Great Men In American Mining

Eugene Guccione, Editor

FOREWORD—At the SME-AIME meeting in Las Vegas this year, the SME Publications Board and the MINING ENGINEERING Committee decided that a fitting way of celebrating the United States' bicentennial would be to publish an article in **ME** covering the great men in American mining. After some discussion as to the inclusion of financiers —men such as William Randolph Hearst, J. Pierpont Morgan, etc.—the group agreed that the feature should be restricted to the "nuts-and-bolt people," e.g., mining engineers, geologists, mineral processing engineers. Thus, from the AIME All Institute Honors roll and from the SME Awards list, the group chose these 11 historical figures: Herbert Hoover, Daniel C. Jackling, Henry Krumb, James Douglas, Rossiter W. Raymond, Hal W. Hardinge, Seeley W. Mudd, Erskine Ramsay, Howard N. Eavenson, Robert A. Richards, Arthur F. Taggart.

What follows is an account of each of these great miners' achievements and the problems they faced, and an assessment by some of today's mining leaders of the challenges that lie ahead.

There is a common denominator or pattern among the 11 great miners that are discussed in these pages.

- Most of them started out poor and were of humble origin.
- They were all fiercely independent men, "rugged individualists" who set up their own consulting practice or formed their own mining company as soon as they could.
- They all made a great deal of money, and most of them became millionaires in their early forties. This is not surprising in view of the fact that throughout the 19th century and up to 1913 there were no income taxes: government expenditures, except for the Civil War, never exceeded 3% of the national income and were easily financed via import duties.
- They were all 19th century liberals—meaning: they were extremely generous *with their own money* which they lavished on hospitals, libraries, universities, relief organizations, missionary enterprises, the arts, and philantropies of every kind. Since there was no income tax and, hence, no deductibility of contributions, their generosity was not motivated by the desire to give away money that would otherwise be paid in taxes. Their generosity was fundamentally the manifestation of their genuine good will, and also stemmed from a Puritan tradition that made them view their fortunes as a trust for which they were responsible both to God and to their fellow man. The support of philanthropic and educational institutions was not considered as charity but as obligatory as the care of one's own family.
- They all enjoyed their work for the satisfaction and inner sense of personal achievement that it generated. Had they been after money, they could have retired in their early forties, but not one of them did. Nor were they after power or prestige, which they correctly viewed as superficial results—not the motive—of their work.
- They all did an immense amount of work, (a) because they enjoyed it, and (b) because they were free to do it in the sense that they weren't paralyzed in the Orwellian straightjacket of government regulations now imposed on their successors. "Theirs was an era in which there was, for most of it, no ICC, no FCC, no SEC, and you pick out any other three letters of the alphabet and it wasn't there either."†
- Many of the problems they faced were as bad, and often even worse, than those of today. For instance: *lack of water*—in many western mining areas water was so scarce that it was brought in on burros; *lack of fuel*—wood often had to be shipped to the mine site from hundreds of miles away, and accounted for more than 10% of the total cost of mining and smelting operations; *inadequate technology*—the first mining and metallurgical laboratory in the US was set up by Prof. Richards at MIT in the late 1870s, and up to the end of the 19th century most mining was done by hand, and powder had to be used sparingly because of its cost; *lack of capital*—the financing of many of the early mining ventures often had to be arranged in Europe; *lack of skilled professionals*—mining schools in the US were few and poorly organized and staffed; *lack of transportation*—unsatisfactory as it may be today, transportation was generally nonexistent in those days, and Phelps Dodge, for example, was gradually forced to build and operate its own railroad; *lack of infrastructure*—roads, schools, churches, hospitals, houses, etc., all of which had to be built from scratch. (Finally, a typical 19th century problem was the perennial risk of Indian attack and outlaw raids against miners.)

There is at least one problem that started in the 19th century, and that has gradually worsened ever since: the ideological and cultural climate in which the mining industry (and every other industry) found itself then and today.

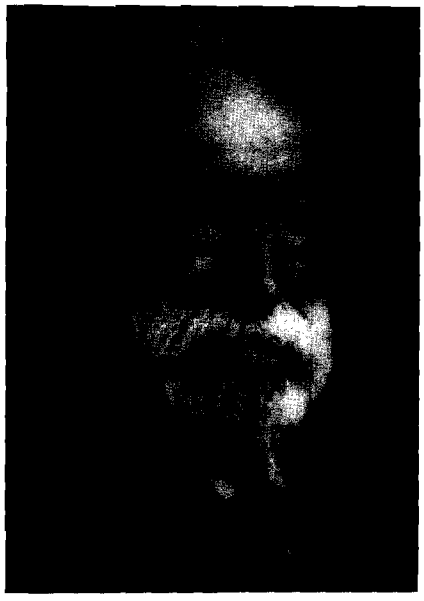
The Muckrackers' Attack

From the beginning of recorded history up to the end of the 18th century, wealth was accumulated primarily by military conquest, plunder, theft, and by physical (which usually meant slave) labor. The Industrial Revolution changed all that, particularly in the US where wealth could now be generated by productive ability and by the uncoerced exchange of values between free men. Tragically, however, the European intellectuals of that time never fully grasped or appreciated the impact and the consequences of the Industrial Revolution and the American Revolution.

With a few exceptions—notably Adam Smith, John Locke, and to a much lesser extent Jeremy Bentham and John Stuart Mill—most of the leading European philosophers failed miserably in understanding what was really happening under their own noses, let alone what was happening in America. Because of this intellectual myopia, reformers and muckrackers such as Karl Marx never discovered that the new wealth was now the result of productive ability and freedom. Instead, they merely looked back into history, then observed their own more or less statist and totalitarian systems of govern-

(Continued on page 71)

† Friedman, M., "Myths of American Capitalism," *The Alternative,* Jan. 1976.



James Douglas (1837–1918)

The man who originated the basic work on the hydrometallurgy of copper and who transformed Phelps Dodge Corp. from an export-import mercantile house into one of the nation's largest copper producers was James Douglas.

Born in Quebec in 1837, James Douglas was the son of a Scottish physician who had come to set up practice in America, and had invested heavily in a number of unsuccessful mining ventures, which ultimately bankrupted him. It was primarily in an effort to liquidate his father's debts that James Douglas, who had first sudied theology at Edinburgh University and then medicine at Laval University, eventually went into the mining business.

It all began when he formed a friendship with Thomas Sterry Hunt, a professor of chemistry at Laval University who had been head of the Canadian Geological Survey. Working together they developed a new method of extracting copper by leaching that came to be known as the Hunt-Douglas electrolytic process. Soon after, James Douglas was asked to install the new process in Chile and, upon returning from South America, was approached by the Chemical Copper Co. to supervise the construction of a similar plant in Phoenixville, Pa., and was subsequently offered the position of plant superintendent. Although the Phoenixville plant was the first to use the electrolytic process of copper on a commercial scale in the US, the Pennsylvania ores did not have enough copper content to make the plant a financial success. Douglas, therefore, had to search for richer material —which he found in the late 1870s when shipments of an unusually high-grade ore began arriving from Arizona.

Greatly intrigued, James Douglas went to Arizona in 1880 to secure from officials of the Copper Queen mine a steady supply of high-grade ore and, among other things, he discovered that the Copper Queen was an immense zone of mineralization averaging more than 20% Cu. There was little Douglas could do about his newly gained knowledge of Arizona copper deposits: a fire had destroyed the Phoenixville plant, and the Chemical Copper Co. had gone bankrupt.

In December of that same year, however, he was hired as a consultant by Phelps Dodge Corp. to evaluate a number of newly opened mines in Arizona —and, on his recommendation, Phelps Dodge acquired a financial interest in the Copper Queen, Atlanta, and other mines in Bisbee, Morenci, and west of Tucson. Since he had advised Phelps Dodge officials to take more than an average risk, Douglas told them he would share the risk with them by taking a 10% interest in the mines rather than the substantial cash payment for his consulting services. As Douglas related years later, "On that sudden impulse and hasty decision depended my whole subsequent career —successful beyond anything I had ever dreamed of." In fact, he became a director of Copper Queen Consolidated Mining Co., president of Phelps Dodge from 1909 until his retirement in 1916, and director of Phelps Dodge from 1908 to his death in 1918.

As head of Phelps Dodge western operations, incidentally, Douglas managed the Copper Queen as well as the other mines at Bisbee and Morenci, a copper mine at Nacozari in Mexico, a coal mine at Dawson, NM, and the large smelter that was built in 1901 in the new town of Douglas, Ariz. To integrate this far-flung empire, James Douglas had to provide rail transportation from the mines to the smelter, and from the smelter to the transcontinental rail connections at El Paso—in all, more than 1200 miles of trackage, known as the El Paso & Southwestern Railroad, which he built against the opposition of some of the most powerful railroad magnates of his time.

Rossiter W. Raymond (1840–1918)

Among his several activities—as soldier, educator, editor, novelist, statistician, consultant, industrialist, poet, and lawyer—Rossiter Worthington Raymond, Ph.D., LL.D., mining engineer and metallurgist, is best remembered as the one man who, more than anyone else, helped found AIME in 1871 and steered it for the next 47 years.

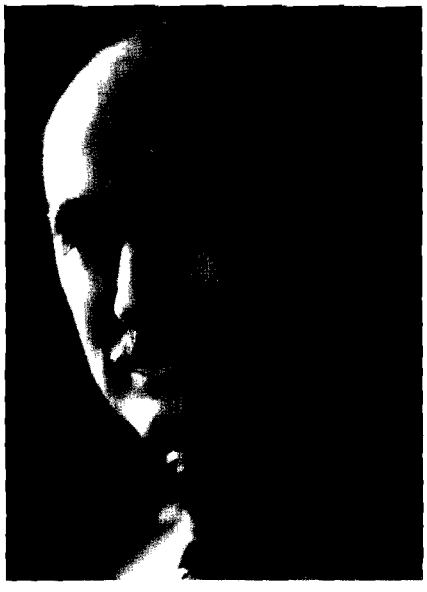
Born in Brooklyn from a well-to-do family, Raymond graduated from Brooklyn Polytechnic Institute in 1858 and completed his studies at the Royal Mining Academy of Freisberg and at the universities of Heidelberg and Munich. Though greatly attracted to engineering, Rossiter Raymond maintained a life-long affair with poetry and literature—a love that was originally stirred in him during the summers he spent in Florence with Robert and Elizabeth Barrett Browning—and developed a passionate hostility to any form of compulsion and tyranny, an attitude undoubtedly reinforced by his friendship with Henry Ward and Harriet ('Uncle Tom's Cabin') Beecher. His outspokenness against the 'Molly Maguires,' the mafia-like Irish labor organizations that ruthlessly exploited their own members, for instance, was so abrasive and devastating that he was threatened several times to "shut up or else." But no one could stop Raymond, or make him shut up, though many tried.

Returning to the United States in August 1861, Rossiter Raymond immediately joined the Federal army as captain, and served under Major General J.C. Fremont who greatly commended him for "gallantry and valor" during the campaign in the Valley of Virginia.

From the end of the Civil War onward, Raymond's career (or careers) proceeded at a dizzying pace, often encompassing three or four positions simultaneously. For instance: He established his practice as consulting mining engineer and metallurgist in New York City from 1864 to 1868; held the post of US Commissioner of Mining Statistics from 1868 to 1876, visited all mining districts in the country, and wrote the eight volumes entitled 'Reports on the Mineral Resources of the US West of the Rocky Mountains;' taught economic geology and mining engineering at Lafayette College from 1870 to 1882; was president of Alliance Coal Co., director of the Lehigh & Wilkes-Barre Coal Co.,

and metallurgical consultant to the steel industry from 1875 to 1895; consulting engineer for the distribution of electric conductors to the New York & New Jersey Telephone Co. from 1885 to 1889; edited *Engineering and Mining Journal* from 1868 to 1890, and was a special contributor to that journal after it was bought by James H. McGraw, Sr., the founder of today's McGraw-Hill Inc.; became a lawyer and was admitted to the bar of the New York Supreme Court and of the Federal District and Circuit Courts in 1898, specializing in cases concerning patent law and mining law, on which he had become an authority; taught mining law at Columbia University in 1903; translated several German mining textbooks; . . . and raised a family of six.

But more than anything else, he poured his energies on AIME, which he assisted in organizing in 1871 by writing its constitution, and immediately becoming its vice-president (in 1871, 1876 and 1877), president from 1872 to 1875, secretary from 1884 to 1911 when he retired, and secretary emeritus from 1911 until he died. The forty volumes of AIME *Transactions,* which he edited, represent his major though not his total contribution to the mining profession.



Seeley W. Mudd (1861–1926)

Cyprus Mines, Texas Gulf Sulphur, Ray Consolidated Copper, and several other mining companies owe much of their early spectacular growth (and, in some cases, their birth) to Seeley Wintersmith Mudd.

Born in Kirkwood, Mo., a suburb of St. Louis, Seeley W. Mudd was the type of man who would have been successful in any profession he might have chosen. Those who knew him intimately agree that Colonel Mudd's most distinguishing trait was the investigative thoroughness with which he tackled every task he undertook. Seeley Mudd never acted on hunches; the range of his actions was always well within the range of his thoughts and knowledge. And that was the secret of his success. The fortunes he earned were never the result of luck or speculative impulses: the Colonel came closer than any of his contemporaries in converting the art of business decision-making into a science. He would quietly and methodically analyze every mining prospect or proposal that came to his attention, and reach his decision only after he had personally studied all the facts about a new project. If the prospect withstood his analysis, Seeley Mudd would then personally back the venture to the hilt with his labor and financial support.

His first job after he graduated in mining engineering from Washington University (St. Louis) in 1883 was with a copper-smelting firm in Missouri. Two years later he went to Leadville, Colo., to become general manager of both Small Hopes Consolidated and Boreel Mining Co., a position he held for the next several years—while simultaneously serving as manager of the Ibex Mining Co., and consulting engineer for New Jersey Zinc. It was in this period that he and a group of associates started to do prospecting work, take on mining leases, and develop various properties into profitable operations.

In 1903, he moved to California and took on a new assignment as consulting engineer for the Guggenheim Exploration Co., to whom he recommended (among other excellent properties) the Utah Copper Co. in Utah. Two years later, Seeley Mudd went into business for himself, was president of Queen Esther Mining & Milling Co., and with his associates became actively involved in developing Ray Consolidated Copper Co. In his search for properties, he and his associates also acquired and developed the great sulfur property of Texas Gulf Sulphur Co., a company in which he then served as a director until his death. One of the great undertakings in which he was involved was the development of the copper deposits on the Island of Cyprus and the creation of Cyprus Mines Corp.

When the US entered World War I, Seeley W. Mudd joined the army as an engineer-officer with the rank of major, became assistant director of the US explosive plants and was promoted to colonel.

A member of AIME since his college days, Seeley W. Mudd gave freely of his time and money to the Institute, as well as to several educational and philanthropic organizations. For the past 45 years, the Seeley W. Mudd Memorial Fund, administered by AIME, has produced many important textbooks and publications for the mining fraternity.

Daniel C. Jackling (1869–1956)

If a date could be picked for the birth of modern mining, it would most likely be one in the period between the late 1890s and the early 1900s. In that period, a man proved that relatively lean ores could be an incomparably greater source of wealth than all the bonanzas that had first attracted swarms of prospectors and speculators to the West.

That man was Daniel Cowan Jackling. What he did, in essence, was to apply the economy-of-scale concept to the entire sequence of extractive operations, from drilling and blasting all the way to concentration and smelting.

Asked in 1898 to evaluate the porphyry copper ores at Bingham Canyon, Utah, Jackling became convinced after preliminary drilling and experimental ore treatment that the 2% Cu Bingham ore—considered far too "low-grade" at the time—could be of enormous commercial value if mined and treated on a sufficiently large scale. At a time when even a 3% copper ore was considered marginally economical, Jackling's crusade to begin a big mining operation at Bingham was viewed with skepticism and considered as madness by many experienced mining engineers. In 1899, Jackling proposed that the waste rock overburden at Bingham be stripped to expose the ore, which would then be mined with huge steam shovels (never used before) and treated in concentrators of at least 2000-ton capacity (roughly two to four times bigger than the largest concentrators in existence). Some years later, when the flotation process hit the scene, Daniel Jackling

also proved that even an ore with less than 1% Cu could be profitably mined.

Jackling's new system of copper mining revolutionized the natural resource industries, made available a plentiful supply of copper for power transmission just when the US was undergoing urban and rural electrification, produced billions of dollars of new wealth from a presumably worthless ore, and created many tens of thousands of jobs in the US and other countries.

A farm laborer at 18, a multimillionaire at 40, and an internationally admired industrialist by the time he became AIME president in 1938, Daniel C. Jackling was the living example of what a rational man could achieve in a free society. Orphaned at the age of two, Jackling was adopted by his aunt and spent his boyhood years on a Missouri farm, walking several miles a day to attend school until he was 16. For the next four years, he worked on the farm, saved a little money, and at 20 entered the Missouri School of Mines, at Rolla. While in college, he supported himself by summer work with the local railroad company, and as assistant to the professor of chemistry and metallurgy.

Graduating in 1892 with a B.S. in metallurgy, Jackling spent the early years of his career in Colorado where he worked as miner, assayer, metallurgist, and construction superintendent. It was in those early years that he met many of his future partners and backers (men like Colonel Seeley W. Mudd and Henry Krumb) for what later became the Utah Copper Co., of which he was successively chief engineer, general manager, managing director, and president.

Among the many honors he received, Daniel Jackling was awarded the Distinguished Service Medal in 1919 by President Woodrow Wilson, who acknowledged Jackling's outstanding service as director of all US Government ammunition plants during World War I.

In his 56 years of membership in AIME, Jackling served the Institute as director from 1914 to 1916, 1927 to 1929, and 1938 to 1940, constantly assisting and encouraging young engineers and greatly contributing to the Institute's growth and vitality.

Henry Krumb (1875–1958)

Modern mining began with Daniel Jackling. But it was a contemporary of Jackling, Henry Krumb, who integrated various mining units into the corporate structures—such as Kennecott Copper and Newmont Mining—which could attract the investment capital and could find the skilled manpower necessary to develop natural resources on a scale large enough to supply world demand.

Henry Krumb started as a poor boy in Brooklyn, NY. One of his friends, Warren Publicover, recalls that Henry walked some 20 miles every day between his Brooklyn home and the Columbia School of Mines which he could attend only because of a $200 tuition scholarship. After graduation in 1897, young Henry learned about business the hard way: his first job as assayer-chemist in New York folded after a year when the company for which he worked went out of business before paying him most of the salary due him. "Henry Krumb never again worked for nothing," says Publicover.

From 1898 to 1904, Henry Krumb ran several mines in British Columbia. In 1904 he joined the famous Guggenheim Exploration Co. and, as field engineer, he evaluated during the next three years all sorts of gold, silver, copper, lead, and zinc mining properties throughout the country—including the Bingham Canyon property that Daniel Jackling was trying to develop. Henry Krumb, who soon grasped the importance of Jackling's proposed mining methods for the low-grade porphyry copper deposit, spent most of 1905 directing extensive underground development and diamond drilling to confirm the extent of the Bingham ore body, and conducted large-scale treatment tests. On his advice, the Guggenheim group furnished Daniel Jackling the capital to start the steam shovel operations at Bingham, build a large concentrator at Garfield, and organize the Utah Copper Co. By this time, Henry Krumb, now totally convinced that low-grade copper deposits could be successfully developed, examined a number of such properties in Nevada, sent his report to New York, and, on his advice, the Guggenheim acquired a controlling interest in Nevada Consolidated and Cumberland Ely, built a concentrator and smelter at McGill, and laid a 140-mile railroad from McGill to the main line of the Southern Pacific Railroad.

In 1907, Henry Krumb set up his own consulting firm in Salt Lake City, but retained his good relationships with the Guggenheim, and added to his roster of clients and sponsors Mr. William Boyce Thomson—with whom he later worked on the formation of Newmont Mining Corp.—plus some of Wall Street's wealthiest investment banking houses, such as J. P. Morgan & Co. It was in this period that Krumb investigated the Copper River district in Alaska and then convinced the Guggenheim and J. P. Morgan people to finance a new firm, Kennecott Mines Co., so as to develop the Copper River property. Several years later, in 1915, Krumb located for Kennecott Mines an ore body averaging 70% Cu in Alaska—and advised Kennecott to use the earnings from this phenomenally rich but limited ore body to acquire some large low-grade ore reserves in the West, by merging and exchanging a large block of Kennecott Mines' shares for Utah Copper shares. This was the birth of Kennecott Copper Corp. which, again on the advice of Krumb, eventually absorbed all of Utah Copper, Nevada Consolidated, Ray and Chino companies—plus other properties in South America, notably Chile's Chuquicamata, which, years earlier, Henry Krumb had evaluated and helped develop.

Krumb's interest in mining engineering education and in improving the profession's status was intense and highly personal. His contribution in time and money to Columbia University and to AIME were unprecedented. At his death, he left to Columbia University more than $20 million which, in addition to the huge sums of money he gave to the school during his lifetime, enabled Columbia to establish the Henry Krumb School of Mines in 1958. His support of AIME lasted for 53 years, from 1905 to 1958. He was AIME vice-president from 1928 to 1942, and a director of the Institute for 30 years.

Hal W. Hardinge (1855–1943)

It is generally believed that highly successful men move nimbly from one achievement to another and that, in their effortless upward climb, they receive instantaneous recognition from a grateful public. That may be true in Hollywood movies. In real life, it's something else. Hal Williams Hardinge was 51 years old when he conceived his conical grinding mill, and spent the next nine years of his life coping against the skepticism and opposition that was met by the Hardinge mill. A less tenacious man would have given up, but not Hal Hardinge: whenever he spoke to other engineers, he always showed a little glass model of his mill and patiently proved that the principles of its conical design were sound.

Hardinge was 26 when he began studying at Colorado School of Mines. The reason for such a late start: very early in life he had to go to work—first in a printing shop, then selling newspapers on New York Central trains, and for some years earned his living as a telegraph operator; when he had saved enough money he enrolled in the Philadelphia High School. Hal also earned his way through college by doing summer prospecting work.

After graduation, Hardinge established a consulting practice that took him to every mining district in the Western States and Canada. Throughout his 60-year career in mining, Hal Williams Hardinge invented a countless variety of devices, from firedamp detectors to new types of furnace hearths and mills, that resulted in about 60 patents.

Though too old to fight in World War I, Hardinge gave his services without remuneration to the US Bureau of Mines in Washington from 1914 to 1918.

He founded the enormously successful Hardinge Co. and actively directed its worldwide affairs until he was 84. His friends remember that even in his late eighties, Hal Hardinge could still beat much younger men on the golf course and could always explain the latest developments in ore grinding and beneficiation to perplexed engineers who sought his advice.

Erskine Ramsay (1864–1953)

Son of a Pennsylvania coal miner, Erskine Ramsay as a youth worked for as little a $2 per month, became a millionaire in his early forties, and then devoted the rest of his life and a considerable portion of his fortune to several philanthropic and educational institutions.

Though Ramsay was only 19 when he graduated from St. Vincent's College, Pa., he was immediately hired as superintendent of the H.C. Frick Coke Co.'s Monastery mines; a year later, he became mine superintendent of both the Morewood Coke Co. and the South West Coal & Coke Co. His career was meteoric: by the time he was 23, he was general superintendent of the huge Pratt mines of Tennessee Coal, Iron & Railroad Co., and within the next few years rose to chief engineer and vice-president of that company.

Erskine Ramsay's best-known invention, the shaking screen process, was never patented, but he patented 40 other devices used in coal mining and coke production. With the royalties from his patents, he formed his own company, the Ramsay-McCormack Land Co., and attracted many industries, especially steel, to Alabama where he resided.

During World War I, he went to Washington and, like many other executives, became a "dollar-a-year" man. After that, and until he was almost 80, Erskine Ramsay plunged enthusiastically into all sorts of educational activities, was president of the Alabama Board of Education for 19 years, and his financial contributions to education in Alabama alone amounted to hundreds of thousands of dollars.

Howard N. Eavenson (1874–1953)

Like his colleague Erskine Ramsay, Howard Nichols Eavenson belonged to a small group of dynamic engineers-industrialists who, by developing America's great coal mines, not only made the nation self-sufficient in energy but enabled the US to become the world's leading energy exporter.

It was people like Eavenson and Ramsay who assembled enormous amounts of capital, built the infrastructure (roads, schools, hospitals, housing, etc.) needed in coal fields, equipped their mines with complex and massive equipment which they often invented and designed themselves, and created nationwide distribution organizations linked to the growing railroad transportation networks. They did all this virtually from scratch—and without government subsidies or handouts. Their energy and resourcefulness were not sapped by thousands of hostile governmental regulations and—since they didn't have to hand over more than half of their profits as local, state, and federal taxes—they could plow back capital into their ever-growing industries, pay wages higher than anywhere else on earth, and provide jobs for the countless millions of immigrants that poured into the United States at the turn of the century.

Howard Eavenson, though trained in engineering (he obtained his B.S. at 19 from Swarthmore College, and a degree in civil engineering at age 22), had an unerring ability in appraising coal properties before he'd start developing them, according to his colleagues. He was only 26 when he became chief engineer for United States Coal & Coke Co., a subsidiary of US Steel, and in the 18 years of his association with that company he opened up several coal deposits and built 15 large coal plants in West Virginia and Kentucky.

In 1920, Eavenson established his own consulting firm in Pittsburgh and, by the time he became AIME president in 1934, was a director of Pittsburgh Coal Co., owner of two sizeable coal mines, and chairman of the board of Appalachian Coals, Inc., which was a joint selling agency through which 137 producers of high-volatile bituminous coal marketed their aggregate output of more than 50 million tons per year.

Busy as he was, Eavenson always found the time to write technical papers for *Transactions*, serve on the board of various AIME committees, and help establish the Coal Division of AIME in 1930.

Herbert Hoover (1874–1964)

The Great Depression began while Herbert Hoover was president of the United States (1929–1933). While history hasn't yet rendered the final verdict on President Hoover's administration, some things are certain: the honesty, integrity, moral fiber, and organizational ability of Herbert Hoover are universally acknowledged and unchallenged.

Born in a small two-room cottage in West Branch, Iowa, Herbert was the second son of Jesse and Hulda Hoover. Jesse, the village blacksmith, died of typhoid fever when "Bert" was six years old, and Mrs. Hoover for the next few years supported her three small children by taking in sewing, thus saving the insurance money her husband left for their education. In early 1884, however, Hulda Hoover was caught in a storm, developed a severe cold "which rapidly grew worse, in much the same way as did my father," and died of typhoid fever and pneumonia.

The 10-year-old Herbert was then sent by relatives to live with a maternal uncle, Henry Minthorn, a Quaker schoolteacher, in Newberg, Ore. When Mr. Minthorn switched to real estate in 1889, Herbert, now 15, went to work as an office boy in his uncle's new business, taught himself typing, and entered night school to learn math and bookkeeping.

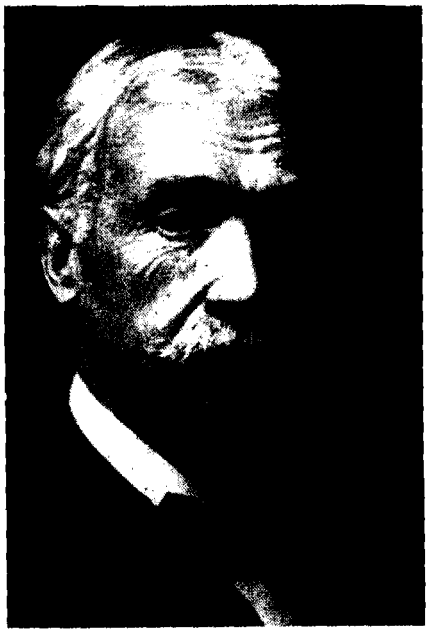
In his uncle's office, Herbert met an engineer from the East who impressed upon him the importance of a college education, and suggested engineering as a profession. And so, when Stanford University opened in 1891, Herbert Hoover entered the Department of Geology and Mining. To earn his living expenses, he organized a student laundry service, became a typist for the head of the Geology Department, and spent his summers working for the US Geological Survey in Arkansas, Nevada, and the High Sierra. When he graduated, Hoover had "forty dollars in my pocket, and no debts." Ironically, the only job that this graduate mining engineer and future president of AIME (1920–1921) could find at the time was in the Reward Gold Mine, near Nevada City, Calif., pushing an ore cart for 20¢ an hour on a ten-hour shift, seven days a week. A few months later, when he had been "promoted" to driller with full miner's wages, the mine closed and he was out of a job. So, he went visiting relatives in San Francisco, and there he met Louis Janin, a prominent mining consultant. Although the only available job was that of a typist, Hoover accepted it. Impressed with the knowledge and initiative of the young engineer-typist, Janin assigned him to more responsible tasks—and, in 1897, Janin recommeded the 23-year-old Hoover to the British mining firm, Bewick Moreing Co., to manage their Australian mining properties. Hoover bought a new suit of clothes, grew a moustache to make himself appear older (see photo), and set out for Australia.

A year later he was appointed chief engineer for the Chinese Bureau of Mines, and he returned to America to marry Miss Lou Henry, a geology student he had met in his senior year at Stanford. The newlyweds arrived in China in 1899, and a year later found themselves besieged in Tientsin during the Boxer Rebellion.

In 1901, Hoover became a partner in Bewick Moreing and for the next eight years he circled the globe five times in his capacity as a mining consultant. In 1908, he withdrew from Bewick Moreing, returned to live in the US, and with his wife began the translation of Agricola's *De Re Metallica*, the Latin mining text of the 16th century still used as a standard reference work. At the same time he set up his own consulting company with offices in San Francisco, New York, and London, and was soon known throughout the world as the "doctor of sick mines."

The rest is history.

Entirely aside from Hoover's political career, notes journalist Lowell Thomas, ". . . [Hoover] probably was responsible for saving the lives of more human beings than any man who ever walked the earth. Look at the relief work he was responsible for after the First World War. That alone entitles him to be ranked among the foremost human beings of our era. He was a colossus in every way."



Robert H. Richards (1844–1945)

When Robert Hallowell Richards was born, mineral processing was not much different than it had been during Agricola's time some three centuries earlier. By 1914, when Richards retired after 44 years of teaching at Massachusetts Institute of Technology, the efficiency of many mineral processing operations—particularly crushing, grinding, gravity separation, and ore dressing—had immeasurably increased because of the progressive mechanization made possible by the shift from water and steam power, and thanks to the pioneer work of Professor Richards.

Graduated from MIT in 1968, Richards first became fascinated with mineral processing during a trip to the Western States in 1871 while visiting many of the mills that had mushroomed since the California Gold Rush of 1848. In those days, according to the late Arthur Taggart, "explanation of ore dressing processes was in the stage passed through several centuries earlier by science—what we may brand 'explanation by postulate.' Richards, instead, sought and accomplished demonstration by experiment, and he impressed its utility on the profession."

Returning from his Western trip to MIT to teach mining and mineralogy, Richards immediately placed ore dressing on the curriculum and pioneered the development of the first laboratory of mining and metallurgy in the United States. As Dr. Nathaniel Arbiter of Anaconda reported at this year's AIME February meeting in Las Vegas, Robert Richards' greatest effort in those early days was to miniaturize operating flowsheets in the lab "so as to reproduce mill processing procedures from start to finish—each student starting with a batch of ore and working it through to final product. Not only this, the laboratory was also available for testing ores for potential operations. The replica plant was suitable for gold, copper, and lead ore processing, and soon small furnaces were built to smelt copper and lead concentrates and, eventually, iron."

Richards continued to visit all the milling plants in the major mining areas and, in 1890, began writing his monu-

mental *Ore Dressing* treatise, published in four volumes between 1903 and 1909. His treatise was the first organized and scientific attempt to present and analyze the art of ore dressing as of those dates. Although Robert Richards invented the jet aspirator for physical and chemical laboratories, as well as several ore separators for copper and iron ores, he achieved international fame because of his *Ore Dressing* volumes.

AIME, which he joined in 1873, was his favorite organization; he was a prolific contributor to the Institute's *Transactions*, and was AIME president in 1883.

Arthur F. Taggart (1884–1959)

by Nathaniel Arbiter, The Anaconda Co.

Taggart's career began as Richards was retiring. He also was originally interested in mining. In fact, after graduating from Stanford in 1910, and after a brief period of mine development in Bolivia, Arthur Fay Taggart taught mining at Yale from 1911, and ore dressing only after 1914. In preparation for teaching ore dressing, he spent six months at Columbia with Richards. In 1919 he was called to Columbia as professor of ore dressing. Almost immediately after beginning his association with Columbia, he started work on the first edition of the *Handbook of Ore Dressing*, which was to appear in 1927. This represents a significant departure from Richards' treatise in several respects. While Taggart also collected a vast amount of practical information from milling operations, he went substantially beyond Richards toward engineering generalization. In this he sought the useful empirical relations and tabulations, which summarized practice, and which represent the first stage in the transition of engineering from an art to engineering science. The second edition of the *Handbook*, which he had started in the mid-1930s and completed in 1944, went even further in this direction.

Taggart's research, unlike that of Richards, was directed more to understanding than to practical results. He was not prolific, but rather provocative. He preferred, because of the needs of the field, to move rapidly toward broad and useful generalizations, rather than study narrow areas minutely. Mineral engineering at the start of his career was largely uncoordinated empiricism. He left it as a developing engineering science, much of this through his own efforts, and the efforts of others stimulated by him. He was not always right. He tended to oversimplify. But even this was useful in provoking controversy and further research.

Source: Arbiter, N., "Antoine M. Gaudin: His Influence on Mineral Processing," Gaudin Memorial Flotation Symposium, AIME-SME, Las Vegas, Feb. 22-26, 1976.

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ment in which a society consisted of the blessed and the damned, masters and servants, exploiters and exploited —and concluded that what was needed was a massive "redistribution of wealth."

This is how throughout the 19th century virtually every successful businessman was accused of being a robber baron who cruelly exploited the poor and amassed obscene wealth at the expense of society. However as economist Milton Friedman points out, "Far from being a period in which the poor were being ground under the heels of rich, exploited unmercifully and the like, there is probably no period in human history in this or any other country in which the ordinary simple man had as large an increase in his standard of living as in the period between the Civil War and the First World War, the period when unrestrained individualism was most rugged. The evidence of this is to be found not only in the statistics that economists have constructed of what was happening to national income, but it is documented in a much more dramatic way by the numbers of people who came to the United States during that period. That was a period when we had completely unrestricted immigration . . .

"Did people come to this country to be ground under the heels of merciless capitalists? Did they come to this country to make their own conditions worse? There is no more dramatic way in which people can vote than with their feet . . .

"Of course, our (present) condition is far better than theirs. In an absolute sense their level of living was low. But we must compare their level of living not to ours but to the level of living they left in Europe."*

* Friedman, M., *Op. Cit.*

Where Do We Go From Here

Leading industry experts and mining executives agree that the major problems now facing the mining industry are the eternal ones of shortages—shortages of capital, fuel, mineral deposits, and adequate technology. There is also widespread agreement that government is not only not part of the solution but that it remains the biggest single obstacle to any solution.

Verbalizing a commonly shared anxiety and hope about the future, consulting geologist Walter Youngquist notes that: " 'Back to basics' expresses the dominant trend I see in American life from here on. In elementary education we've had our fling at 'life adjustment' courses. ('How's my boy doing in math?' 'Oh, he's well adjusted to the class.') So, just as we go back to basics in education now that Johnny cannot read, write, add, or subtract, the American people are also going to go through an educational process in the basics of what sustains our economy and life itself. Government cannot simply print oil, gas, iron, or copper. Wealth must be produced before it can be redistributed. Essentially all wealth comes from mining, agriculture, and fishing. If these basic industries are not viable, the nation itself cannot survive. This will become painfully but, I believe, healthfully apparent to all Americans the next decade and beyond."

Mining people today are more concerned than ever with dwindling nonrenewable resources. "In energy and minerals," says USBM director Thomas Falkie, "the US is entering what might be called a perpetual emergency." Donald H. McLaughlin, chairman of the executive committee at Homestake Mining Co., and 1950 AIME president, stresses that "Serious troubles from lack of ores, minerals and fuels have already been experienced in some

lands, but even for the few nations in currently comfortable situations the moment of truth cannot be long postponed."

Conservation, recycling, and better technology can be partial solutions. "Secondary resource recovery—from industrial and urban wastes—is not only desirable as a means to increase our primary supplies of raw materials, but is also environmentally essential to reduce the wastes that must be disposed of," says Falkie, "and we certainly must improve the recovery methods to treat lower-grade ores." Technological improvement, adds McLaughlin, "is a challenge that should attract some of our best minds." But this also presents difficulties:

"Although the so-called common heritage of mankind derives entirely from the creativity of a few individuals, the US will undoubtedly revise the Mining Law of 1872 whose basic premise—the right of a mineral discoverer to protect his findings and to benefit from them through patent—may be eliminated," observes Paul A. Bailly, president of Occidental Minerals Corp., pointing out that this will result in drying up "the inventiveness of mineral discoverers and the extraction specialists, and in undermining the foundations of a productive and free society: self-reliance, initiative and pride of achievement."

Yet, "the mining industry must again assume the position of leadership in technology," emphasizes R. W. Ballmer, executive vice-president of Amoco Minerals Co. As Ballmer sees it, "Dependence on technology rather than on ownership of deposits may be the only way to survive in the future." That may indeed be so—but there's a rub to it since "the less developed nations quite often expect transfer of technology for nothing or at best for a fee," says Plato Malozemoff, chairman of Newmont Mining Corp., noting that "fees do not create capital and, without capital accumulation, the multinational corporations will not be able to exist in their present form, nor accumulate the experience and special know-how that can only be gained from being committed to succeed in operations."

Where Is The Money Coming From

In tackling the question of how new mining ventures might be financed, Malozemoff cites a long list of familiar obstacles—e.g., return on investment has been decreasing because of inflation; the requirements of nonprofitable and arbitrarily mandated antipollution installations; the delays in exploration and mine development caused by the environmental movement; the growing nationalism abroad; and the adverse political and fiscal climate at home. "All these risks," he says, "have undermined the confidence of investors and lenders."

In the face of political uncertainties abroad, Malozemoff thinks that the International Bank for Reconstruction and Development (World Bank) has been a constructive influence in financing new ventures. As to the other device to safeguard foreign investment by way of insurance against political risks—OPIC—Malozemoff reports that such insurance is expensive, not as attractive as touted, and that "some countries refuse to make appropriate guarantees to OPIC on the grounds of violation of their sovereignty." Thus, he predicts "a greater proliferation of partnerships among equity investors to reduce the financing burden and share the risks."

One subject that invariably touches on everybody's raw nerves is that of taxation. Noting that American iron ore producers, for example, are forced by market conditions to compete against foreign producers, many of which are subsidized in one way or another by their governments, H. Stuart Harrison, chairman of The Cleveland-Cliffs Iron Co., advocates "an equitable tax base not only for iron ore but for the entire mining industry." Elaborating on this same point, James N. Purse, president of The Hanna Mining Co., spells out that ". . . We do not want subsidies. We must have a competitive tax structure —one that stimulates research and recognizes the need for the continuing formulation of capital to create new jobs and to modernize our tools of production . . . Every new additional tax [at federal, state and local levels] and every new government restriction weakens our competitive position."

Government Regulation: No End in Sight

The *Federal Register* is the government publication that lists all the rules and regulations issued daily by the thousands of federal agencies. In 1965, the *Register* consisted of about 15,000 pages of fine print. By the year 1975, it had blossomed to nearly 50,000 pages that included more than 25,000 regulations. Today, ". . . The cost of federal regulatory activities is rising faster than the sales of companies being regulated," says Murray L. Weidenbaum, director of the Center for the Study of American Business at Washington University. Weidenbaum ought to know: until a few years ago he was assistant secretary of the Treasury.

For obvious reasons, it is extremely difficult to enforce all these regulations which few people, if any, can keep track of, understand, or obey. The result is the selective enforcement of these regulations against any "violator" who, for some reason or other, displeases federal authorities. The implication of this selective enforcement of thousands of often incomprehensible and contradictory regulations is tyranny—and, fortunately, there is now a growing bipartisan awareness and concern that such regulatory activity has perhaps become the deadliest danger for the Republic.

Meanwhile, it's business as usual in federal agencies. Howard L. Edwards, vice-president of Anaconda, gave a pertinent example at a local AIME meeting in Salt Lake City on May 20. Referring to the new federal coal leasing program and the new leasing regulations announced by Secretary of the Interior Kleppe, Edwards stated that "the new regulatory scheme is a mishmash of bureaucratic obfuscation containing so many opportunities for delay that I expect it will be years before the first lease is issued. When that lease does issue—after state input, public input, advice of the state governor, land-use planes with state and public participation, environmental analysis and impact statements, BLM and USGS agreement of tract selection, Washington office evaluations, etc.—the disincentives to develop contained in the lease terms will likely cause even further delays in mining the coal."

Coal, everyone agrees, is the answer to the energy shortage. When coal leases are issued, they'll be the first ones since 1971, says Edwards, adding that in April 1976 —for the first time in the history of the nation—"over 50% of our oil needs were supplied by imported oil."

As the United States begins its third century of existence, it needs more than ever men like Henry Krumb, Daniel Jackling, Howard Eavenson, Erskine Ramsay —not only in the mining industry, but in Washington. If there is a comforting thought it is that a great nation never fails to produce great men in times of crisis. □