well. Though the first- and second-generation oil producers have all passed on, quite a few pumpers, secondary-recovery operators, and others concerned with the industry from the 1930s to the present era survive. One fourth-generation oil producer, furnishing a philosophical perspective, has noted that much of a small producer's remuneration is in the form of self-satisfaction. Petroleum production on such a small scale appeals to a person's social responsibility; regulatory regimes aside, the industry is a good example of sustainable economics and appropriate technology. The systematic care of a central power lease—mowing the rodline paths, tinkering with the engine, lubricating the machinery—bonds the independent producer to the land and his lease. A central power system arguably is less intrusive and more in harmony with the environment than are unit pumpers.[211] The depth of the producer's involvement with the land, coupled with the longevity and durability of the technology, represents both an appropriate land use and a cultural heritage unique to the Pennsylvania oil region.

[210] Personal Communication, "Skip" McKenna, at Jo Jo field near Kane, Pa., March 1994.

[211] E. Patrick Munday III, "Technology and the Bradford Oil Field" (Unpublished manuscript, 1978, in possession of USDA Forest Service, Allegheny National Forest, Bradford Ranger District), 2-5.

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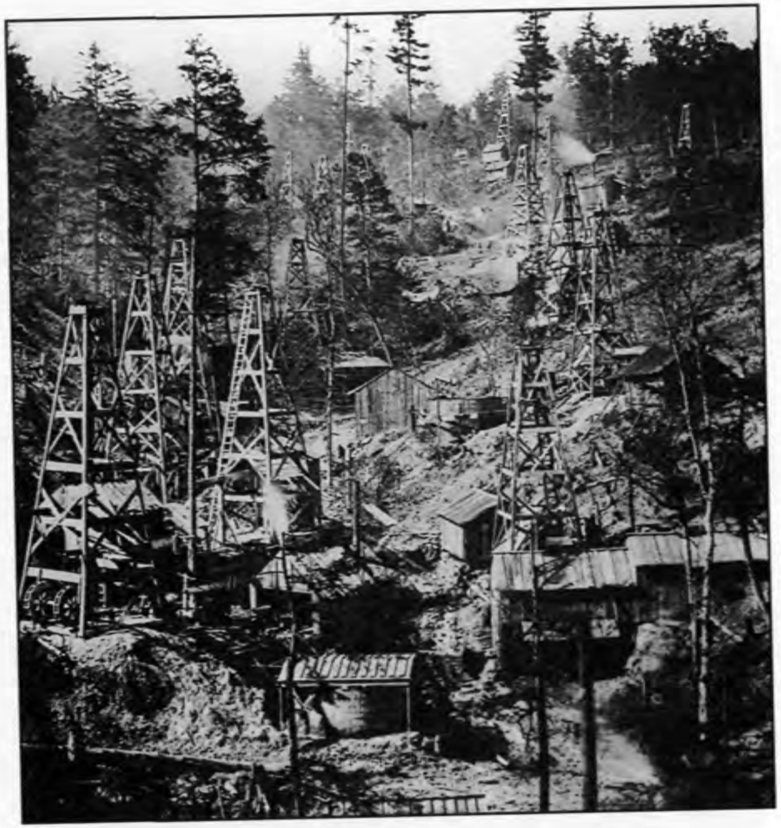
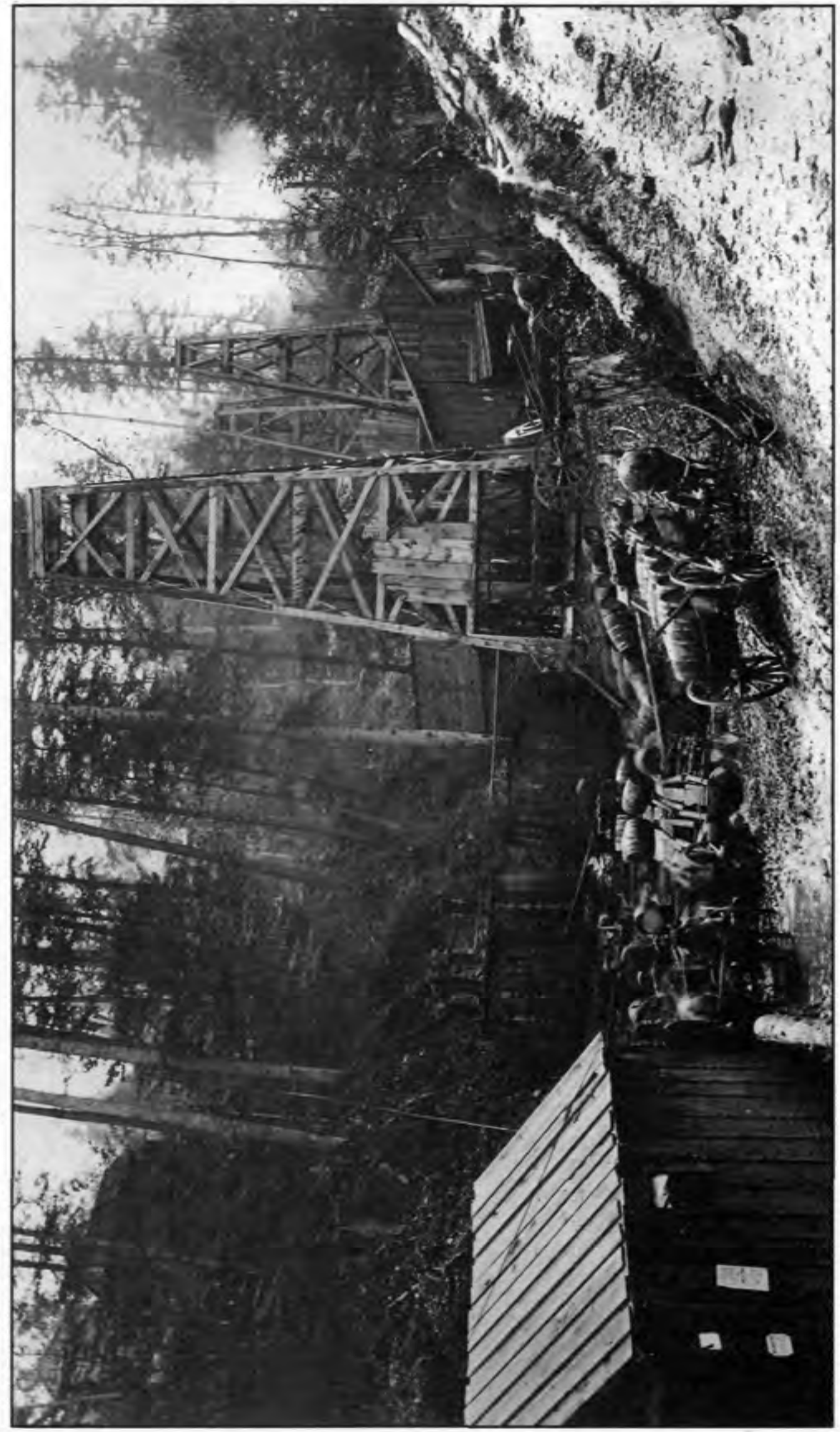
Appendix

Tidioute, Pa., in 1864: the eastern outpost of the Oil Region. *John Mather Photo / Drake Well Museum (DWM)*

The Economy Oil Company, owned by a millennial religious society, in 1864. It was one of the more successful Tidioute operations during the industry's first decade. *DWM*



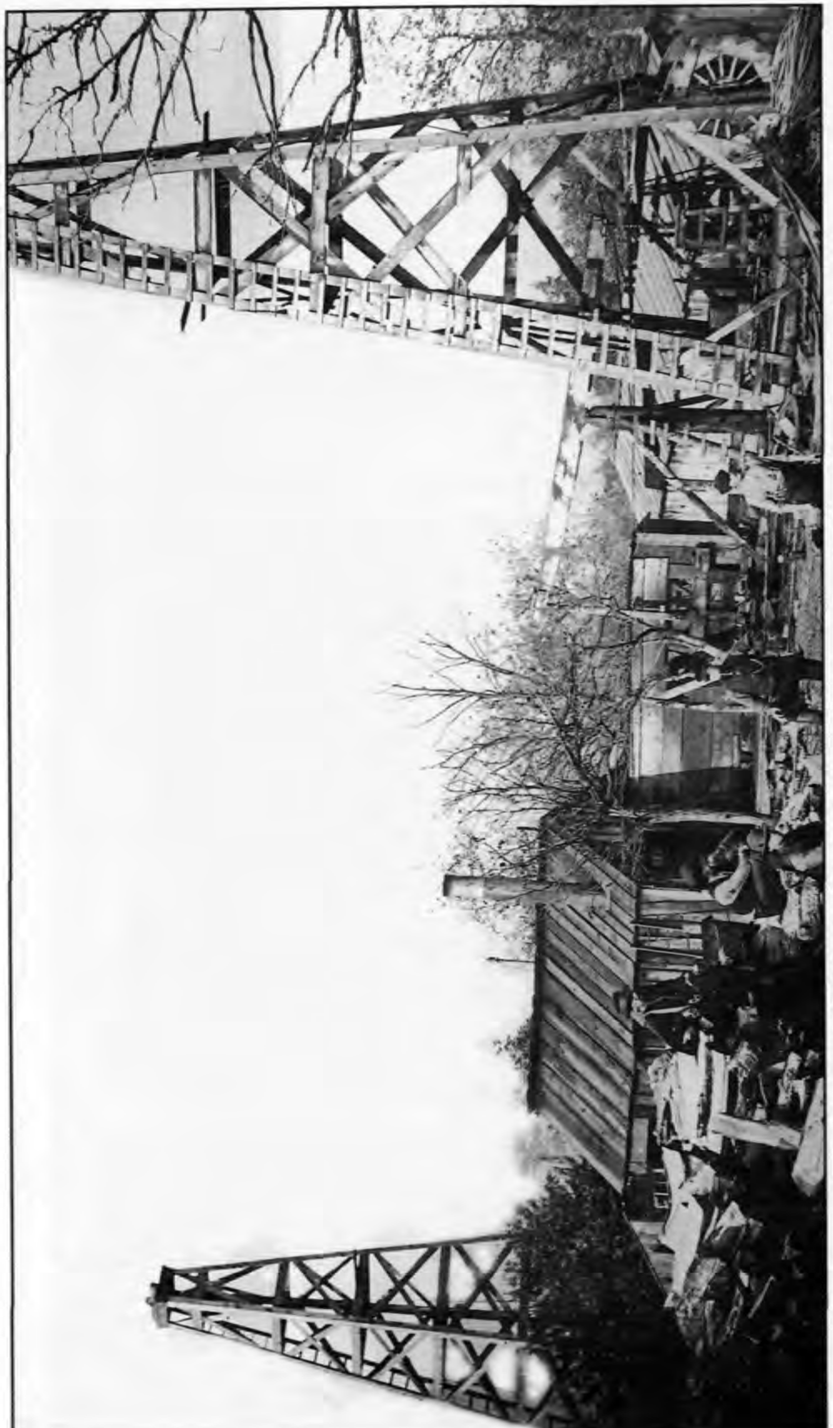
Operations on Dennis Run, Tidioute Field, circa 1866. *DWM*



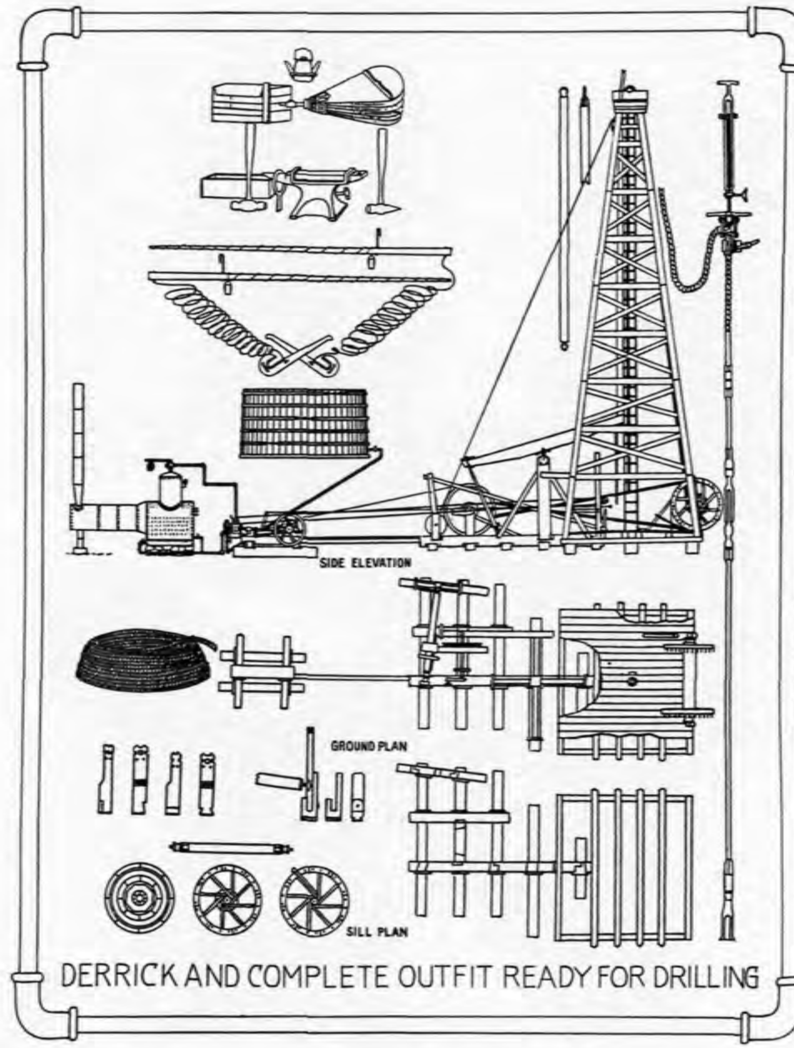
Gilbert No. 1 well on Dennis Run. Oil was still transported in barrels at this location. *DWM*

Forest of derricks on Triumph Hill in 1871. *DWM*

The business district of Triumph City , 1871. *Warren County Historical Society (WCHS)*

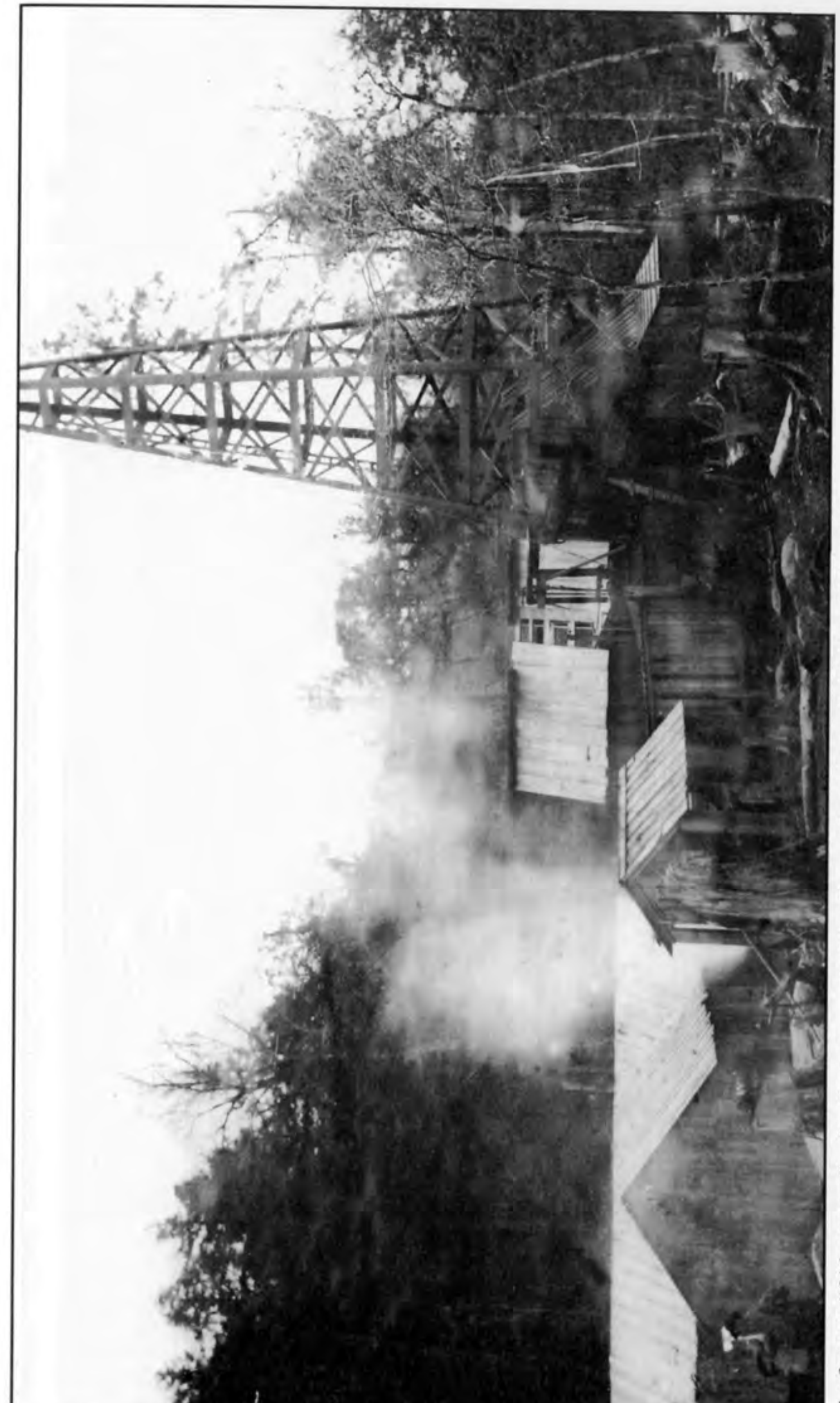


Pumping well in Tidioute Field, circa 1872. *DWM*

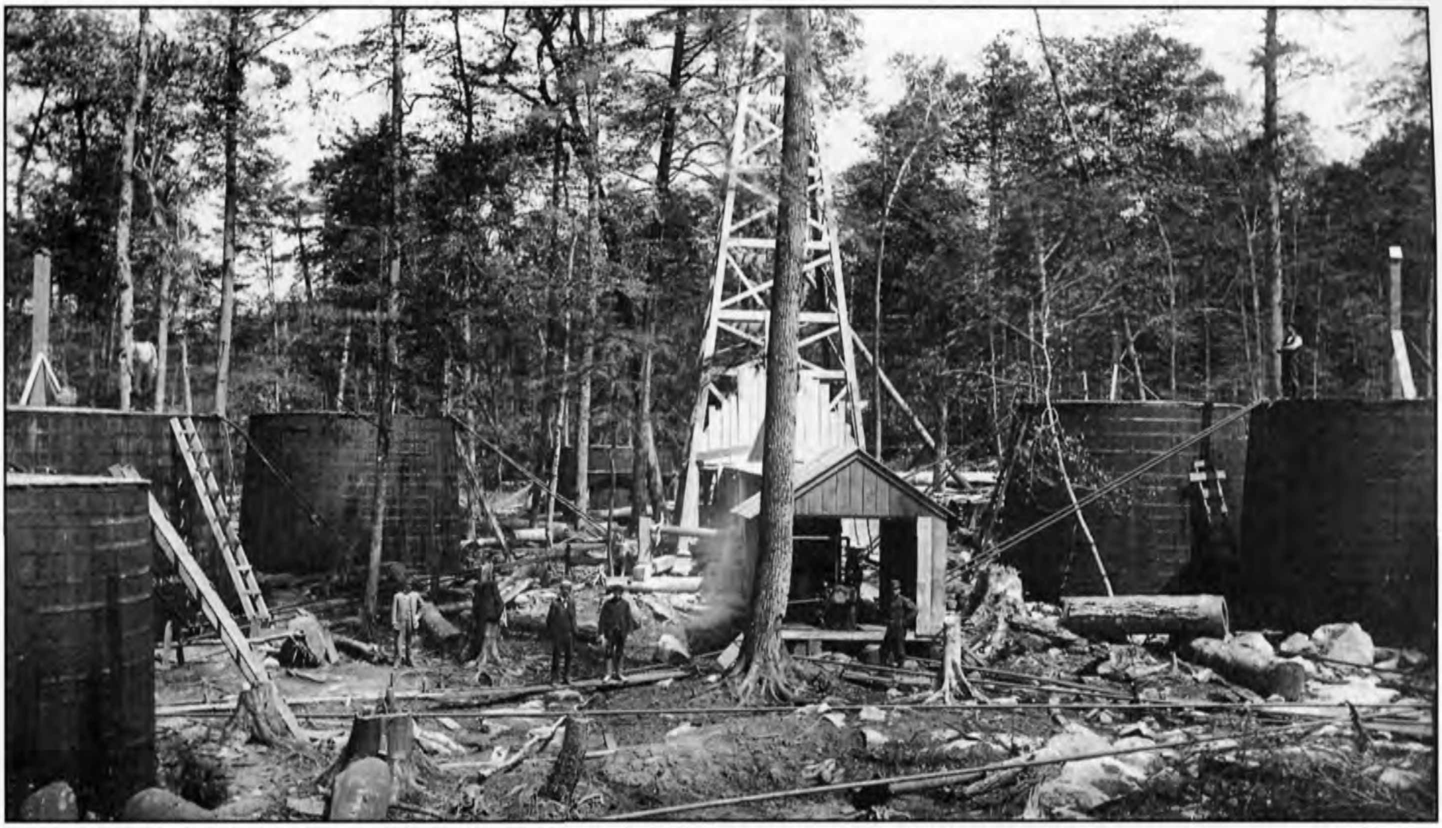


Standard drilling and pumping rig, 1880. *The Oil-Well-Driller (1905).*

An artist's impression of sentries guarding a "mystery well" from inquisitive oil scouts. *DWM*



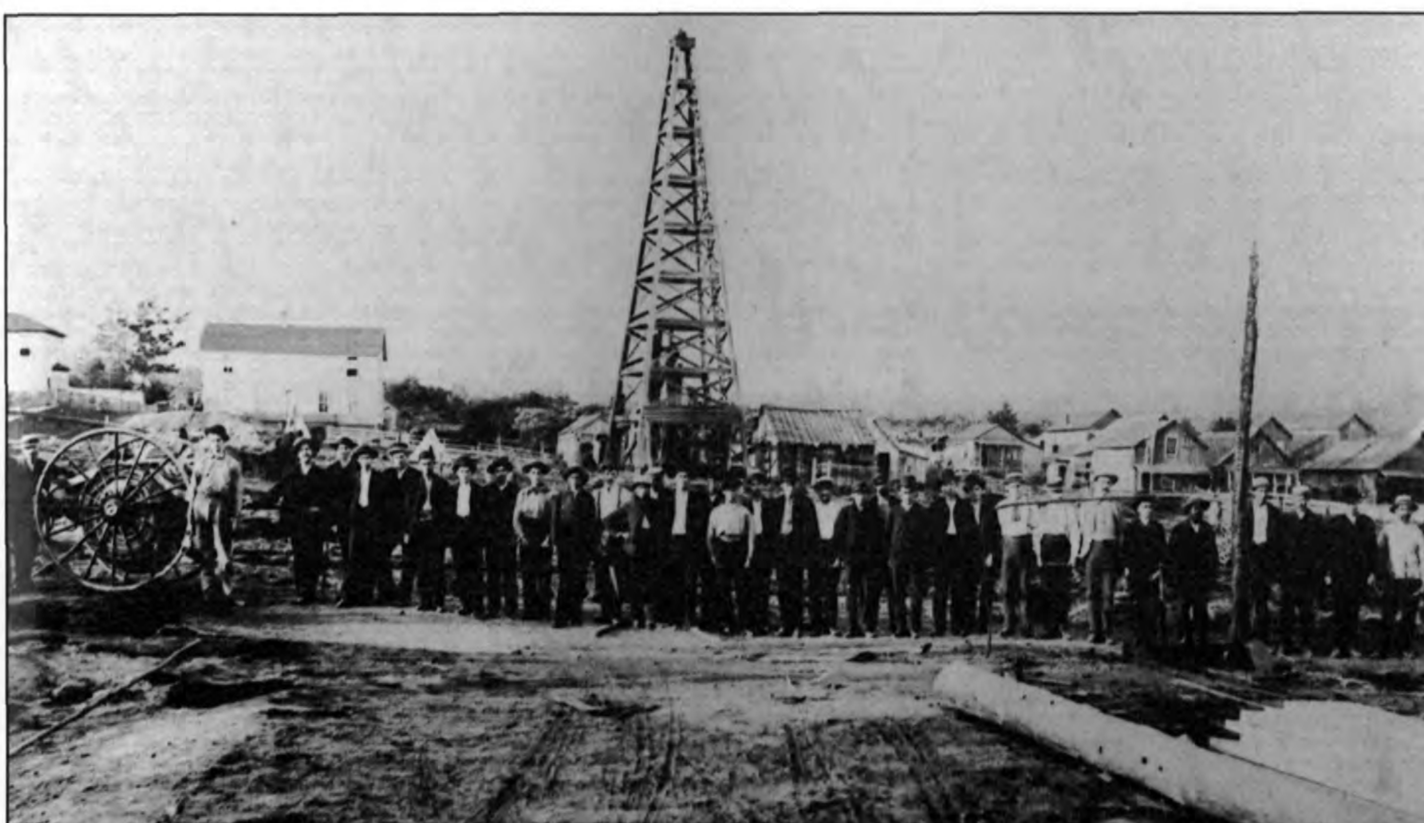
The famous "646 mystery" – the discovery well of the Cherry Grove boom field, May 1882. *DWM*



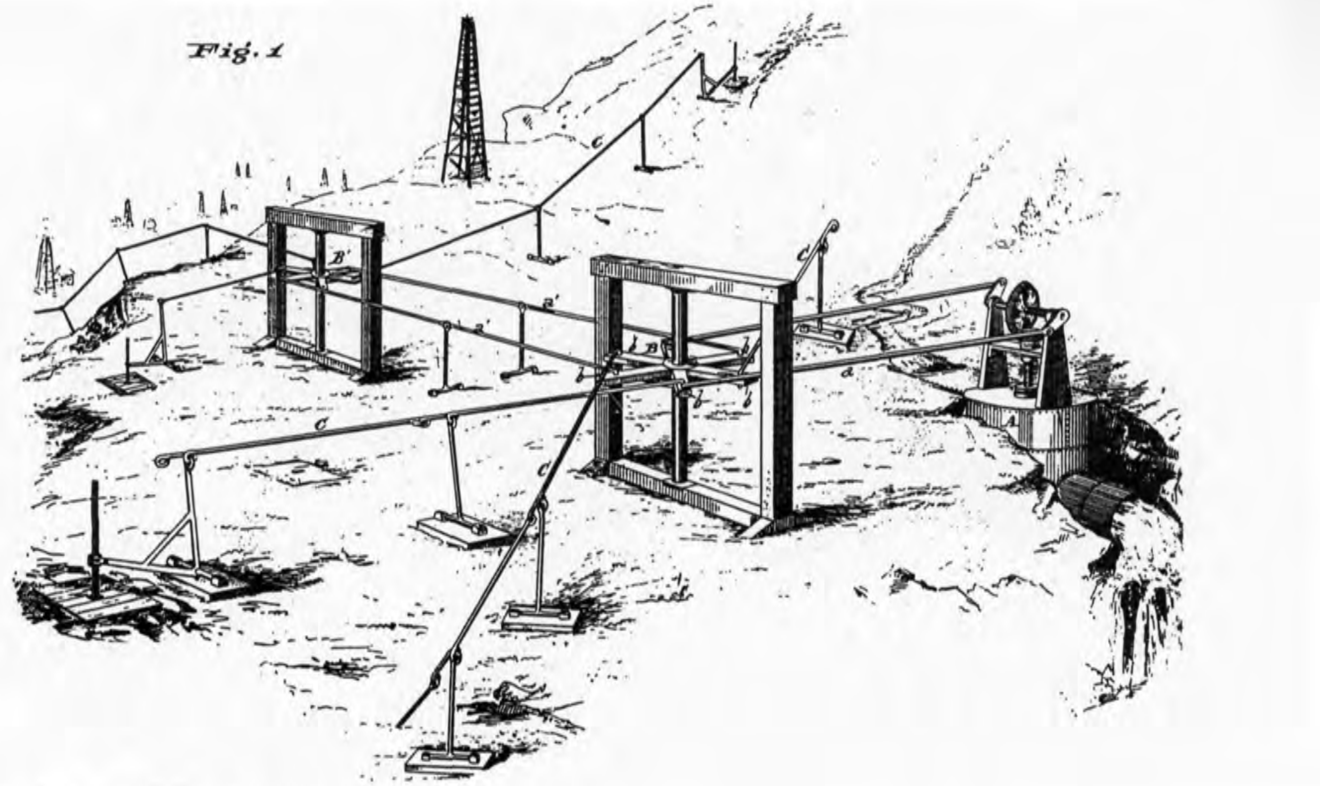
Operations at Cherry Grove, summer 1882. The pipeline companies required the huge tanks to "settle" the oil. *DWM*

Operations at Cherry Grove, summer 1882. *DWM*

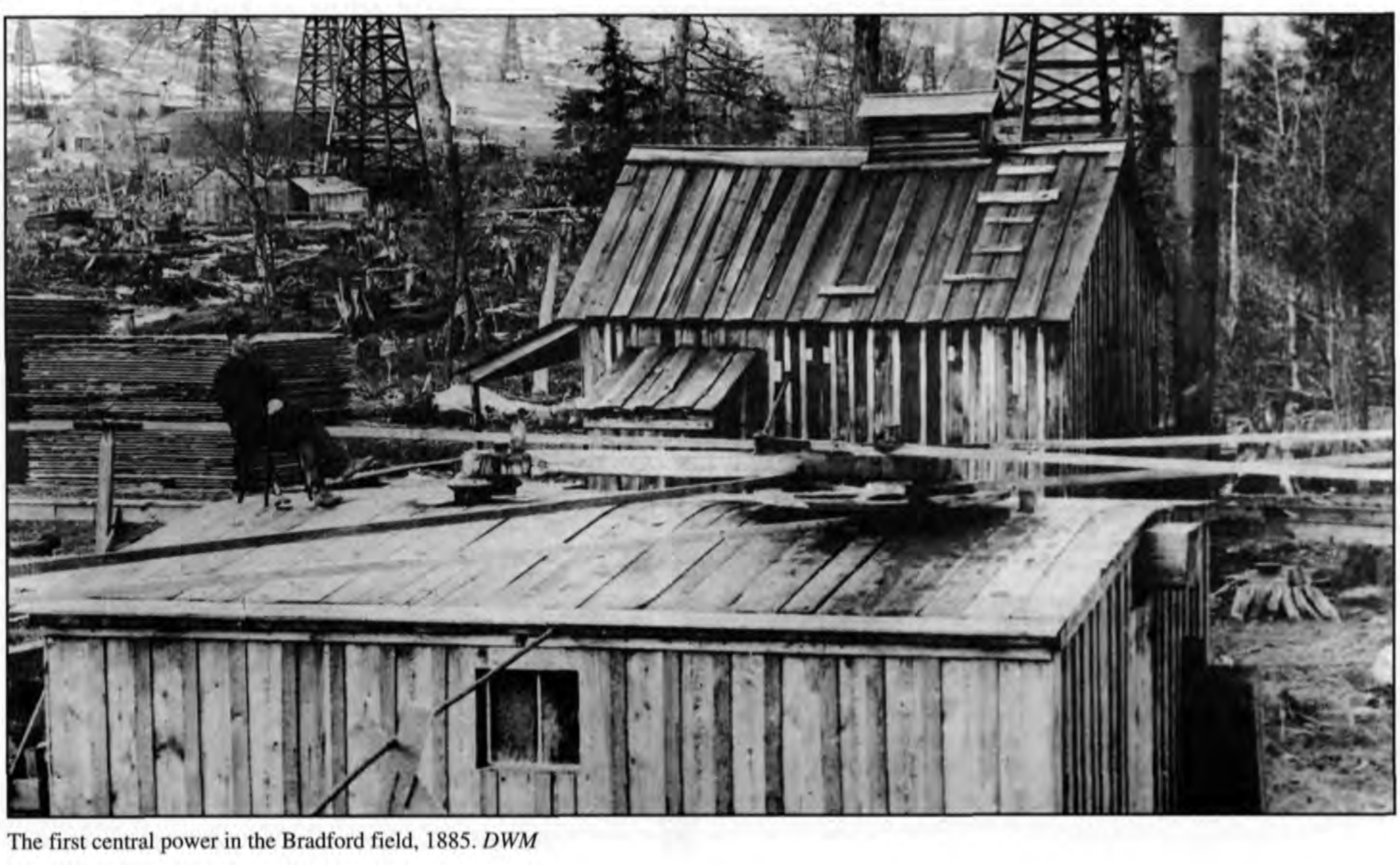
Clarendon, Pa., July 4, 1887. Most of the town burned hours later. *WCHS*

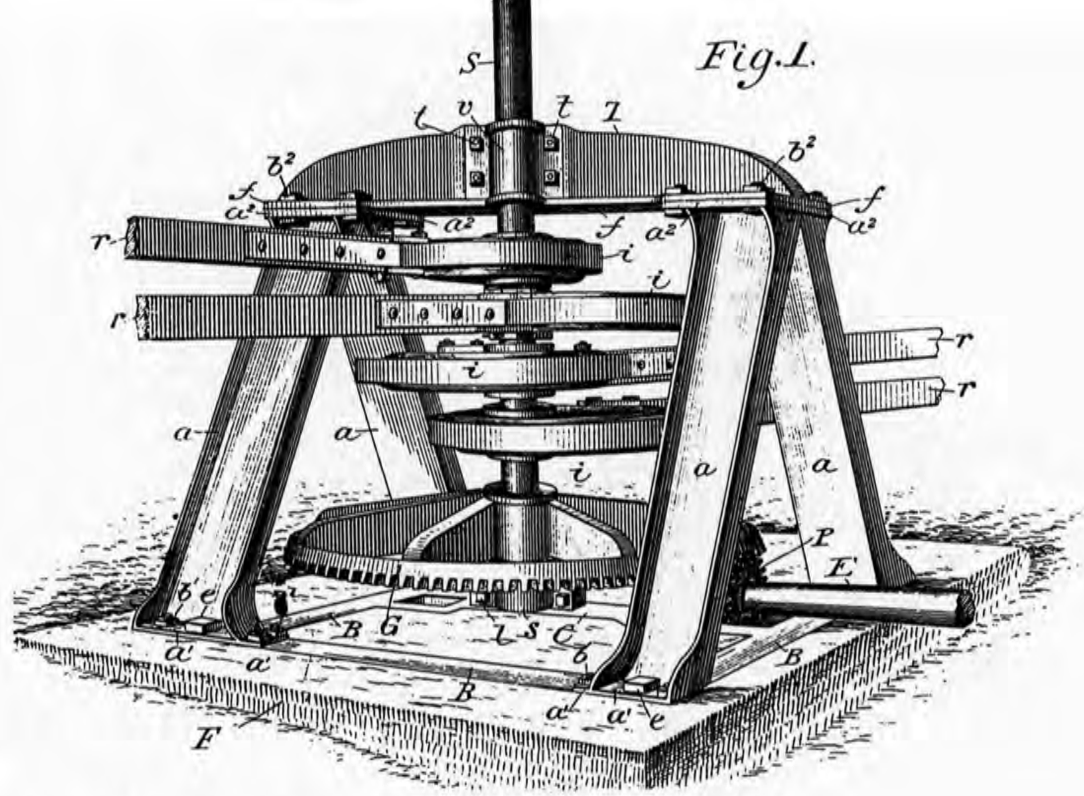


A hose brigade at Clarendon, circa 1890. *WCHS*

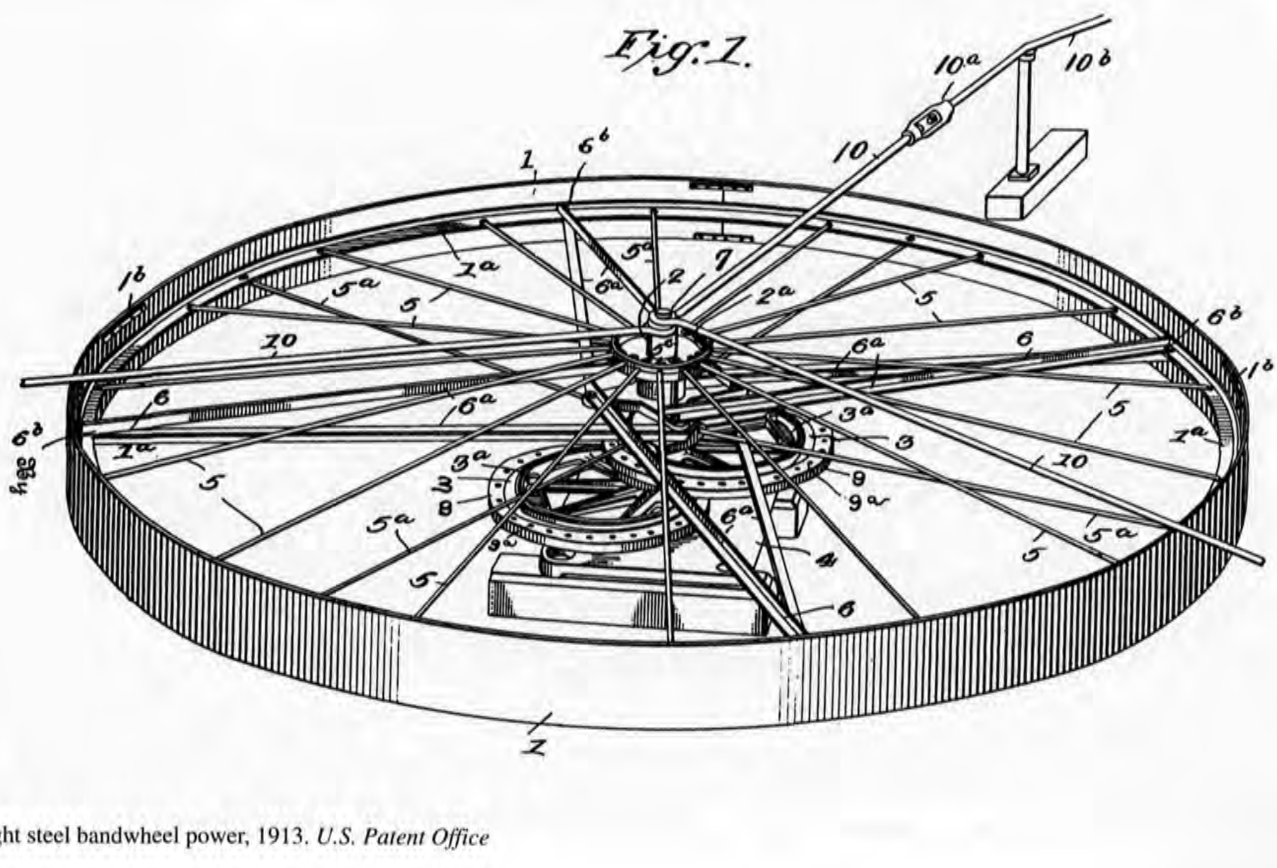


Yates patent central power system, 1879. *U.S. Patent Office*

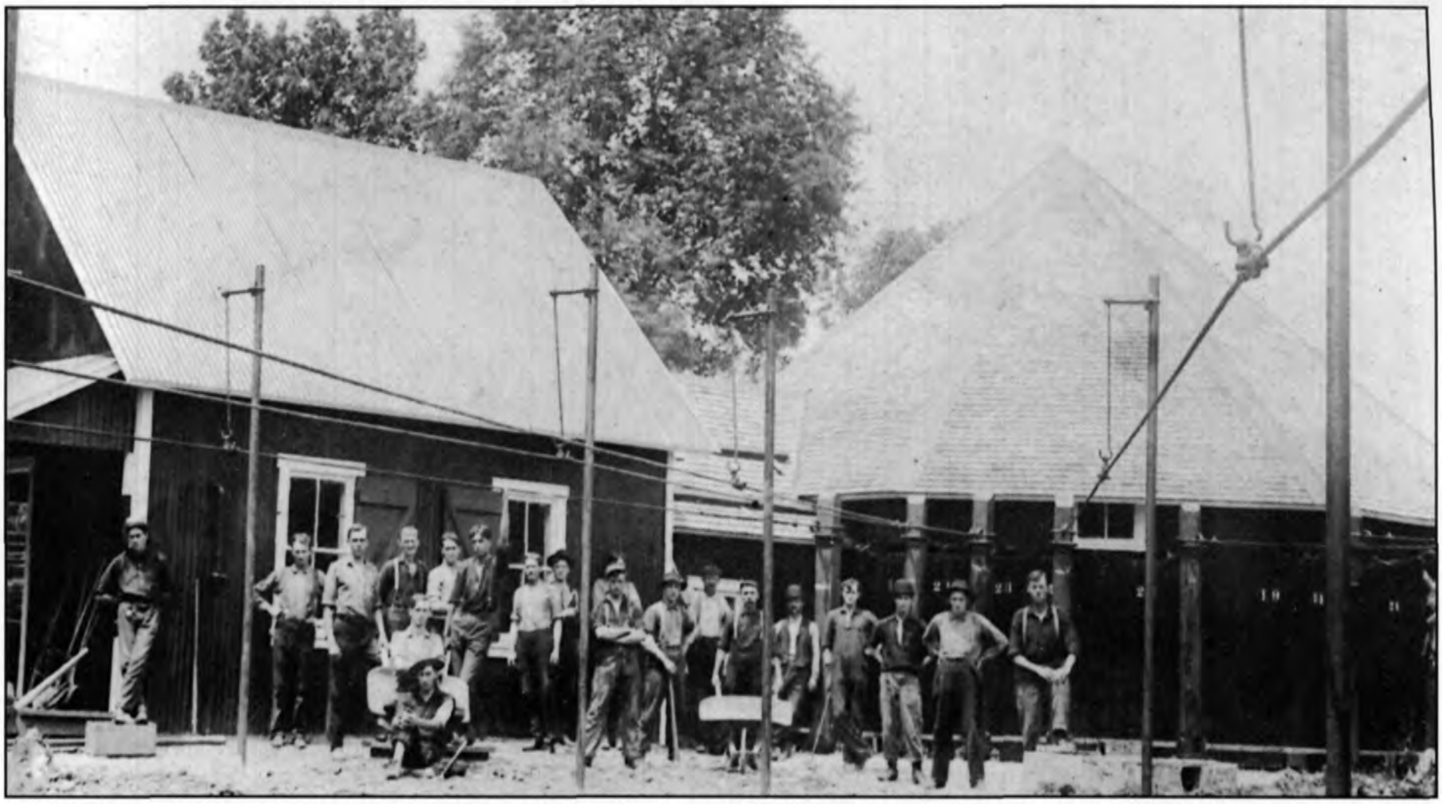

The first central power in the Bradford field, 1885. *DWM*



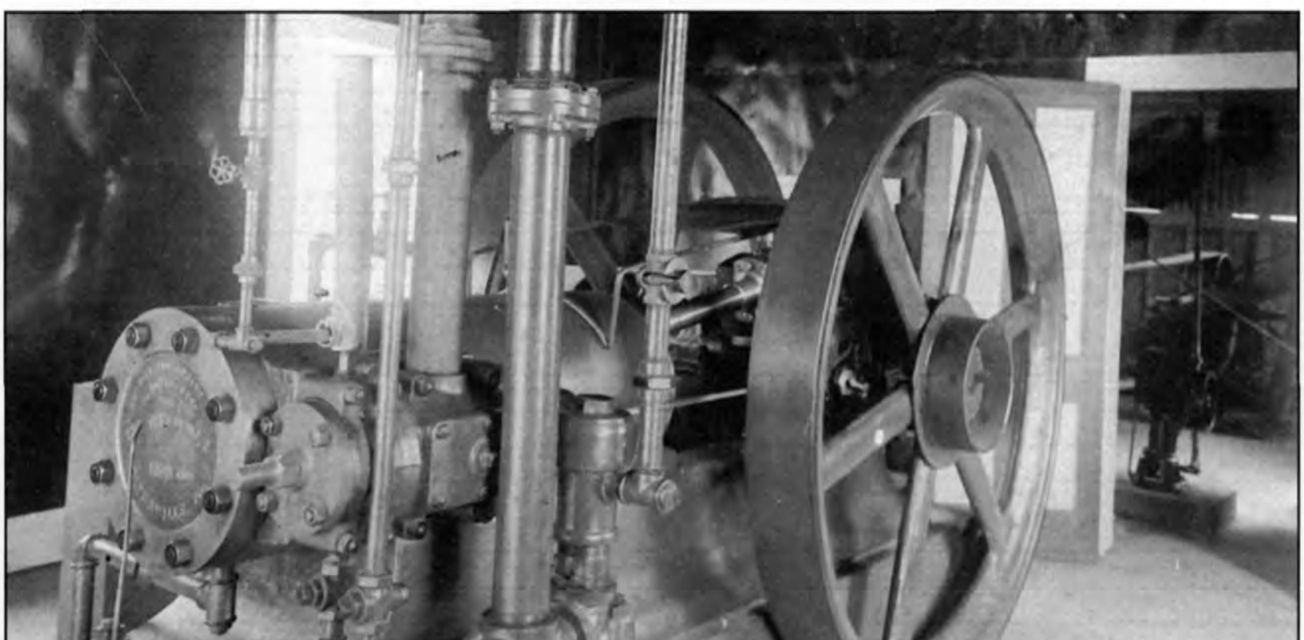
Allen's Patent Geared Eccentric Power, 1885. *U.S. Patent Office*



Lightweight steel bandwheel power, 1913. *U.S. Patent Office*



The South Penn Oil Company's standard design "octagon" central power, Bradford Field, circa 1900. The design allowed 330 degrees of unobstructed pull. The company's pride in workmanship is evident. *Jim Bryner/Penn-Brad Oil Museum*



Olin gas engine installation in new octagon power, circa 1900. *Jim Bryner/Penn-Brad Oil Museum*

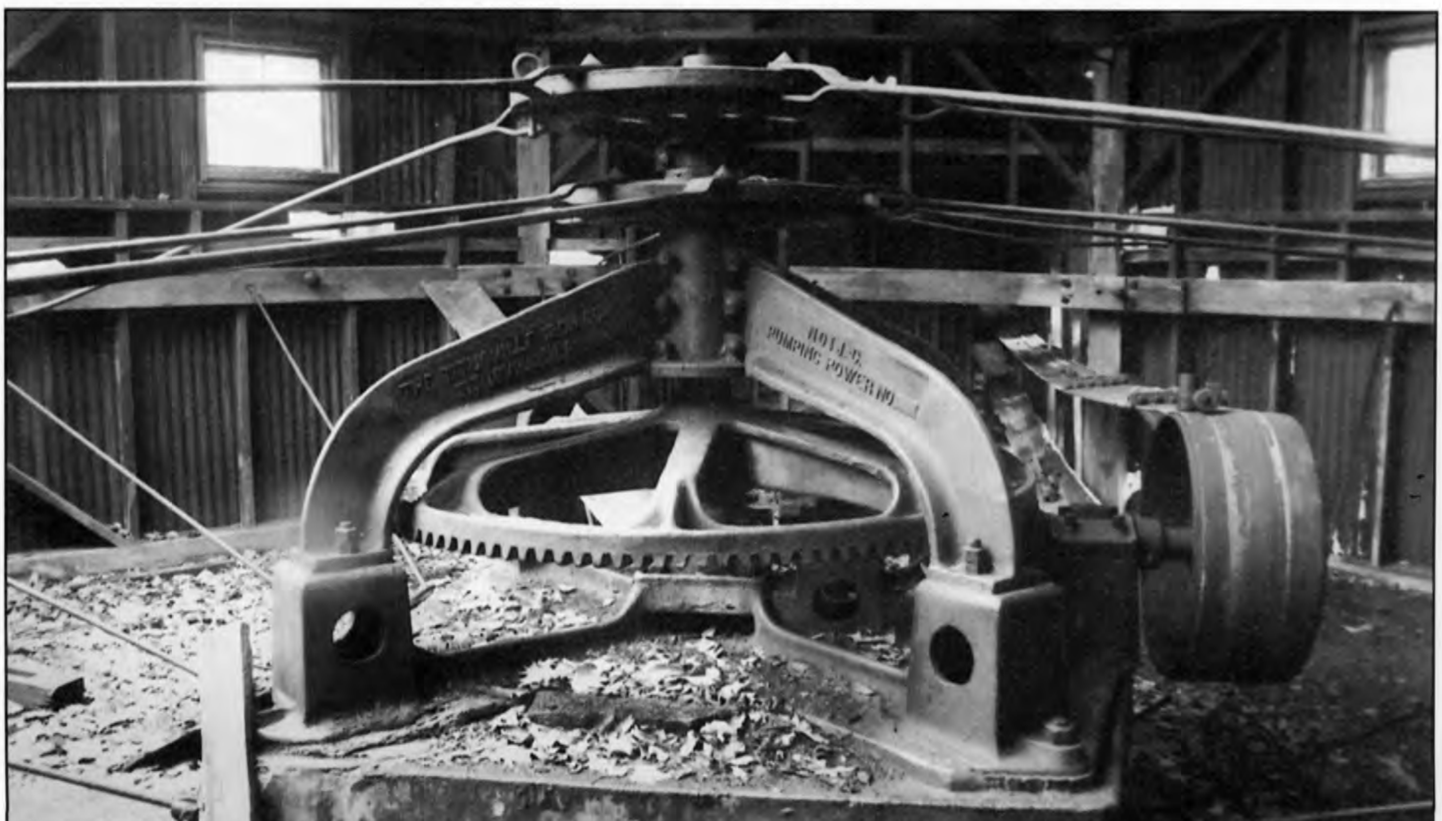
Late design South Penn central power, Bradford Field, 1970. *Mike Fuoco*

Cline Oil Co. central power, still operating at Degolia, Pa., 1994. *Phil Ross*

The Forest Service began purchasing much of the surface area of the Middle Field in 1923. The early Allegheny National Forest hosted a well-established producing industry. Pictured here is a Barcroft" or "Blaisdell" compressed-air pumping rig, in 1926. Note the modified Farrar & Trefts steam engine. *USDA Forest Service*

Standard pumping rig, 1925. *USDA Forest Service*

Disappearing relic: South Penn "octagon" power in the Wardwell Field, 1995. *Phil Ross*



Geared double-eccentric power, installed in 1909. South Penn Mead Lease, Gartland/Morrison Run Field, 1996. *Phil Ross*

Wooden bandwheel double-eccentric power, Lot 202. Tiona Field, 1994. The bandwheel is installed parallel to the slope of the hill. The sash-mounted belt tensioner in the foreground is a very old example. *Phil Ross*

Forest archeologist Rick Kandare records an abandoned central power on Stone Hill in the Clarendon Field, 1994. *Phil Ross*

The "Old Powerhouse" (ca. 1939), an operable former South Penn central power the Allegheny National Forest is developing as an interpretive site. *USDA Forest Service*

A unit pumping jack at Cooper Tract, 1994. This is the standard oil-lifting device today. *Phil Ross*

Appendix A

ANF Oil Fields and their Discovery Dates

1.* Tidioute	1860
2. East Hickory	1866
3. Fagundus	1868
4. West Hickory	1870
5.* Bradford	1871 [1875]
6. Warren-Glade	1875
7.* Guffey	1876 [1878]
8.* Stoneham-Clarendon-Tiona	1878
9. Dew Drop	1880
10. East Kinzua	1880 [1885]
11. Kinzua	1880 [1885]
12.*Cherry Grove	1882
13.*Cooper	1882
14.*Balltown	1877 [1882]
15.*Wardwell	1876 [1883]
16. Morrison Run	1883
17.*Kane	1881 [1885]
18. Watson-Duhring	1890
19. Deerlick	1890
20.*Watsonville-Klondike	1896
21. Bull Hill	1899
22. Salmon Creek	1907
23. Lacy-Guitonville	1908
24. Lewis Run	1909
25. Queen	1922
26. Marshburg	1929
27.*Music Mountain	1937

*Indicates historically significant field

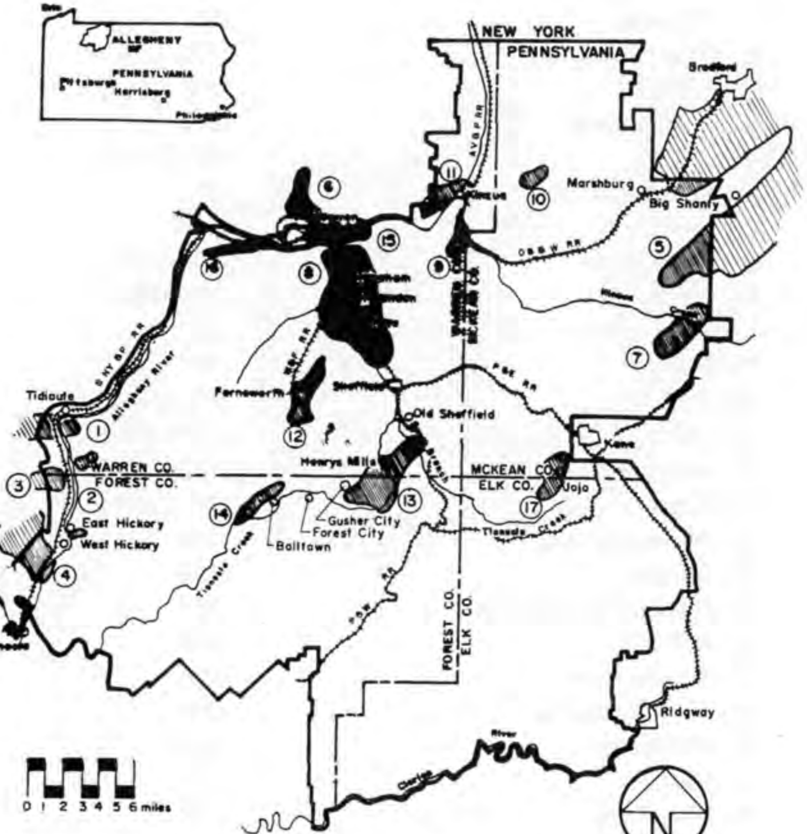
[dates in brackets indicate actual development date if different from discovery date]

William S. Lytle, *Crude Oil Reserves of Pennsylvania,* Bulletin M32, Pennsylvania Geological Survey, Fourth Series (Harrisburg: Topographic and Geological Survey 1950).

Maps

Appendix B

See key on previous page.



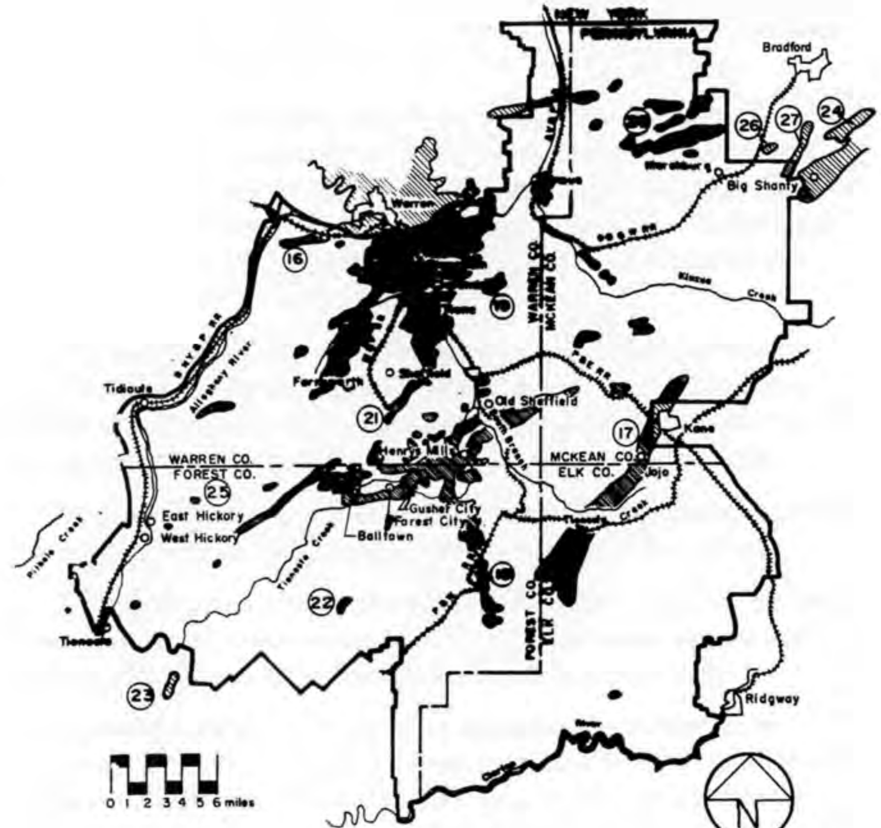
OIL FIELDS

in

ALLEGHENY NATIONAL FOREST

Circa 1885

Delineated by K. McClung - I.H.T.I.A.



OIL FIELDS

in

ALLEGHENY NATIONAL FOREST

Circa 1945

Delineated by K. McClung - I.H.T.I.A.

Appendix C

Drilling for Oil, Circa 1880

From ***Illustrated Catalogue of Oil Well Supply Co., Limited*** Bradford and Oil City, Pa., 1884. Excerpted from J. E. Brantly, ***History of Oil Well Drilling*** (Houston: Gulf Publishing Co., 1971) 171-176.

Published contemporaneously with the Middle Field development of 1882-1885, this account describes the essential process used to drill thousands of wells with the Standard Drilling Rig, a design that had been, as its name suggests, standardized by 1880. Brantly notes that this detailed description of the oil well drilling and completion process is one of the most succinct and complete on record.

The operators on a well consist of four men—two drillers and two tool dressers. One of each work together from twelve at night to twelve at noon, making what is known as the morning tour (always pronounced "tower" in the oil regions). The others make the afternoon tour, from noon to midnight.

When the walking beam is mounted, and the drilling hook hung, a plumb line is let fall from the hook, and it will mark the centre of the well hole.

If the earth is firm a hole twelve inches in diameter is "spudded" by means of the spudding bit. A wooden conductor, made in an octagon form, is inserted in the rock. This prevents the surface earth from caving into the well.

If, however, the bed rock is at such a distance below the surface, or if the surface soil is of such a nature that it is not practicable to "spud" a hole for the conductor, the bed rock is reached by drive pipe, which is a heavy iron pipe, commonly eight inches in diameter on the inside, armed at its lower end with a steel shoe. This is driven through the surface soil by means of a heavy maul, similar to the manner in which piles are driven by a pile driver. The pipe, while being driven, has a heavy iron cap to prevent injury by the blows of the maul.

The maul is made of a sound log from 15 to 20 inches in diameter, and from 12 to 15 feet long. Two opposite sides are smoothed, the lower end is cut off square and dressed in a circle, and a heavy iron ring is shrunk on it to guard against splitting. In the other end is fastened a heavy staple. Two wooden pins are driven in near the top, and also near the bottom of each square side. They are two inches apart and project two inches. They fit each side of the guides, and serve for grooves.

A line is drawn on the derrick floor through the center of the well, at right angles to the walking beam, and planks two inches thick are placed on that line perpendicularly, and carried up in the derrick five feet higher than the length of the maul and of a length of drive pipe. Great care should be taken that those guides are truly vertical. They should be placed as far apart as the thickness of the maul; planks are spiked on each side so as to allow the centre one to project about two inches, and enter between the pins on the maul They must be securely braced at the bottom, and from the sides of the derrick. A short cable 150 feet long is fastened to the bull wheel shaft, carried over the crown pulley, and tied to the staple in the end of the maul. A rope is fastened to the wrist pin and tied loosely around the cable. The engine is started, and every revolution of the crank twitches upon the cable and raises and drops the maul. As the pipe is driven down the operator at the brake lets out more rope as needed. When the pipe is driven to the rock it is cut off square at the derrick floor.

As the drilling tools are about sixty feet long they cannot be operated in the regular way until the hole is deep enough to allow them to sink beneath the derrick floor. The first sixty feet are "spudded."

The end of the short cable used in driving pipe is disconnected from the maul and attached to the swivel box to which is attached the sinker bar, and the auger stem and a bit. Water is poured in to float the mud and the bit is raised and lowered the same as described for the maul. The sand pump is used to clean out. Sometimes the drill and the maul are worked alternately, as it much facilitates the driving of the pipe to have it cleaned out and to have the earth loosened in advance of the pipe. In such cases the guides of the maul are cut a proper height and hinged, so that they can be thrown up out of the way when the drill is used.

In case of a buried boulder, or other large rock, encountered before the bed rock is reached, such rock is drilled through by the drilling tools, and the drive pipe can afterward driven through the hole thus formed. By means of the Clary bit the hole may be enlarged below the drive pipe.

When the bed rock is reached the hole is drilled into it a few inches, and the drive pipe firmly driven in so as to form a tight union, in order that no surface water can leak, or dirt get into the well.

As soon as the hole is deep enough to "bury" the tools, the cable is coiled upon the bull-wheel shaft, and its end united to the tools which are swung up in the derrick. The tools are then lowered into the hole.

The temper screw is closed up and attached to the drilling hook. The pitman is connected to the wrist pin of the crank. The cable is carefully wrapped, and the clamps of the temper screw are firmly fastened upon it, the cable is slackened from the bull wheel, and the tools hang in the well suspended from the walking beam.

The engine is started and the tools will rise and fall with each rotation of the crank. The driller turns the clamps (which are united to the temper screw by a swivel) round and round until the slack of the cable is coiled several times around the straight cable below the temper screw. He then reverses the motion, uncoils it and recoils it up the other way, and again and again. This rotates the drill, and this is kept up constantly while the drilling goes on. As the drill penetrates the rock, the operator loosens the nut of the temper screw and feeds it out gradually, until it is at its extreme length. When the screw is all fed out, a new hold of the cable must be taken by the clamps with the screw closed. When the tools are to be drawn, the bull rope is thrown on the bull wheel, and the driller stands at the brake, and his assistant (the tool dresser) at the engine. The bull wheel revolves and draws up the slack of the cable, and just as the rope tightens and commences to lift the tools, the engine is stopped and the brake set.

The clamps of the temper screw are thrown off the cable, the pitman is disconnected from the walking beam and lowered to the main sill. The engine is started and the tools drawn from the hole. When the top of the bit appears the engine is stopped, a wrench is put on the squared portion of the bit just below the collar, and another wrench on the squared part of the auger stem just above the box. A bar is inserted in one of an arc of holes in the wrench circle which is firmly fastened to the derrick floor, and the united strength of both men applied to the lever will start the joint so it can be unscrewed by hand. (The joints are always "set up" by the same leverage, that no risk may be run of their unscrewing in the well.)

The engine is again started, and the tools drawn entirely up from the hole. When the bit is entirely out the assistant stops the engine, and the driller applies the brake to the bull wheel. The tools are swung out of the way of the sand pump, and the sand pump or bailer is run. The bit is unscrewed and is dressed or sharpened, and carefully dressed out to the size of the gauge, and one is screwed on ready to drill again.

The sand pump is placed in the well, down which it runs by its own weight, and is withdrawn by pulling upon the lever and thus holding the friction pulley against the face of the band wheel.

At any time, either in its ascent or descent, the rate of speed of the sand pump can be checked or stopped by pushing the lever and throwing the brake pulley against its back brake. The sand pump is run one or more times, until the debris made by the drill is removed.

The sand pump is stood to one side of put under the bull wheel shaft and the tools are allowed to drop a little way into the well. The joint between the bit and auger stem is carefully tightened, as before described, and wrenches taken off and the tools lowered, their rapidity of descent being controlled by the brake. Connections are make as before, and drilling resumed.

While the driller is rotating the tools his assistant dresses the worn bit. For this purpose the tool dresser has a blacksmith's forge, which is generally erected at one side of the derrick.

A rope is tied on the walking beam, which passes up to a pulley in the derrick and down through a pulley fastened to the floor near the bellows and is then looped over the bellows handle.

When the tools have just been drawn from the hole the next step will be to throw off the tug rope from the bull wheel, swing the lower end of the tools to one side of the derrick, and hook them there so that they will be out of the way, and lower the sand pump.

When the tug rope is thrown off from the bull wheel, it remains loosely on the grooved pulley and its bight lies over the bull wheel shaft. There is so little friction upon it that it remains upon the pulley.

The sand pump will be run down into the well and withdrawn and emptied several times.

When the well is sufficiently cleaned of debris by the action of the sand pump, the tools are lowered into the well, the clamps are fastened to the cable, and the drilling is resumed.

In the Oil Regions there are many seams of fresh water intersected by the drill before the oil rock is reached. If this water is not cut off from the well it will fill the hole, and when the oil rock is reached its hydrostatic pressure (sometimes over 600 pounds to the square inch) will drive the oil away and the cold water will throw down the precipitate of paraffine, clogging up the pores of the rock.

Formerly the practice in Pennsylvania was to allow the water to remain in the hole until the oil rock was penetrated. Tubing was then inserted into the well, and upon that tubing, at a point which would rest below the lowest water veins, a "seed bag" was placed. This was a round cylinder of leather (like the leg of a boot) made the size of the hole, firmly tied below, filled with flax seed, carefully rounded to the size of the hole, and loosely tied at the top. When this was lowered to its place, the water soaking though the pores of the leather would swell the seed, and press the bag firmly against the sides of the well. When the water below was pumped out the water above the seed bag was effectually prevented from getting down to the oil rock. Seed bags are no longer used, the patent packers having entirely superseded them.

But since 1870 nearly all oil wells have been drilled by driving the drive pipe, eight inches inside diameter, down to the bed rock. The well is drilled eight inches in diameter down below the lowest fresh water seams. Casing 5-5/8 inches inside diameter, is then inserted and adjusted water-tight upon the rock.

After casing the 8-inch bit is removed, and the 5-1/2 inch bit substituted, and the well drilled that size as far as desired.

The sand pump soon removes all water from the hole and therefore water must be poured in for the drilling tool to work in.

The well is then practically dry, and the drilling is much more rapid, and there is much less danger of the rock's caving than in wet holes.

The drilling is carried on continuously, from Sunday at midnight to Saturday at midnight. Before leaving the well on Saturday night, the driller attaches to the sand pump line the casing tester and lowers it into the well below the casing. The casing tester is a small tin pail with a rubber flange at the top, which fits closely to the hole. It is left 24 hours in the well, and it collects any water that leaks through the casing. It is withdrawn from the well at midnight on Sunday, and if it contains any water, that indicates that the casing is not tight. If necessary, the casing is withdrawn, and again replaced so as to be water-tight, but generally some debris from the sand pump poured around the casing will effectually tighten it.

When the well is being drilled, and especially when completed, it should be measured.

The popular McClure reel can be readily fastened in an auger hole in any of the uprights of the derrick. Its line is a flat steel tape, accurately marked every fifty feet. The brake by which its motion is regulated is very ingenious and efficient. Nothing can exceed its neatness and reliability.

When the well is completed, it is tubed. A casing head is screwed on the end of the casing. There are different kinds of heads.

The tubing is two inches inside diameter, and it extends from the bottom to the top of the well, the lower section (called the anchor) being perforated to admit the oil, or an Innis Patent Flower is inserted, in place of a coupling between two section of tubing.

The tubing is in lengths of from 18 to 20 feet, screw threaded at each end, and a coupling unites two lengths. A standard length of tubing, as sold, has a coupling at one end; short pieces, when cut to order, do not have couplings.

Tubing is put in and taken out of the well by patent elevators. None are made except under patents owned by us. The principal ones are the Fisher and the Fair. A pair (two) are required.

The manner of tubing a well is as follows: A tubing line 240 feet long is carried over the crown pulley and fastened to the beam at the top of the derrick. The bight is dropped down to the floor. The end is fastened to the bull wheel shaft.

A snatch block is placed on the bight of the line.

A piece of tubing is placed in the well hole, with the coupling up, and under the coupling is clasped the elevator. This will prevent the tubing from falling into the hole. The other elevator is clasped under the coupling of another piece of tubing, and the hook of the snatch block is inserted in the bails; a pull upon the line hoists it in the air, and its threaded end is suspended over and then lowered into the coupling. One workman holds the lower coupling with a pair of tubing tongs. Another workman, with a similar pair of tongs, screws the tubing into the coupling.

Our Lay Patent Tubing Tongs are the best for the purpose. The superiority of the Lay tongs is in the four-cornered steel bit, which has four sharp edges, and which can be removed when one edge is worn and replaced with a sharp edge uppermost, and when all are completely worn out, a new bit can be substituted at trivial expense.

When the second joint is made fast to the first, one workman takes his place at the brake. The tubing is hoisted a trifle, so as to take its weight off the elevator; the elevator is opened and taken off. The tubing is then allowed to slowly descend by its own weight until the elevator checks it at the well's mouth. The hook is then detached and the first elevator is united to another piece of tubing, which is placed on the tubing already in the well. This operation is repeated until all the tubing is inserted.

Appendix D

Central Power Lease Equipment, 1936

Sample valuation records from 1936 for Clinger Oil and Gas Company, with holdings at Fagundus, Colorado, Red House Hill (Queen sand development), and Cooper Tract. They are unusually detailed as to ancillary equipment and tools used at the pumping sites.

Hunter Power # 2 (Red House Hill pool, near Tidioute)

Bessemer Gas Engine and clutch
20 hp 180 rpm #30011
$632.00
Wico igniter #44652

Titusville Iron Co. Power #1 "J.C." #16905	470.00

Equipment:

1 Pint Powell Lubricator	11.00
1 Pint Glass Lubricator 3 opening	
1" Gas regulator	20.00
1" Gas Quieter	
57'6" x12" Canvas belt	89.42
60 gallon Oil storage tank & pump	
18" Trimo wrench	2.00
14" combination wrench	3.00
Blacksmith Hammer	1.50
Claw Hammer	1.50
2 Fire Rakes	.80
D.B. [double-bit] Axe (poor condition)	2.50
Bar	1.00
Mattock	1.25
L.H. Shovel	1.25
Belt Tighteners	3.00
15 bbl. wood tank	
Paige jack [for tightening rod lines]	13.35

Cooper Tract Power #1 [extant—visited 11/93]

Bradford Supply Co. Gas Engine / A.C. Thomas Cyl.	150.00
Pulley 14"x14"	
Pint Powell lubricator	
Clutch series 14D Carruthers & Fithian	
Bessemer Power #2	
Pulley 13" face 26" diameter	475.00
29'6" center	
Belt tightener	8.00
1 D.B. axe	2.50
1 pick	2.50

Cooper Tract Power #4

Steam Engine w/ Bradford Supply (A.C. Thomas) Gas Eng. cylinder 150.00

14"x14" clutch Pulley
1 - 1 Pint Powell lubricator
Clutch 14D #11463R Carruthers & Fithian

Reid Power #8 Iron Frame	700.00
Pulley 24" Dia x 13" face	
25' center	
Belt stretcher	8.00
Square	1.00
Hand saw	3.00
Powell lubricator	11.00
Ratchet brace and bit	2.50
Scoop shovel	3.00
Pick	1.60
D.B. axe	2.50
Brush hook	2.25
Paige jack	13.35
Scythe	3.25
14" combination wrench	2.93
Pein Hammer	1.50
36" Trimo wrench	6.25
Gealy Chain Tongs #00	6.30

Appendix E

Oral History Tapes at Drake Well Museum

Interviews with oil and gas workers who worked on Allegheny National Forest; conducted by David Weber, Pleasantville, Pennsylvania, on behalf of the Drake Well Museum. These tapes are a valuable resource for interpreting the folklore and social history for the early- to mid-twentieth century era of oil and gas production on the ANF.

Ed Anderson (1 hour, 15 min) Gas well tender for United Natural Gas in Kane area. About age 50.

Miles Blanchard (1:00) Civil engineer for Quaker State/Northern Ordnance. Worked with repressuring system at Cooper Tract. Deceased; born 1908.

William Brown (0:50) (b. 1904) Driller; South Penn in Bradford, Kane fields.

Gordon Burdick (1:30) Born 1912. Pumper for Bryner Oil Co. at Marshburg before WWII.

Sherman Burdick (1:00) Age 83. Driller; worked in Queen Sand pool near Tidioute in the 1950s.

Floyd Clinger (1:00) 1891-1988. Well-known Cooper Tract producer.

John Comet (1:30) Last VP in charge of United Gas. Started career as a roustabout in Kane area.

David Gourley (1:15) Born 1904. Surveyor for United Gas. Worked near Queen and Kane.

John "Augie" Holtz (1:00) Pumper for Northern Ordnance at Fagundus and Cooper Tract. Age 65.

Marion Hoovler (2:00) Born 1918. Worked almost every possible position in the oil fields, from roustabout to shooter to producer. Worked at Clarendon, German Hill, Tionesta, Minister, Sackett, etc.

Alfred Hunt (1:00) 1901-1989. Serviced engines for Titusvillle Iron Co.

Russell Hunter (1:00) Born 1905. Tooldresser, pumper, shooter, driller in Queen and Balltown-Truemans fields.

Walter McGraw (1:15) About age 70. Gauger and pump station operator for National Transit at Tiona, Tidioute, and Kane.

Charles (Mike) Nason (1:30) Born 1913. Folklorist, tooldresser, driller, pumper, and lease foreman for Clinger Oil and Gas at Cooper Tract and Kellettville. Tells a unique Gib Morgan tale, as well as story of the Cherry Grove boom.

Bob Peterson (1:30) Pumper for Clinger at Fagundus, Queen, and Mayburg. Born 1914.

Doris Rassavage (1:40) Formerly married to pumper who worked on Jennings lease in the Queen field. Age 81.

John "Jack" Samonsky (1:30) Compressor station manager for National Fuel Gas. Compressor stations at Queen, Roystone, Lamont and Sackett.

Lyle Sampson (1:30) 1905-1988. Gauger and pump station operator for National Transit. Pipelines at Tidioute, Queen, and Porkey. Describes Queen boom in 1922.

Paul Stine (1:30) Born 1913. Shooter for Otto Cupler Torpedo Co. Shot wells at Owls Nest. Also worked at National Transit Shops at Oil City.

Steven Slocum (1:30) About age 50. Grew up on oil leases at Cooper Tract and Pig's Ear.

Quentin Wood (1:30) Former chairman and CEO of Quaker State. Talks about waterflooding in Lafayette Twp. in McKean County.

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