Two hundred years of American Physics

Benjamin Franklin's bifocals, from The Franklin Institute, Philadelphia. Safety goggles by Bausch and Lomb.

Early American Physics, 1740-1870

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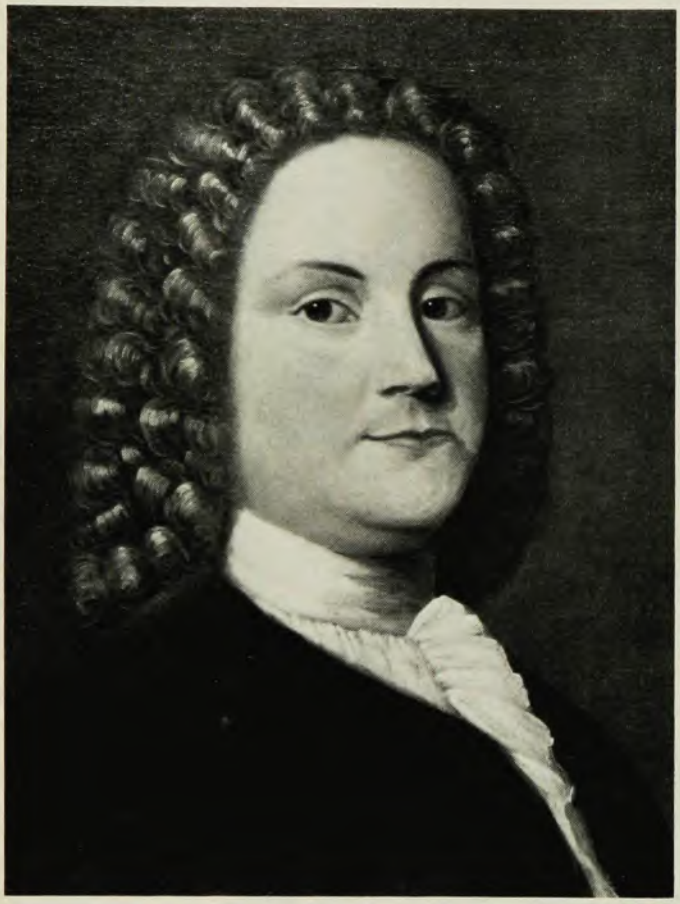

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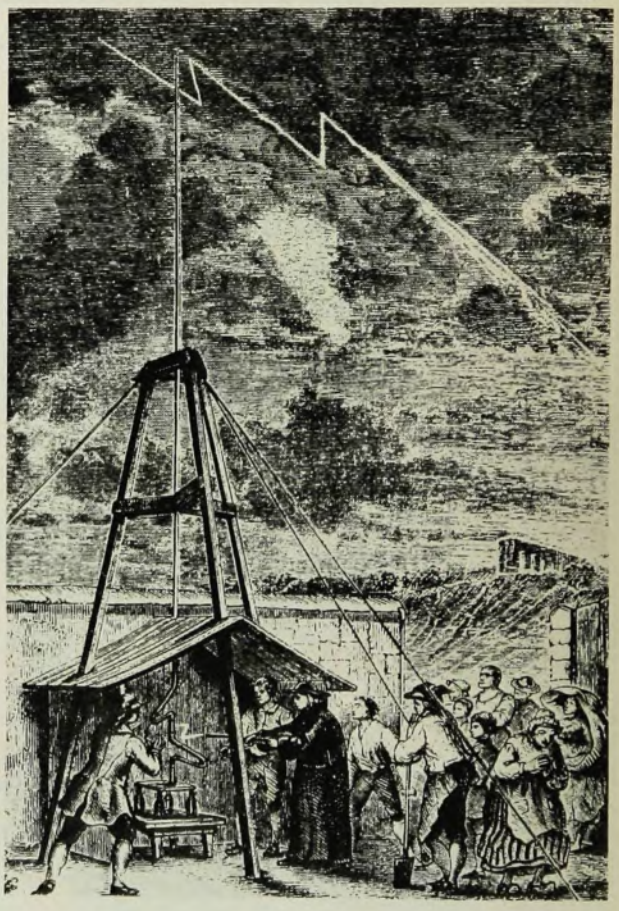

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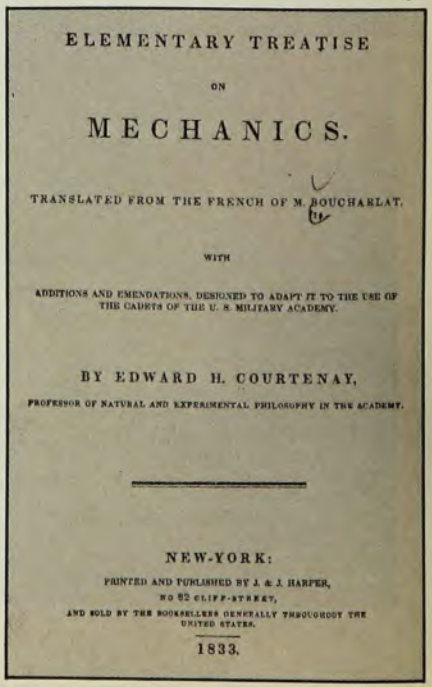

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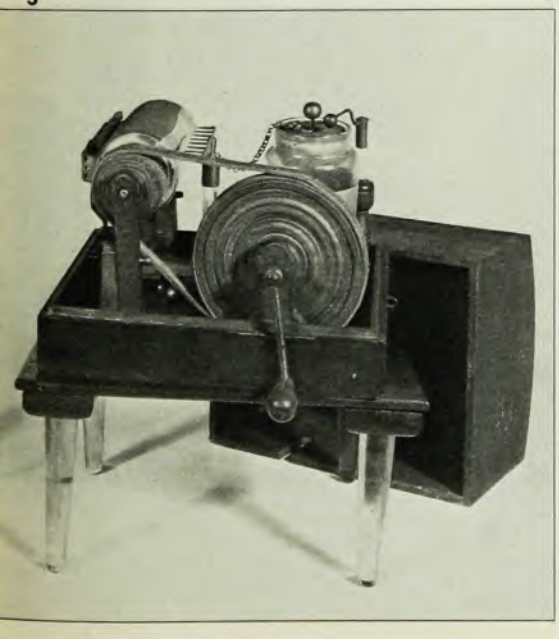

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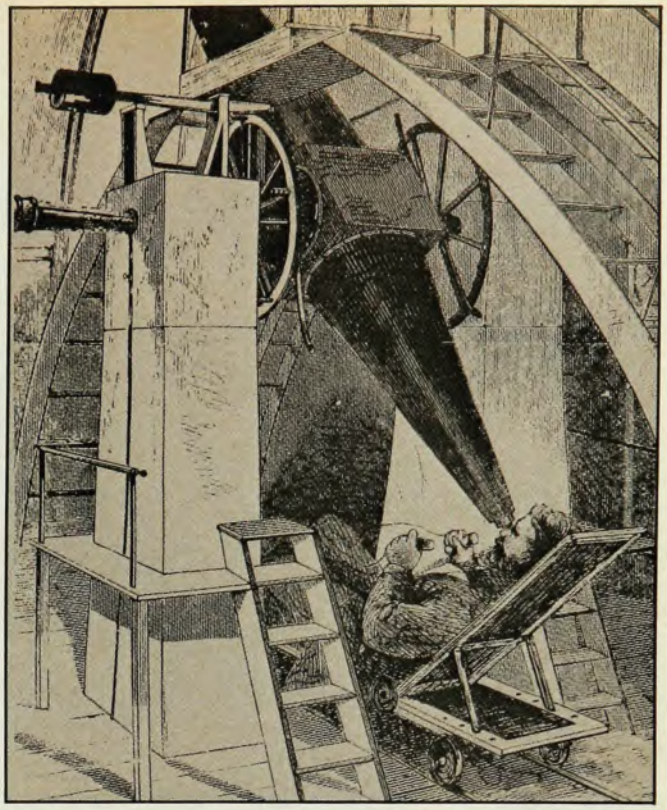

PURE SCIENCE DID NOT FLOURISH in America during the first centuries of European colonization, yet one of America's greatest physicists—Benjamin Franklin, who also was the first to receive world attention—made his significant contributions to science around 1750 (**figure 1:** detail from a painting by Robert Feke). Among his achievements were a revolutionary theory of positive and negative electricity and a demonstration that thunderclouds could induce electricity in grounded rods. First tried in France, the lightning experiment **(figure 2)** attracted universal acclaim, which helped Franklin greatly in his later diplomatic efforts.

After Franklin, American physics relapsed into a sleepy state. At small, chronically poor colleges, such as the College of William and Mary, Williamsburg, Virginia (**figure 3:** from the mid-19th century lithograph by Thomas Millington), professors of "natural philosophy" labored to teach the subject. The low state of American physics in the early nineteenth century is shown by the textbooks (such as the one by Edward H. Courtenay, whose title page is **figure 4**) that were invariably lifted, with or without attribution, from European sources and were typically several decades out of date at time of publication. Gradually, however, public attention turned towards science, and the schools acquired decent texts, some expertise and apparatus (**figure 5:** an electrostatic machine at Harvard University).

From this background came the second great American physicist, Joseph Henry **(figure 6),** whose researches in electromagnetism were of great theoretical and practical importance. Henry completed his career as the first Secretary of the Smithsonian Institution. The Smithsonian, along with other Federal institutions such as the US Navy's Astronomical Observatory (**figure 7:** obtaining sidereal time at the Observatory), brought government aid to the nation's struggling scientists.

The struggle to create American Physic

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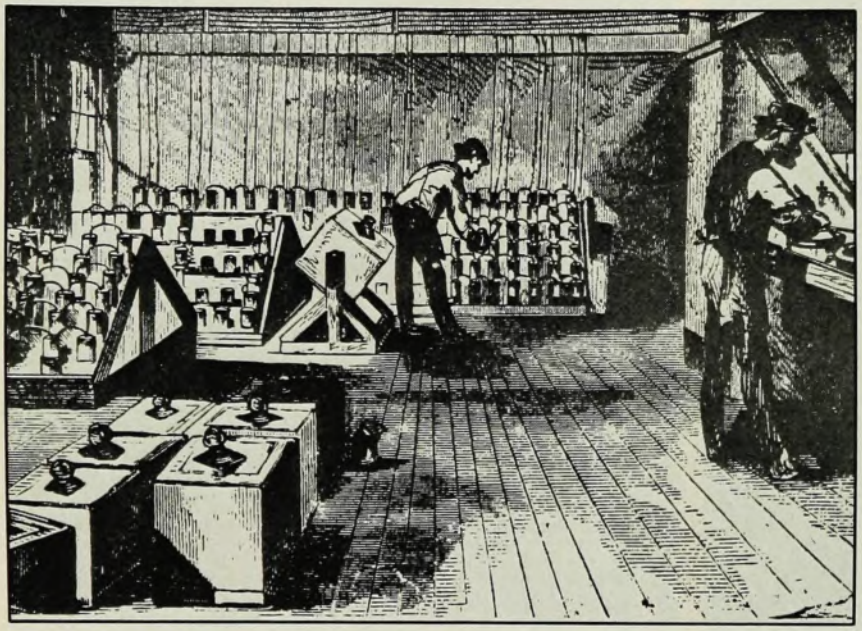

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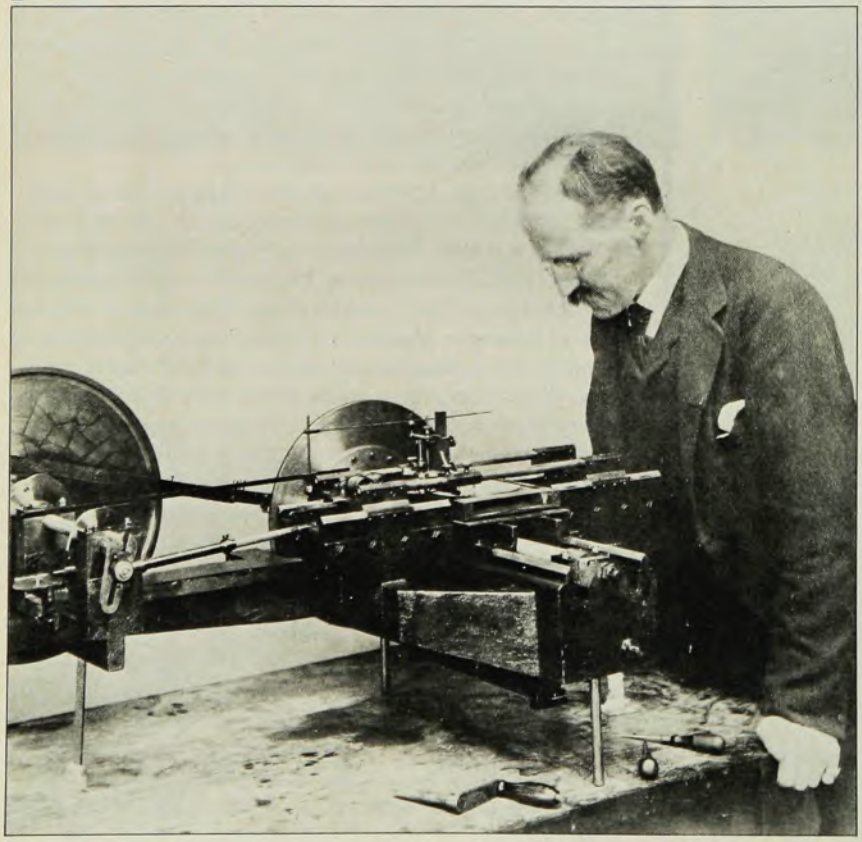

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1870-1900

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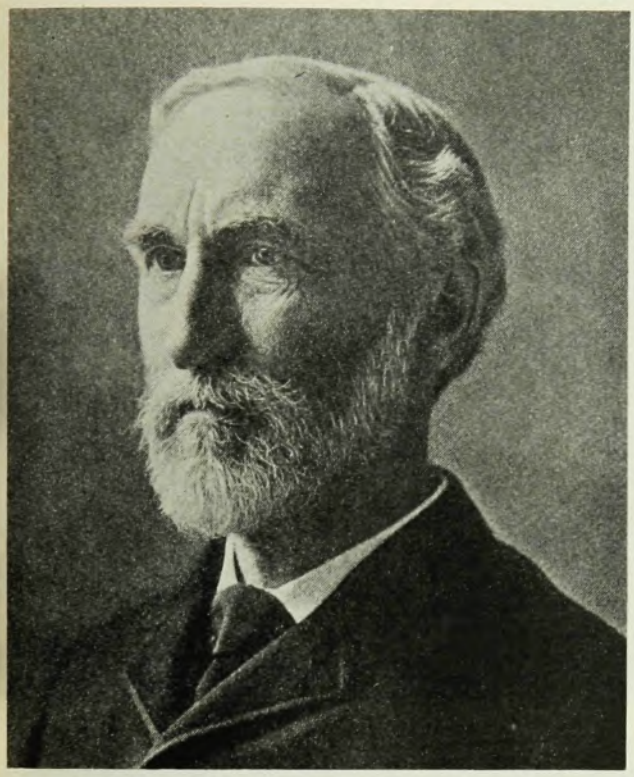

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IN THE LATTER DECADES of the nineteenth century the first physics-related industries began to emerge, led by the telegraph (**figure 1:** a Western Union battery room). The need for electrical standards and the urge towards a deeper understanding of electricity were met by physicists such as Henry Rowland **(figure 2),** who established a beautifully equipped physics laboratory and building **(figure 3)** at the newly endowed Johns Hopkins University, which offered graduate education on the successful German model. Rowland also contributed to spectroscopy (figure 2 shows him with his engine for ruling diffraction gratings), a passion shared by America's first Nobel Prize-winning scientist Albert A. Michelson **(figure 4)** and others.

With help from the physicists, along with popular enthusiasm for science, observatories multiplied across the continent (**figure 5:** Harvard College Observatory). Instrumentation and experimentation became American specialities, while theoretical work continued to lag behind European accomplishments. But J. Willard Gibbs **(figure 6)** showed that Americans, with the help of some training abroad, could pioneer in theory too. American scientists of Gibbs's generation tended to be isolated, finding their peers across the Atlantic more often than at home—but in the 1890's the founding of the *Physical Review* **(figure 7)** and of The American Physical Society strengthened the native community.

A time of growth, 1900-35

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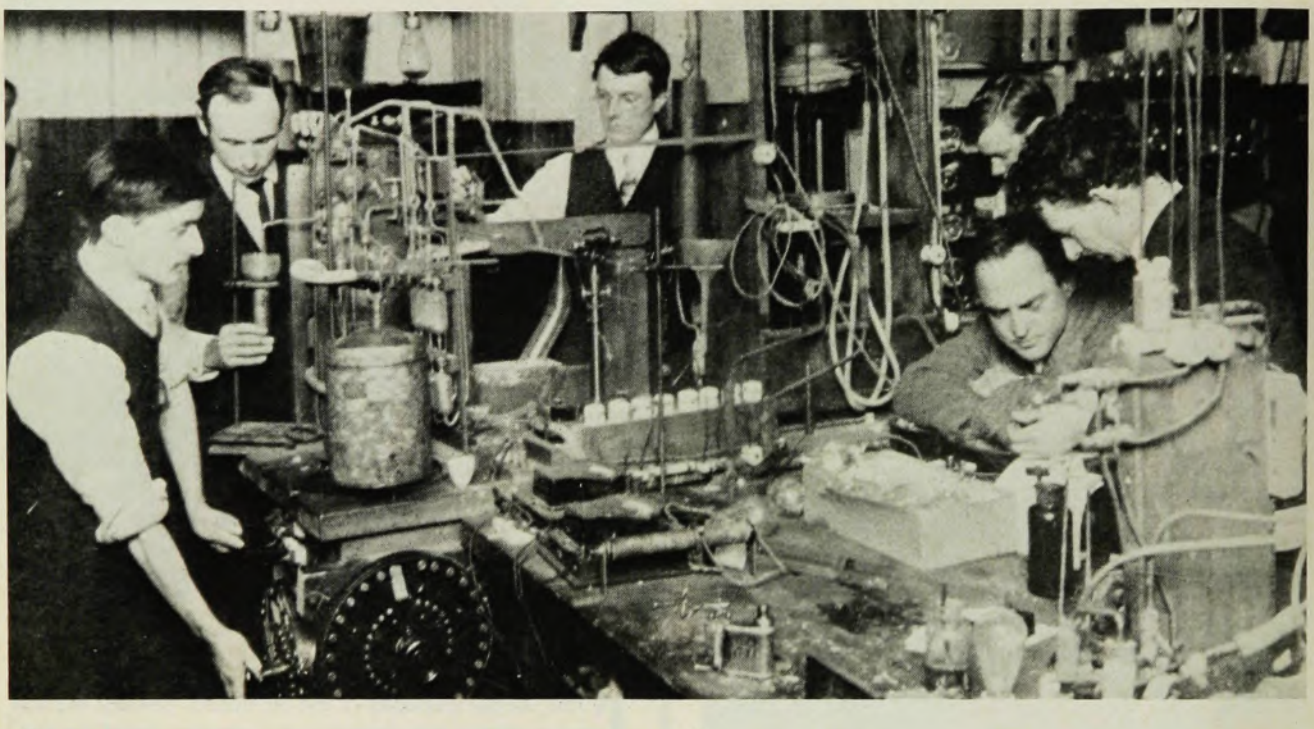

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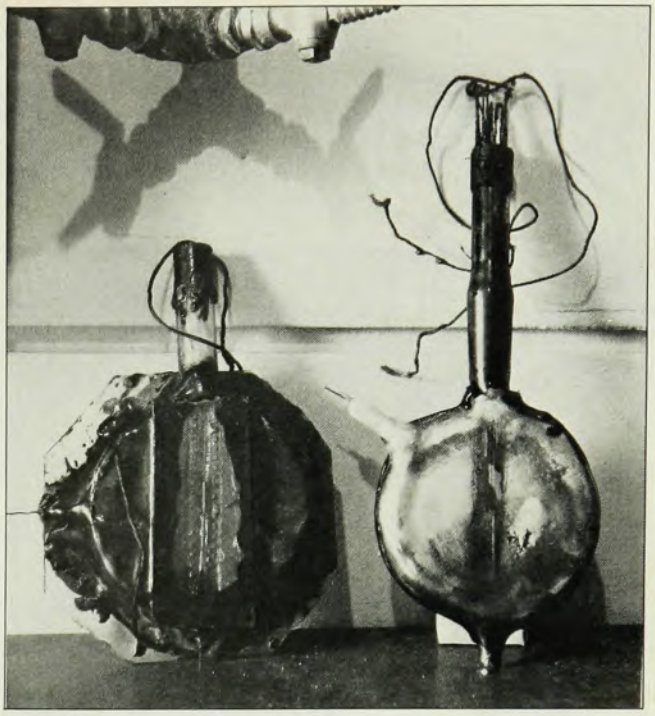

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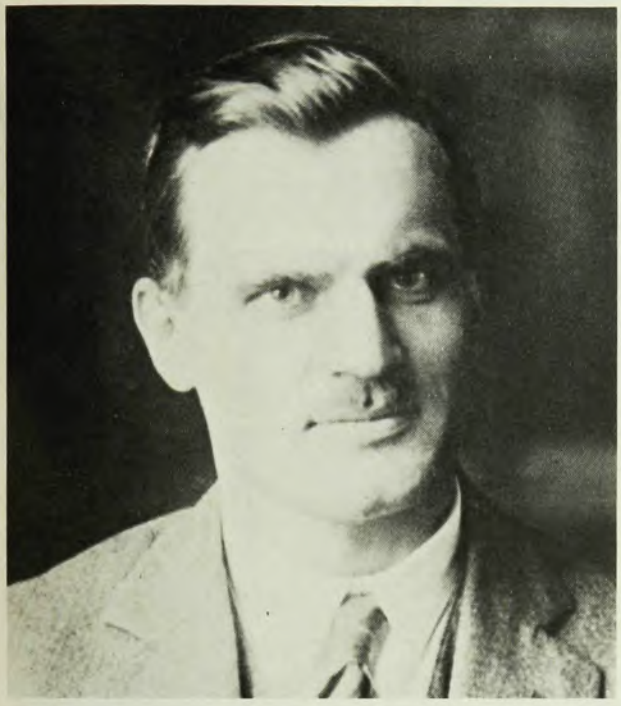

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INDUSTRIAL RESEARCH LABORATORIES began to appear around 1900, and by 1920 were employing a fifth of all American PhD physicists. Some of these physicists, like Irving Langmuir (center of **figure 1,** in the General Electric Research Laboratory), did work of great value to both pure science and industry. The importance of applied physics was brought home to the public in the First World War and by such developments as vacuum tubes for radio (discussed in **figure 2** by J. J. Thomson, left, and Frank B. Jewett in the Western Electric Company laboratories).

Meanwhile the universities grew swiftly and doubled their output of PhD physicists every ten or twelve years. Most spectacular was the emergence of the California Institute of Technology, midwifed by George Ellery Hale, Arthur A. Noyes and Robert A. Millikan (left to right in **figure 3** at Cal Tech). Hale, Millikan and others continued the American habit of experimental excellence, but a more rounded foreign tradition was arriving through published communications, the return of American students trained abroad and a steady stream of visiting European professors.

The University of Michigan Summer School in Theoretical Physics **(figure 4)** became a meeting-place for the new generation. The result of this movement was work like that of Arthur Holly Compton **(figure 5),** which combined painstaking instrumentation with ground-breaking theory. Experiment was still a matter of individual workmanship, but in the first cyclotrons **(figure 6),** this tradition produced the seed of a new sort of growth.

The challenge of leadership, 1935-76

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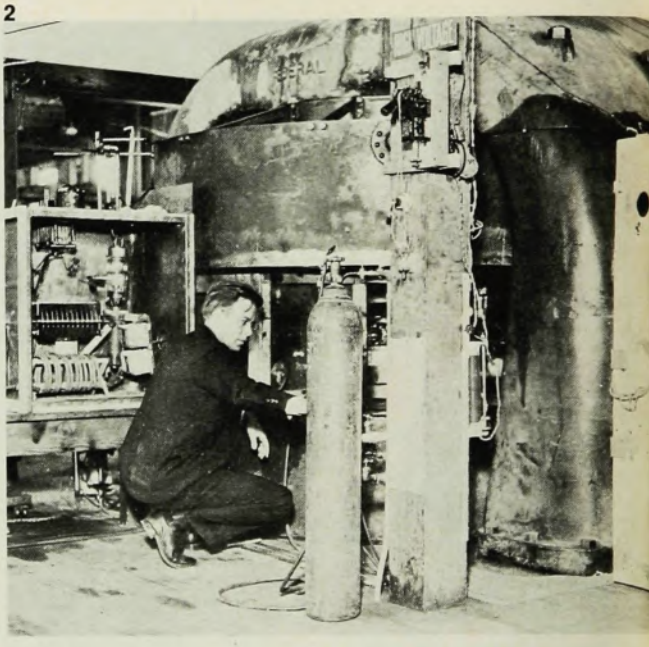

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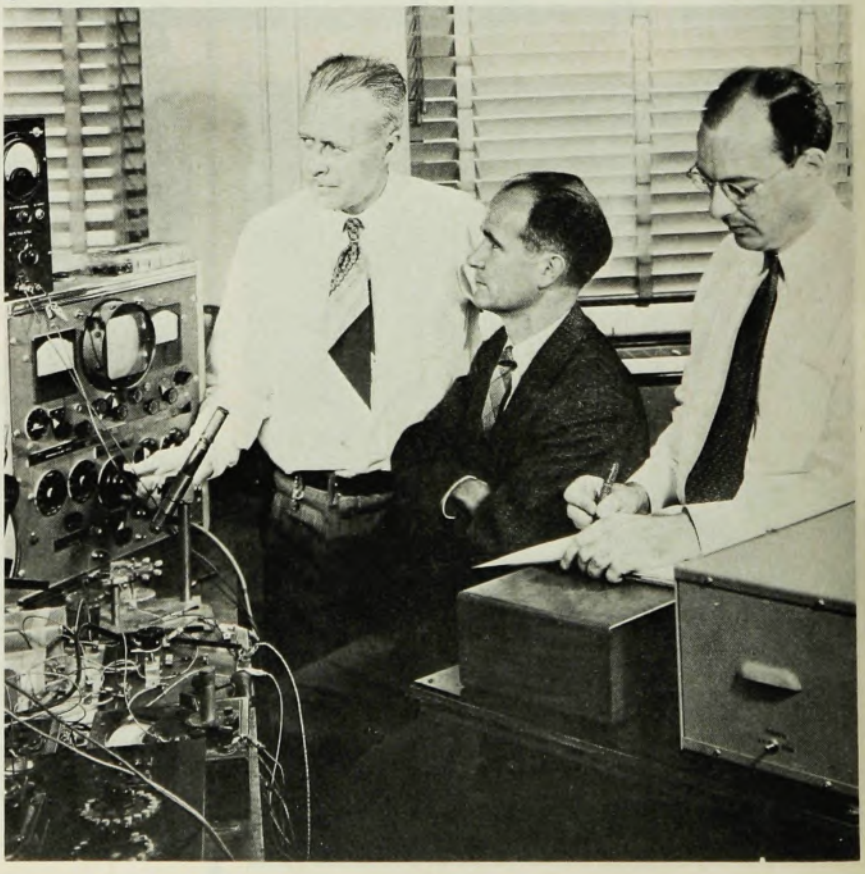

CREDITS

Pages 24–5: figure 1: Harvard University Portrait Collection; figure 3: College of William and Mary; figure 5: Harvard University Collection of Historical Scientific Instruments; and figure 6: Smithsonian Institution.

Pages 26–7: figures 2 and 3: The Johns Hopkins University and John D. Miller; figure 4: University of Chicago, courtesy AIP Niels Bohr Library; figure 5: Niels Bohr Library, Shapley Collection; and figure 6: Niels Bohr Library.

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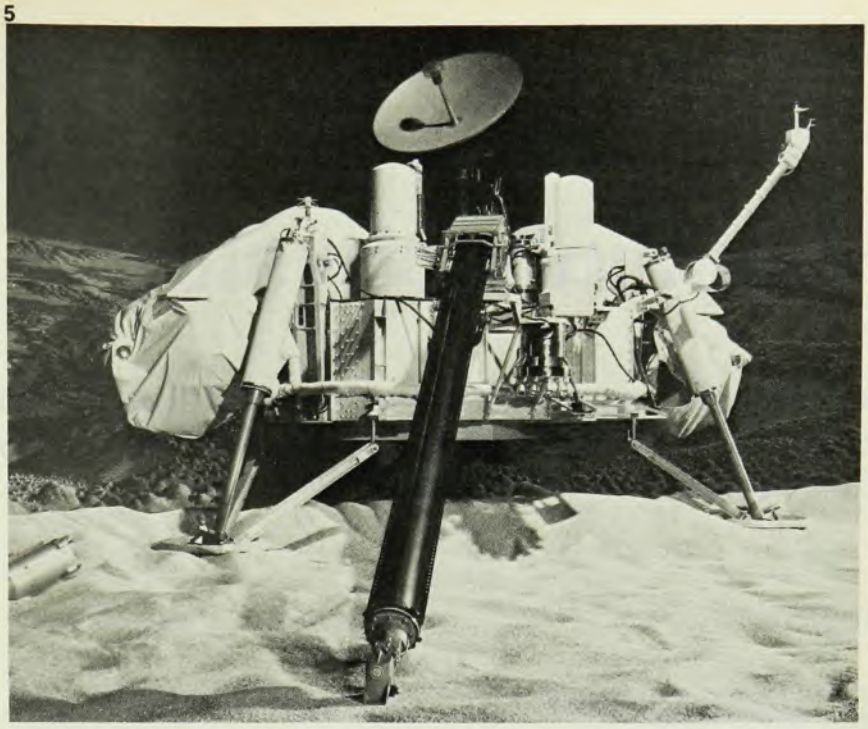

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THE WEALTH AND PROMISE of American physics induced some Europeans to emigrate to the United States before 1932, but political disaster in Europe brought many more over during the next decade (**figure 1:** George Uhlenbeck, Enrico Fermi and Felix Bloch, left to right). They found the old experimental tradition transformed into the concept of a co-operative, engineered laboratory, as pioneered by cyclotron-builder Ernest O. Lawrence **(figure 2).**

The fears of the refugees and American organization combined during the Second World War to thrust physicists into the center of a new geopolitical situation (**figure 3:** the first atomic bomb test). American industrial physicists were revolutionizing the world in their own way through devices like the transistor (**figure 4:** left to right, Walter H. Brattain, William Shockley and John Bardeen with their apparatus at Bell Telephone Laboratories).

By the 1950's it was obvious that the United States had risen to dominate world physics. This position was maintained through generous Federal funding for the space programs **(figure 5:** Viking Mission to Mars, scheduled for landing 4 July 1976) and enormous, semi-autonomous experimental facilities like Fermi National Accelerator Laboratory **(figure 6).** In the 1970's the decline of aerospace funds and apparent saturation of the universities forced a respite in the exponential growth of American physics, but there remained many aspiring students **(figure 7)** to ensure that America's leadership could be maintained as the country moved into its third century.

This photo-essay was prepared with the assistance of the American Institute of Physics' Center for the History of Physics. The Center will aid anyone seeking further information on these topics.