

The Evolution of the Sherman Act, by Charles Nagel of the St. Louis Bar, President of the Corporation of Washington University.

Types of Modern Corporate Securities, by Alfred Fairbank, Vice-President of the Boatmen's National Bank, St. Louis.

The Regulation of Corporate Financing, by Henry T. Ferriss, President of the Investment Bankers' Association of America.

Consolidations in the Field of Banking, by Marion C. Early of the St. Louis Bar.

Taxes, the Corporation and the Lawyer, by Ralph R. Neuhoﬀ of the St. Louis Bar and Lecturer on Taxation in the School of Law, Washington University.

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### SAMUEL BRECKENRIDGE NOTE PRIZE AWARDS

The Samuel Breckenridge prize of fifteen dollars for the best note in the issue of December, 1930, of the ST. LOUIS LAW REVIEW has been awarded to Thomas G. Jeffrey for his note on *The Federal Trade Commission's Power With Reference to Stock Acquisitions*. The prize for the best note in the issue of February, 1931, has been awarded to Carl V. Eimbeck for his note entitled *Some Recent Methods of Harassing the Habitual Criminal*. The committee which is judging the notes in volume 16 consists of Messrs. Charles H. Luecking, C. Sidney Neuhoﬀ, and Frank P. Aschemeyer.

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## Notes

### THE NEED FOR CONSERVATION OF OIL AND GAS

Crude petroleum was known to the ancients as a building material—a constituent of pitch used as cement and in caulking vessels. It was found by early American pioneers searching for salt as they crossed the Alleghenies but was regarded by them as a nuisance because it fouled their salt wells. Petroleum's value as an illuminant was not recognized until 1854 when two lawyers had Professor Benjamin Silliman, a noted chemist of Yale University, analyze a sample. He found that petroleum contained some of the properties of kerosene or "coal oil," which was already in use, and that it was the source of a good lubricant. A company was formed to produce petroleum, but failed soon after. The year 1859 saw the birth of the petroleum industry when the first well was drilled in the Oil-Creek region of western Pennsylvania. This well produced about one thousand barrels daily. Petroleum's sole use at the time was as a source of refined kero-

sene replacing "coal oil," whale oil, and tallow candles as illuminants.<sup>1</sup>

From that small beginning uses for petroleum have doubled and redoubled almost in geometric progression until today it is the source of over ten thousand products, including vaseline, innumerable coal-tar remedies, cosmetics, lubricating oils and greases, kerosene, benzine, fuel oil, and gasoline. Petroleum, aptly termed "liquid gold," makes possible the operation of the 25,501,443 automobiles in the United States, thousands of airplanes, and numberless power boats, motor cycles, oil-burning ships and locomotives. It furnishes heat to countless homes, buildings and factories; lubricants which enable the wheels of industry to turn; and the liquid that sustains the dry-cleaning business.

Production in the United States has increased from 500,000 barrels in 1860 to 57,071,000 barrels in 1899, 183,171,000 barrels in 1909, 378,367,000 barrels in 1919<sup>2</sup> and the stupendous figure of 1,005,265,000 barrels in 1929,<sup>3</sup> a quantity large enough to create a lake a foot deep 251 square miles in area.

How long may the earth be expected to continue to yield up its petroleum in such increasing quantities? Estimates of resources vary with the time when they were made and with the authority, and considerable inaccuracy is evident in all estimates. Below appears a summary of the principal estimates of future supplies of petroleum in the United States made from 1908 to 1925.<sup>4</sup>

1908—David T. Day, chief geologist, United States Geological Survey: minimum, 8,500,000,000 barrels; maximum 15,000,000,000 to 22,500,000,000 barrels. (Production from 1908 to 1929 was 10,441,447,000 barrels.)

1914—Dr. Ralph Arnold, petroleum engineer: 5,700,000,000 barrels. (Production from 1914 to 1929 was 9,178,396,000 barrels.)

1915—United States Geological Survey (revised estimate by Day): 7,600,000,000 barrels. (Production from 1915 to 1929 was 8,912,633,000 barrels.)

1918—David White, chief geologist, United States Geological Survey: 6,700,000,000 barrels. (Production from 1918 to 1929 was 7,995,446,000 barrels.)

1921—Certain petroleum geologists of the American Association of Petroleum Geologists: 9,150,000,000 barrels. (Production from 1921 to 1929 was 6,818,222,000 barrels.)

<sup>1</sup> STOCKING, THE OIL INDUSTRY AND THE COMPETITIVE SYSTEM (1925) pp. 6-8.

<sup>2</sup> Figures for 1860, 1889, 1909, and 1919 from STOCKING, *op. cit.* 242.

<sup>3</sup> Bureau of Mines, *Annual Petroleum Statement*, Feb. 17, 1931.

<sup>4</sup> OKLA. GEOL. SURV. BULL. 54 (1930) p. 106.

1925—Committee of Eleven of the American Petroleum Institute: 5,300,000,000 barrels. (Production from 1925 to 1929 was 4,343,161,000 barrels.)

The foregoing table indicates two things: that an accurate estimate of future supply is impossible and that the estimates in the past have consistently been too low. The latest figure by Dr. Ralph Arnold, who estimated that there were only 5,700,000,000 barrels available in 1915,<sup>6</sup> is that there are now about 26,000,000,000 barrels which may be recovered.<sup>6</sup>

Dr. Arnold gives as the two principal methods of estimating the future supply the "saturation" and "production-curve" methods.<sup>7</sup> The former involves finding the cubical contents of each underground reservoir in which petroleum is found,<sup>8</sup> determining the degree of porosity of the volume, and then estimating the total supply of oil in the pool in question. The volume is approximated by multiplying the area of the pool by the average thickness. The porosity, or percentage of oil, is approximated by drilling samples in the reservoir. Gas in solution and free water contents are uncertain but may be disregarded. The unreliability of such a method, since all figures are mere approximations based on the most meager facts, is obvious. The second method is based on a plotting of curves for the known pools, based upon the oil actually produced in the past. It rests on the theory that a yield will be developed slowly, will gradually reach its peak, and will slowly decline. Although this method is somewhat more accurate than the first, it, too, is unreliable because production in all fields is not represented by a gradual curve. The period of decline is particularly susceptible to unexpected vicissitudes.

The uncertainty of estimates of future supply from a field becomes more apparent when the difficulties of estimating the potential production of even one well are realized. The "rated potential" of a well is determined by letting it flow uninterruptedly for a certain definite period of time and then multiplying the production by the number of such periods which is necessary to make a day. For example, a well may produce 400 barrels if allowed to flow wide open for ten minutes. Multiplying by 144, we find its "rated potential" to be 57,600 barrels a day. But this simple test is no assurance that the well actually would

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<sup>6</sup> Arnold, *Petroleum Resources of the United States*, SMITHSONIAN INST. ANN. REP. FOR 1916, 285-6.

<sup>7</sup> Dr. Arnold testifying before the House of Representatives Ways and Means Committee considering a bill to put an embargo on oil, UNITED STATES DAILY FEB. 16, 1931.

<sup>8</sup> N. 5, above.

<sup>9</sup> These reservoirs are horizontal layers of sand which contain petroleum much as a sponge holds water.

produce 2400 barrels in an hour or even 400 barrels the second ten minutes. "Actual potential production" is a mere guess as to what the well will ultimately produce.<sup>9</sup>

When to these manifest difficulties in estimating the future supply from fields already discovered there are added the probable errors in calculating the supply in undiscovered fields, the uncertainty becomes well nigh overwhelming. A guess as to how many fields existing in the United States have not yet been discovered is scarcely worth hazarding. Many sections, particularly in the Rocky Mountain region, have not been very closely examined, but the explanation is that they are regarded as less favorable for finding petroleum. Geologists are making some progress in locating new fields, however. They located in advance 80 out of the 109 fields in existence in 1926.<sup>10</sup>

Other sources for petroleum than the free deposits in oil sands have been suggested. It is known that oil may be extracted from oil shales, coal, and lignite. Dr. Arnold gives the following statistics as to the petroleum resources of the United States:<sup>11</sup>

Free oil originally in sand.....	39,000,000,000 barrels
Recoverable oil in shales.....	92,000,000,000 barrels
Recoverable oil in coal and lignite..	595,000,000,000 barrels
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Total.....	726,000,000,000 barrels
Petroleum extracted from oil sands	
1859 to 1929.....	11,500,000,000 barrels
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Present resources .....	714,500,000,000 barrels

Thus but 70 per cent of the original free oil in sands remains, which at the present rate of consumption of almost 1,000,000,000 barrels a year would last less than thirty years. But more than 98 per cent of the total resources remains, enough to last about two centuries if petroleum can be extracted from oil shales, coal, and lignite by commercially practicable methods. Mr. Dean E. Winchester has estimated that to produce oil from oil shales at the present time would cost at least \$5.00 per barrel,<sup>12</sup> several times the cost of extracting from oil sands. The great German chemical trust, *Interessen Gessellschaft*, announced in 1928 that coal may be made to yield 70 per cent of its weight in crude oil,<sup>13</sup> but it is not yet known how expensive the process will be.

While exhaustion of petroleum resources is not imminent, it is evident that the most available supplies are rapidly being

<sup>9</sup> McIntyre, OIL AND GAS J., Dec. 18, 1930, p. 29.

<sup>10</sup> Hager, OIL AND GAS J., April 8, 1926, p. 158.

<sup>11</sup> See n. 6, above.

<sup>12</sup> ISE, THE UNITED STATES OIL POLICY (1926) pp. 425-31.

<sup>13</sup> DENNY, WE FIGHT FOR OIL, p. 239.

depleted. Reasonably frugal methods of exploitation are necessary to insure against a repetition of such ruthless and unnecessary exhaustion of this natural resource as has characterized the lumber industry.

Despite the evident demands of sound policy, exploitation of petroleum in the United States has been characterized by woefully inefficient and wasteful methods. Physical waste of petroleum is of four types: (1) by duplication of wells; (2) by unscientific or inefficient methods of exploitation, including (a) ineffectual and partial use of gas pressure and (b) flooding of oil sands by water; (3) by escape of gas; and (4) by failure to extract gasoline from gas.

Loss by duplication of wells is caused by the very natural desire of surface proprietors to obtain as much oil as possible. Oil pools are far greater in extent than the lands of any one proprietor and each owner is anxious to capture as much as he can before someone else drains the pool.<sup>14</sup> The result is that wells are improperly spaced frequently being drilled in pairs, one on each side of a property line. The offset wells (second to be drilled in each such pair) usually are poor producers, and most of what they bring forth would have been yielded by the original wells without the expense of drilling the offsets. The refusal of competing operators to divulge information found in their drilling, in order to prevent nearby owners from knowing where to sink their wells, results in the drilling of a vast number of dry holes at great expense. These wastes, of course, are economic, but it also appears that improper spacing of wells may lead to a smaller ultimate recovery of oil because of the inefficient use of gas pressure. Gas dissolved in or associated with oil is the chief force in expelling oil from the ground. There being less frictional resistance to the gas, it travels to the well outlets more quickly than the oil and is dissipated too rapidly if the surface of the pool is punctured in too many places. A sudden decrease of pressure results. Allowing the gas to escape rapidly from individual wells in order to produce oil as quickly as possible likewise causes the gas pressure to decline. The gas pressure thus becomes exhausted long before all the oil has been recovered, and the total amount produced is less than would have been realized if the oil had been taken more slowly. Estimates of the proportion of the oil which is unrecovered range from 40 to 90 per cent. J. O. Lewis estimates that under current methods of re-

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<sup>14</sup> The desire of landowners for the greatest possible profit is reflected in the law of oil leases, according to which it is an implied obligation of the lessee to develop the property as quickly as is reasonably possible. See *Young v. Thompson* ((1922) 194 Ky. 192, 238 S. W. 387; *Cole v. Butler* (1918) 103 Kan. 419, 173 Pac. 978; *Leonard v. Prater* (Tex. Civ. App. 1929) 18 S. W. (2d) 681.

covery perhaps 80 to 90 per cent of the total petroleum remains underground.<sup>15</sup>

The flooding of oil sands by underground water is probably the greatest single cause of waste in oil production. It may result in a curtailment of the gas flow, a diminished oil production, increased cost of lifting the oil, and a poorer quality of oil due to its emulsification with water. Hundreds of wells have been abandoned because of one or more of these troubles. Four classes of water may lead to the impairment or ruin of a well: top water, in layers above oil pools and separated from them by solid strata; intermediate water, in layers between oil pools of different depths; bottom water, in layers below oil pools but separated therefrom by only a thin shell; and edge water, at the bottom of the oil pool itself. Detrimental effects of both top and intermediate water may be avoided by proper casing of wells. Bottom water gets into a pool when wells are drilled too deep in an effort to produce a larger flow of oil. If one operator is careless and contaminates an oil pool with water it may migrate from well to well and ruin or impair all. Edge water, being in the same pool as the oil and meeting with less frictional resistance, will migrate more rapidly than the oil, and if the oil is withdrawn too rapidly the water may flow in and entrap the remaining oil, preventing its further extraction. Wells which are operated at full strength are always open to this danger. The Yates Pool in Pecos County, Texas, is an example of a pool which has been conservatively operated to prevent this disaster.<sup>16</sup>

Waste of natural gas, itself a valuable fuel and source of energy, while perhaps not as important as the incomplete recovery of oil on account of dissipation of gas, is a needless loss of a valuable resource. In drilling for oil, sands containing gas alone are frequently encountered but are regarded only as a nuisance since they impede drilling operations. Escape of the gas could be prevented by drilling with a mud-laden fluid in the hole, but it requires greater care and retards drilling progress. Therefore the customary practice of our "shortsighted" producers is to let the gas escape and continue drilling if possible. Sometimes the practice is to allow the well to "blow wild" until the pressure has subsided, or until an oil well may be "blown in," if the stratum should prove to be an oil stratum.

The amount of gas wasted in this manner is appalling. One well in Texas which tested about 100,000,000 cubic feet per day was allowed to "run wild" for about six months. The gas escaped with such velocity that the roar could be heard for miles. Thus approximately 13,200,000,000 cubic feet of gas were wasted. They would have supplied 132,000 families with fuel for a year.<sup>17</sup>

<sup>15</sup> Lewis, BUREAU OF MINES BULL. 148 (1917) p. 28.

<sup>16</sup> *Op. cit.* n. 9, above.

<sup>17</sup> STOCKING, *op. cit.* n. 1, pp. 77-8.

Secretary of the Interior Wilbur estimates that over 450,000,000 cubic feet of gas are wasted daily in the Kettleman Hills District in California, although only six out of the thirty wells are producing. This waste of energy is twice the estimated future output of the Hoover Dam.<sup>18</sup> In the Cushing, Oklahoma, field more than 100,000,000,000 cubic feet were wasted during the year 1913—enough to supply the entire city of New York with fuel for that year. About 30,000 barrels of oil a day were produced in the field. In other words gas worth \$75,000 a day was wasted to obtain a daily oil production valued at less than \$25,000.<sup>19</sup>

Gas, moreover, contains a considerable quality of the more volatile petroleum components in vapor form. As many as four gallons of gasoline have been extracted from 1000 cubic feet of gas. It has been proven commercially profitable to extract it where the yield was one-sixteenth that amount.<sup>20</sup> Thus millions of gallons of gasoline are lost yearly in escaping gas at the same time that refiners exert every effort to make petroleum yield more gasoline through the "cracking" process.<sup>21</sup>

Obviously, conservation of petroleum, in the sense of a wise use of natural resources, coupled with maximum efficiency and minimum physical waste in their production,<sup>22</sup> is highly necessary and should be one aim of all programs for control of the industry.

HAROLD C. HANKE, '31.

#### OIL AND GAS LEGISLATION IN OKLAHOMA

Statutes controlling the production of natural gas in Oklahoma are closely related to those concerning oil, both in form and administration. There are several reasons for the connection. Geologists have established the proposition that it is the gas which is responsible for much of the pressure of the petroleum, both being contained in sand or porous rock formations. Hence waste of gas lowers oil pressure, often causes seepage of salt water into the oil-bearing strata, and prevents the owner from bringing all of the crude to the surface. Aside from this geological relation, there is the fact that they are combined commercially. Although all the Oklahoma statutes on the subject are contained in a single chapter of the General Laws,<sup>1</sup> there is no combination of oil and gas in any one section.

<sup>18</sup> Wilbur, OIL AND GAS J., Dec. 4, 1930.

<sup>19</sup> MANNING, YEARBOOK OF THE BUREAU OF MINES (1916) pp. 122-4.

<sup>20</sup> STOCKING, *op. cit.* n. 1, pp. 182-3.

<sup>21</sup> Thirty-nine per cent of the 375,000,000 barrels of gasoline produced in the United States in 1929 were obtained by "cracking." Jacques C. Morill, NAT. PETROLEUM NEWS, Dec. 7, 1930, p. 61.

<sup>22</sup> M. L. Requa, N. Y. TIMES, Apr. 7, 1929, xi:3:1.

<sup>1</sup> Comp. Stat. Okla. (1921) c. 68.