PETROLEUM IN SEARCH OF AN INDUSTRY

By Arnold R. Daum*

It seems particularly appropriate at this meeting of the members and guests of the Pennsylvania Historical Association, held as the American petroleum industry is about to celebrate its 100th anniversary, to review the circumstances of the ante bellum and Civil War periods that most vitally affected the birth and subsequent growth of this industry. All members of this audience, I am sure, are familiar with the main outlines of the story, from Drake's epochal discovery at Titusville in 1859 to the emergence of petroleum during the remainder of the nineteenth century as the main source of illumination not only for Americans, but for other peoples throughout the world. It is my purpose to bring into perspective elements in the American environment which paved the way for the rise of a new industry as well as basic uncertainties and problems that had to be resolved after Drake's discovery before a new type of mining enterprise could acquire the complementary marketing and refining facilities of an industry.

Few environments have been so thoroughly conditioned for the entry of an industry as ante bellum America was for petroleum. Markets, technology, lamps, and related facilities for illuminating oils from mineral resources had been developed to an extent suggesting that perhaps the broad course of subsequent illumination in this country might not have been radically different without the entry of petroleum. There is no profit in seeking an answer to such a question, but certainly the genuinely unique role of petroleum in the nineteenth century was to make improved lamp light available to the entire world within a remarkably brief time.¹

At the close of the 1820's America's illumination, as Henry Adams once said of its agriculture, had progressed little since the

*Dr. Daum is Associate Director of the Petroleum History Project at Northwestern University. This paper was read at the dinner meeting of the Pennsylvania Historical Association on October 10, 1958, in Pittsburgh.

days of Tubal-cain. The ordinary man both entered and departed from this world by tallow-candle light. Lamps, burning natural animal oils only, were badges of social distinction. In 1830 there issued the first of a number of developments which finally converged to make the 1850's the most revolutionary decade in illuminating history.²

The initial stimulus was a perennial glut of crude turpentine in seaboard markets from which a New York lamp dealer saw a chance to obtain a cheap illuminant. He introduced and patented a product called camphene. It consisted of redistilled or rectified spirits of turpentine burned either alone or mixed with about six parts of alcohol. Having a higher carbon content than animal oils, camphene required a special burning apparatus and this in turn resulted in the development of the camphene lamp.³

Highly volatile, camphene caused many lamp accidents, but these did not stay its swift rise to popularity, for it was far cheaper, cleaner, and more convenient to use than fatty oils. In the 1840's although supplemented by improvements in lard oil quality, camphene had succeeded in democratizing lamp light. Camphene's contribution to the future of the petroleum industry was unquestionably great. Not only had it broadened the market for lamp illuminants, at a time when whale oil was rapidly receding in supply and being increasingly diverted to lubricants, but the camphene lamp was the first big step forward in the development of a strong enough draft to burn coal oil or refined petroleum efficiently.⁴

Without the growth of a manufactured gas industry in these earlier years, petroleum's entry into illumination would have been much more difficult. Chartered utility companies, distilling il-

luminating gas from coal and sometimes from rosin oil and distributing it through mains, originated in Baltimore in 1816. They entered New York and Boston in the next decade, and by the early forties were established in all leading coastal cities. Though gas was universally considered superior to all other illumination, gas distribution was almost entirely confined to street lights, public buildings, and factories until 1845. About this time technological improvements not only established coal as the cheapest source of gas, but made possible substantial economies of scale. The result was that by 1850 private consumption of gas in homes was more important than public and industrial consumption in 41 cities. By 1860 gas distribution had extended to 403 cities and towns in all areas of the country, and the basis of modern illumination—piped or wired from central manufacturing plants—was fully established.6

Gas manufacture provided the basic technology for the distillation of bituminous materials, and though these techniques would be transmitted with vital modification through the coal oil industry, petroleum is yet in its debt. The essential link was this: high temperature distillation of coal in large-scale gas manufacture provided the most widely available source for obtaining technical knowledge of low temperature distillation required to obtain profitable yields of oils from either solid or liquid bitumens. Moreover, coal oil manufacturers adopted stills and in turn drew on other facets of gas technology for many modifications of equipment to obtain better heat control, all of which became the foundation of petroleum distillation.6

Coal oil refining in Europe preceded development in America. In the 1830's the French chemist and industrialist, M. Selligue, pioneered low temperature distillation of schist to obtain a volatile oil for enriching illuminating gas. Early in the forties he successfully modified his process to obtain a lamp illuminant which


formed the basis of small commercial industries in France and the Germanies. His published reports received much attention in America later when commercial refining got under way. 7 James Young in Scotland in 1850 obtained an English patent on the low temperature distillation of coal and all bituminous materials and in the same year erected a plant that made him the largest producer of paraffin oils. Young refined only lubricants, naphthas, and paraffin until 1856, when he began producing paraffin oil illuminants. 5

In 1850 a Canadian, Dr. Abraham Gesner, first visited America to promote and demonstrate a product he called kerosene for use in making illuminating gas both in portable air-gas machines and in large plants. He obtained his kerosene by low temperature distillation of Albert coal deposits in Nova Scotia or asphaltic materials. Taking up residence in the United States in 1853, Gesner later became interested in kerosene as a lamp illuminant, and in 1854 assigned his patents and trade name to a firm which eventually became the New York Kerosene Company, a leader in the coal oil industry. 9


It was not until 1856 that commercial refining of coal oil illuminants began on a modest, almost tentative, scale in this country. Of three initial entries, the newly erected Downer's Oil Works at Boston was by far the most important throughout the industry's existence. Samuel Downer, resourceful entrepreneur with long experience in the oil trade, and Joshua Merrill, his general superintendent, between them fashioned nearly every major innovation necessary to make their own enterprise and an entire industry that followed them a success. After two years in which their major efforts were devoted to research and improvements in stills and treating practices, they scored the first marketing success in the industry during the burning oil season of 1858. A greatly improved product and adequate lamps jumped their sales to 500,000 gallons with a realization of $100,000 net profit. This released an enormous boom in coal oil markets; new plants by the end of 1859 brought the industry's daily output to 23,000 gallons. Nearly sixty refineries, representing approximately eight million dollars in plant investment, were distributed among the primary refining centers of New York, Boston, Pittsburgh, the Kanawha Valley in western Virginia, and the Newark, Ohio, area—in that order of importance.

The completion of through rail connections between all major eastern and mid-western states in 1857, welding those sections of the nation into a great economic empire, exerted a remarkable effect on coal oil markets. Not only did it thrust coal oil into the first national distribution enjoyed by any illuminant, but it completed the organization of distribution channels, which embraced kerosene coal-oil for making illuminating gas has not previously been reported. See his recent and most perceptive of biographers, Kendall Beaton, "Dr. Gesner's Kerosene: The Start of American Oil Refining," The Business History Review, XXIX (March, 1955), 36-45.


retail and wholesale grocers and druggists, and formed the basis of petroleum marketing for almost two decades to come.

As early as 1859 numerous brands of coal oil from Pittsburgh, New York, Boston, Cincinnati, and Covington, Kentucky, could be purchased in small western cities. Of equal importance eight to ten makes of lamps could also be bought locally. The first lamp with adequate strong draft to burn coal oil or petroleum entered production in 1857. The early Knapp coal oil lamp soon was followed by improved models ranging from 5 to 14 candle power. No later than 1859 manufacturers had introduced the production of burners by assembly line techniques. Some sold for as low as three dollars a dozen, although eight dollars was probably the average. By the end of 1859 coal oil and the low priced lamps to burn it had truly democratized lamp illumination. There were 1,800,000 coal oil lamps in homes and an equal number in sales channels.

The technological advancements in coal oil refining were even more indispensable to the future petroleum industry. Joshua Merrill developed effective chemical treating with sulphuric acid and caustic soda (as a final process) which helped accelerate the development of these auxiliary industries so crucial to refining. In conjunction with his associate, Luther Atwood, Merrill also pioneered the destructive distillation or “cracking” of heavy oils to obtain larger yields of lighter burning oils. The most advanced refiners not only improved ordinary distillation by direct fire in both vertical and horizontal stills, but they brought into refining practice distillation by steam, superheated steam, and in partial vacuum. In short, the best refining practice for coal oil involved adequate knowledge of every type of distillation and chemical treating that petroleum refining would require.

How heavily the incipient petroleum industry would draw upon these contributions of coal oil manufacturers is a great tribute to


their pioneering achievements. Nevertheless, while the existence of a well-developed coal oil industry conditioned the acceptance of petroleum into the near-revolution that had taken place in illumination, it did not eliminate the considerable uncertainties which had to be dispelled before the new mineral could establish a new industry.

To attract capital and all the complementary facilities necessary for an integrated industry, petroleum production would first have to demonstrate reliability in supply and cheapness in price. The new oil territory’s location at Titusville and along Oil Creek hampered rather than expedited that demonstration. The expanding web of rails that had made national distribution of oil illuminants an accomplished fact offered no efficient outlets. The nearest depots lay northward twenty to thirty miles along the Sunbury and Erie. Then shipments went to Erie, Pennsylvania’s port on Lake Erie, forty miles due north of Titusville, where cargoes had to be reloaded for shipment either east or west. From this point there were three alternative routes to New York City. First: via steamer to Buffalo and then along the Erie Canal. Second: via rail to Buffalo with transshipment over the New York Central System, which required four cargo transfers due to gauge differences. Most popular of the alternatives was the Lake Shore Road to Dunkirk, midway between Erie and Buffalo, and transshipment over the Erie Railroad’s 6-foot-gauge trunk line to New York. At the juncture of Oil Creek with the Allegheny, steamers bound for Pittsburgh sixty-one miles southward took on limited cargoes twice weekly. From Pittsburgh the Pennsylvania Central offered reasonably good transportation to the miserably jumbled terminal facilities at Philadelphia, but transshipment via either of two roads to Jersey City left much to be desired.15

Hobbling this entire complex was the need to dray oil, five or six barrels to the wagonload, to all shipping points over execrable trails which were often made completely impassable by rain or snow. Drayage often cost more than the oil and as much as the

rail charge to the seaboard. Early in 1862 when some improvements had been introduced, transportation charges to New York City still totaled $8.00 a barrel; during most of the previous two years they probably ranged around $11.00.16

Inadequate as transportation facilities were, Drake’s discovery had unleashed a mining boom, and though confined entirely to small pumping wells, petroleum production made impressive gains. The increased production, however, did nothing to lower the excessive unit costs of transportation or to stimulate improvement in the almost hopeless irregularity of transportation. Contrary to common belief, ante bellum petroleum production stimulated no important conversion of major coal oil refineries, and understandably so. Requiring dependable supplies of raw materials, most refineries were tied to long term coal contracts not readily broken, and their processing costs did not make conversion inviting unless they could obtain petroleum at a delivered price of less than $12.00, in some cases appreciably less. Coal oil output in 1860 increased, rather than receded, from 23,000 gallons daily to about 30,000 in the last quarter.17

In May 1861, it became distinctly questionable how much longer an estimated production of 1,250 barrels from some 135 pumping wells could be supported in the face of a progressive price decline to two dollars a barrel. A combination of a high rate of dry holes, short well life, and high pumping costs had made not only a two-dollar price unremunerative, but the four- and six-dollar prices earlier in the spring as well.18 But in the same week that the opening of the Civil War raised a host of new uncertainties on the future (among other things) of petroleum, the necessary catalyst to place production on an entirely new basis unpredictably occurred in the form of a horrifying tragedy. On April 17 Henry

36 Scientific American, LXV (February 27, 1862), 134; Venango Spectator, January 15, 1862, reported many instances of fees as high as $5 a bbl. to haul oil from Tarr Farm on Oil Creek 31 miles to Corry, the most used railhead.
Rouse struck the first gusher or flowing well on John Buchanan's farm along Oil Creek, a few miles south of Titusville. Roaring in uncontrollably under intense gas pressure at a rate of 3,000 barrels daily, the deluge caught fire, fatally burning Rouse and eighteen others.29 Other gushers were hit that summer in the same vicinity, but it was not until fall that the Empire Well with a daily flow of 3,000 barrels for months, and a succession of others, announced a new era of petroleum production along Oil Creek. If one well still did not make an industry, any one of numerous gushers exceeded the entire previous production of pumping wells. Flowing wells in the fall quarter accounted for a major share of the year's estimated output of two million barrels, almost four times the annual capacity of coal oil refineries, and prices sagged to ten cents a barrel at the wellhead.30

Not until this time did petroleum production acquire the power to magnetize the elements with which to form an integrated industry. The huge gap between output and existing transport and refining facilities was too great to fill overnight; indeed, the immediate effect was to swamp facilities to an extent that compounded all previous confusion and difficulties. But the outpouring of crude oil transformed the attitude of businessmen and capitalists generally toward the future prospects of welding an industry around petroleum.

Tangible evidence of this change appeared at every hand in the last quarter of 1861—an accelerated movement to convert coal oil refineries to petroleum, construction of new petroleum refineries beyond a mere teakettle scale, development of improved shipping facilities, more effective organization of domestic marketing channels, and a measured bid for foreign markets. To cite a few examples, in transportation the Erie Railroad for the first time displayed interest in supplying cars, while the Atlantic and Great Western mustered rolling stock to make effective their connective between Corry in the oil region and the Erie trunk line to New York City.31 Not only was the barging of barreled oil to Pittsburgh pressed on a large scale, but in December barging of oil in

bulk was introduced. At Pittsburgh this was complemented by
the erection of iron storage facilities, the advancement to various
stages of completion of several new refineries with weekly capaci-
ties of 1,000 barrels, and early in 1862 the conversion of three
equally large coal oil refineries.

Samuel Downer converted his major coal oil refinery in Boston
and began construction in the oil region of a $250,000 petroleum
refinery with a weekly capacity of 1,800 barrels. The Ludovici
Brothers of New York also began construction of their Hum-
boldt refinery at Plummer, which with Downer’s and one other
built later, gave the oil region its only efficient refining capacities
for half a decade. The New York Kerosene Company, the
largest coal oil refinery, in December established its employee,
Charles Wheeler, in the region as permanent crude oil buyer.

Fires in transit and at refineries, excessive leakages and weight
losses in shipment, shortages of barrels, rolling stock, and terminal
facilities retarded the rate and effectiveness of conversion and in
some instances even the continued existence of seaboard refiners,
but by the close of 1862 the survival of New York and Boston
as refining centers was assured. It was in this interim that Pitts-
burgh, with ready access to crude oil, barrels, machinery, equip-
ment, and the decisively important treating chemicals and refining
know-how, gained a leadership in refining.

The impetus to complete the organization of the petroleum in-
dustry came none too soon, for the Civil War introduced many
new uncertainties which vitally affected markets and to a lesser
extent supply. Both petroleum production and an important seg-
ment of coal oil refining in the Kanawha Valley were cut off by
guerilla warfare within weeks after the firing on Fort Sumter.
The Breckenridge coal of Kentucky and the refining industry
built upon it also were lost to production. Of far greater im-

22 Pittsburgh Gazette and Commercial Journal, April 15, 1862; Edwin C.
Bell, Oil City Derrick, reprinted in Oil and Gas Journal, XV, 31 (January
4, 1917), 32, 33.
23 Philadelphia Commercial List and Price Current, August 27, 1864, 138:
Samuel Downer to W. H. L. Smith, Boston, January 7, 1862, and April 16,
24 Allan Norton Leet, Petroleum Distillation and Methods of Testing Hydro-
25 "Charles L. Wheeler," The Petroleum Age, IV, No. 11 (December,
1885), 1184.
26 C. H. Shattuck, "Coal Oil in West Virginia," Report of the Commis-
ioners of Agriculture for the Year 1863, (Washington: G. P. O., 1863), 528.
One of the early signs of permanence in the new oil industry was the erection in 1862 of the first major petroleum refinery in the oil region, at Corry, Pa., by Samuel Downer of Boston. Completed in the spring of 1863, at a cost of $250,000, it had a charging capacity of 1,800 barrels of crude oil weekly. Throughout the decade this and Downer's original plant at Boston were the only general refineries, producing a complete line of by-products: gasoline, refined naphthas, refined lubricants, and paraffin, in addition to kerosene. In 1863 Downer installed at his Corry works the first refrigerating plant in the petroleum industry to permit year-around manufacture of paraffin and dewaxed lubricants. Facilities included a large coopering shop that gave him self-sufficiency in barrels, a machine shop, and a hotel and housing development for skilled laborers whom he imported from Boston. His labor force ranged between 175 and 200 employees.

From Corry he supplied the New York domestic and export markets, via the Atlantic and Great Western Railroad and the Erie. In the foreground are double tracks to accommodate the smaller gauge of the Oil Creek Railroad from Corry to Titusville without reloading. From Corry there were also rail connections with Erie, Pa., via the Pennsylvania and Erie, where transfers could be made to the New York Central and Lake Shore systems to the seaboard.

The Humboldt refinery at Plummer near Oil Creek, also erected in 1862, with a weekly charging capacity of 1,000 barrels, was the only other important refinery in the region. By the end of 1862 Pittsburgh had five refineries on a similar scale, three capable of charging 2,000 barrels weekly, but none engaged in by-product manufacture except for crude and refined naphthas until late in the decade.
portance, the defection of eleven states with a population of nine
million people to the Confederacy sheered off almost one-third of
the immediate market for mineral lamp illuminants. Another blow
to annual domestic demand for 250,000 to 300,000 barrels of il-
 luminants fell when the wartime Congress at its first meeting early
in 1862 announced its intention to impose heavy duties on both
crude and refined. Congress waived taxing crude but imposed a
duty of ten cents a gallon on refined petroleum illuminants, which
became effective September 1, 1862. The depressant effect of the
tax on demand was ameliorated, however, by a heavy tax on
camphene, already in reduced supply because of the cut-off of
crude turpentine from North Carolina, and a tax of fifty cents on
alcohol, which taxed it and all burning fluids out of illumination
markets. Thus, surprisingly enough, the net effect of wartime
taxation was to remove the main competitors to petroleum illumi-
nants.

Perhaps the final affirmation of the arrival of a permanent new
industry occurred in 1863. Not only did exports about equal
domestic consumption, but refined oil exports exceeded those of
crude. The continuance of this trend thrust refined exports per-
manently ahead of domestic consumption by 1866, to make petro-
leum refining a unique manufacturing industry whose foreign
markets exceeded domestic.

Experienced refiners and commission merchants like Samuel
Downer and Richmond and Delaware in 1861 fully expected for-
eign markets in refined oil to comprise a major part of their trade
and to overshadow crude exports because of the much heavier
losses of the latter in long distance shipments. Due to heavy
domestic commitments for future delivery, they could not take
full advantage of foreign orders in 1862, when refined oil totaled
about one-third of total exports, but they prepared themselves for

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*S. S. Hayes, "Report on Petroleum," 1, 2; U. S. Revenue Commission,
"Distilled Spirits and the Influence of the Duplication of Taxes on American
Ex. Doc. No. 60, 38th Cong., 1st Sess., 1863, 23-26; Exports Compiled from
U. S. Treasury Reports, H. C. Folger, Jr., "Petroleum, Its Production and
Products," Annual Report of the Secretary of Internal Affairs of the Com-
monwealth of Pennsylvania, 1892, Pt. III, Industrial Statistics (Harris-
burg: Edwin K. Meyers, State Printer, 1893), B170-173; Hayes, Report
on Petroleum, 6, 18, 19, 22, 33, 34, 38, including reports on tax collections,
probably the best yardstick of home consumption for comparison with foreign.
heavy export demands in the following year.\textsuperscript{29} It was only wartime shipping abnormalities that cast doubt upon the realization of these expectations. By 1862 American ocean-going bottoms were virtually unavailable and they carried a heavy war-risk insurance rate. The availability of foreign bottoms, in heavy demand for possibly more profitable cargoes than petroleum, was far from a certainty. Severely strained diplomatic relations with both the British and French governments over the possible recognition of the Confederate government, the outfitting of privateers for the Confederacy, and many related questions further menaced the new trade.

With doubts as to the availability of foreign bottoms removed before the end of 1862, the catapultic rise of foreign markets became less astonishing than is usually reported. The stereotyped explanations all have their validity. When Charles Lockhart, pioneer Pittsburgh refiner, toured Europe in the spring of 1860, displaying samples of crude and refined petroleum to people in the oil trade and others, he helped to create a groundwork of interest in the new American commodity. Faced with an increasingly unfavorable balance of trade because of huge wartime imports and the loss of cotton exports, the United States government took an encouraging attitude toward the development of foreign trade in petroleum. As one result, American consuls in leading European countries and elsewhere, including Russia, actively and effectively promoted the introduction of American petroleum. In the extremely important British markets, English financial backers of the Atlantic and Great Western Railroad, connecting the oil region with the Atlantic seaboard, exerted powerful influences on the London Chamber of Commerce and Liverpool oil brokers in behalf of American petroleum. Finally, the big supply and low prices of petroleum resulting from gushers throughout 1862 and afterwards expedited early trial shipments to almost every major foreign port.\textsuperscript{30}

But greater attention should be given to more neglected facts.


Sixteen American lamp manufacturers were in assembly-line production of cheaply priced kerosene burners with which they deluged British and European markets in 1862 and 1863. Still more basic was the cumulative effect of wartime currency inflation and the exemption of refined oil exports from the ten-cent domestic duty. Through currency inflation alone foreign buyers realized an average advantage of nine cents a gallon on refined oil in 1863. In the next two years this advantage was twenty-one and twenty-four cents respectively. This significant advantage was further swelled by exemption from the ten-cent tax. In effect, foreign buyers received a subsidy with which to offset the higher costs to them and the leakage losses in transportation. These benefits occurred at a critical time before ocean traffic in oil had reached a state of organization that would permit the more nominal rates which prevailed in the latter part of the decade. Wartime inflation of currency and wartime taxes supplied foreign markets with a unique accelerator to their growth rate. One of numerous results was that by 1863 the fledgling petroleum industry had passed its last critical year in terms of survival.

To complete the establishment of petroleum as an integrated industry capable of supplying the expanding world markets, one further development was needed. Some form of bulk transportation, weather-proof and reliable all year around, had to be devised to sustain a swelling flow of crude and refined products to overseas refineries and far-flung markets. With the introduction of the rail tank car, and the unique innovation of gathering pipelines in 1867, this final requirement was fulfilled.

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32 Average currency and gold prices computed from Wesley G. Mitchell, *Gold, Prices, and Wages Under the Greenback Standard* (Berkeley, California, The University Press, 1908), 4, 5; and *Reports of Committees of the Senate of the United States for the 2nd Session of the 52nd Congress, 1892-1893* (Washington: G. P. O., 1893), III, 239, 1394. For average monthly and annual wholesale prices of refined (currency) and the impact of currency inflation on refined exports see Hayes, *Report on Petroleum*, 6, 7, 18, 19, 24, 25.

33 See Maybee, *Railroad Competition and the Oil Trade*, 175-181, 238-243, 251, and passim.