



## A Failed Idea Leads to a Powerful New Analytical Tool

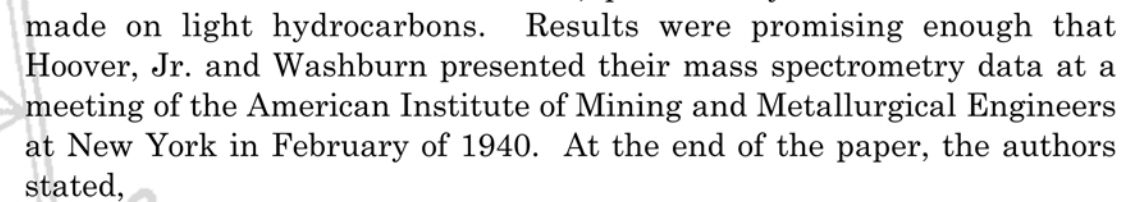
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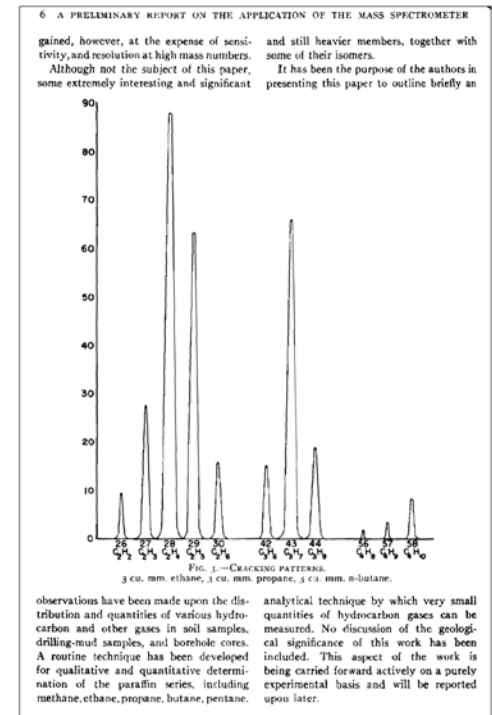
**TIME**  
The Weekly Newsmagazine

HERBERT CLARK HOOVER JR.  
November 2, 1942

In 1930, Herbert Hoover, Jr. was promoted to President of Aeronautical Radio Inc., an organization that provided radio communication between airplanes and the ground. This was an important task for the fledgling air transport industry. Hoover's interest in both aviation and radio communications along with his technical and business background made him an ideal person for the job. The company survives today as ARINC.

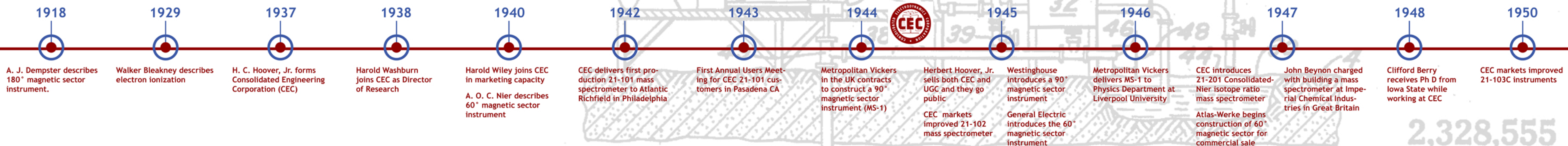
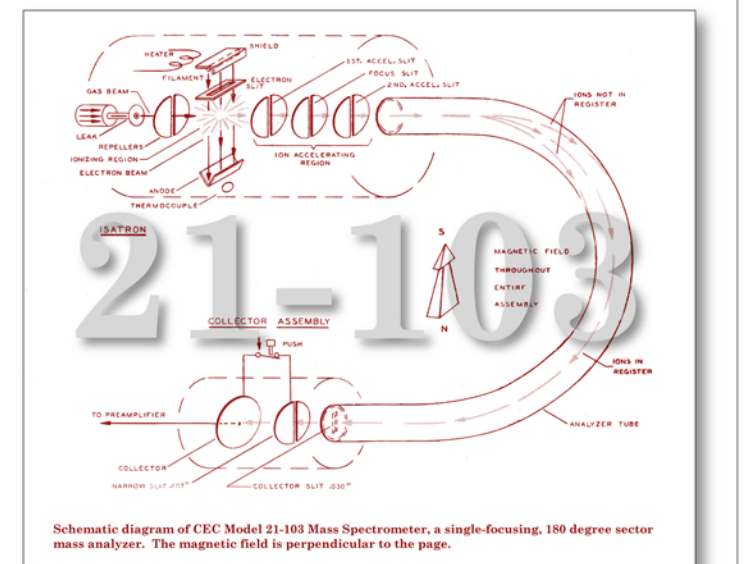


Washburn's literature search suggested that the mass spectrometer would be sensitive enough for the job. Using an instrument from the California Institute of Technology that David D. Taylor, a new-hire at CEC, used for his doctoral work under Robert Millikan, preliminary measurements were



## 21-101 Mass Spectrometer

The instrument was based on the 180° design of Dempster<sup>2</sup> with an electron impact ion source of CEC design called the Isatron. It was scanned by varying the magnetic field and used a Faraday cup detector. The mass range was ~100 amu. It was designed for quantitative analysis of light hydrocarbons through hexane. Over the years, this basic design was improved and refined as shown in the schematic of the 21-103 instrument introduced in 1950.





Unfortunately, the popular press had gotten wind of their presentation and when Hoover, Jr. and Washburn returned to Pasadena California, they found packages of “hundreds of quarts of earth from people all over the United States”<sup>3</sup> for analysis. However, they soon found that light hydrocarbons were ubiquitous in soil, mostly from biogenic sources, and this concept of prospecting for oilfields was flawed.

CONSOLIDATED ENGINEERING CORPORATION

R.P. Wiley  
1-19-46

A Test of Major Oil Refineries in the U.S.A.  
(40,000 crude oil capacity or greater)

Showing the refineries which are now using the CEC MS

Company	City	Crude oil capacity	Crushed gasoline capacity	Type
*General Petroleum	Perrone	66,000	6,000	SO
*Richfield Oil Corp.	Wetmore	70,000	13,000	Comp.
*Shell Oil Company	Vilavilangon	44,000	16,900	SO
*Standard Oil Company	El Segundo	95,000	28,000	Comp.
*Standard Oil Company	Richmond	132,000	19,000	Comp.
*Tampa Company	Vilavilangon	40,000	13,700	SO
*Tidewater Associated	Arva	60,800	48,800	Comp.
*Union Oil Co.	Glenn	40,000	6,200	Comp.
*Union Oil Co.	Vilavilangon	60,000	10,000	SOA
*Have MS-4 Do not have MS-2				
Illinois				
Shell Oil Company	Wood River	85,000	79,000	SOA
Tampa Company	Ledford	50,000	18,000	SOA
*Have MS-4 Do not have MS-2				
Indiana				
*Standard Refining Co.	St. Chicago	85,000	14,000	Comp.
*Standard Oil Co.	Whiting	132,000	48,000	Comp.
*Have MS-2 Do not have MS-4				

Page from Market Analysis conducted by Harold Wiley in 1946. Note emphasis on petroleum companies.

From collected papers of Charles Adams, Chemical Heritage Foundation, Philadelphia Pennsylvania

They received the first CEC 21-101 mass spectrometer in December of 1942. It was installed and operational the next year. Other petroleum companies soon followed the lead of Atlantic Richfield and by 1946 a number of instruments had been purchased for use at other refineries.

The mass spectrometer project was going to be shut down, but Washburn had a contact at Universal Oil Products Company who was interested in finding a faster way to analyze cuts from the distillation of aviation gasoline during the refinery process. The existing method was slow, taking up to a day to complete; by which time the information was useless. Washburn requested sample mixtures from the Atlantic Refining Company for analysis by mass spectrometry and showed that they could be analyzed in an hour, thus providing the needed information in a timely fashion. In addition, he found and reported that the sample bulbs contained a trace of acetone, a compound that was used to rinse out the bulbs prior to loading the sample. This so impressed the Atlantic Refining Company that they placed an order for the instrument immediately.

The First Hi Tech Company?

When Hoover, Jr. set about creating Consolidated Engineering Corporation, he began by assembling a very talented group of individuals with sterling credentials. Harold Washburn was a student of E. O. Lawrence, a Physics Nobel Laureate. David Taylor did his graduate work under the Physics Nobel Laureate Robert Millikan. Clifford Berry was a graduate student of Atanasoff at Iowa State and was key in the development of what is now considered to be the first modern digital computer. Robert Langmuir later became noted for his development of the electron synchrotron, first at General Electric, and later at the California Institute of Technology. Al Nier consulted for CEC and would go on to become the pre-eminent American mass spectrometrists. By the early '50s contributions of this highly talented staff of competent scientists had created the field of commercial mass spectrometry and dominated it for most of the next decade.

Fifteenth Annual Conference  
on Mass Spectrometry  
and Allied Topics

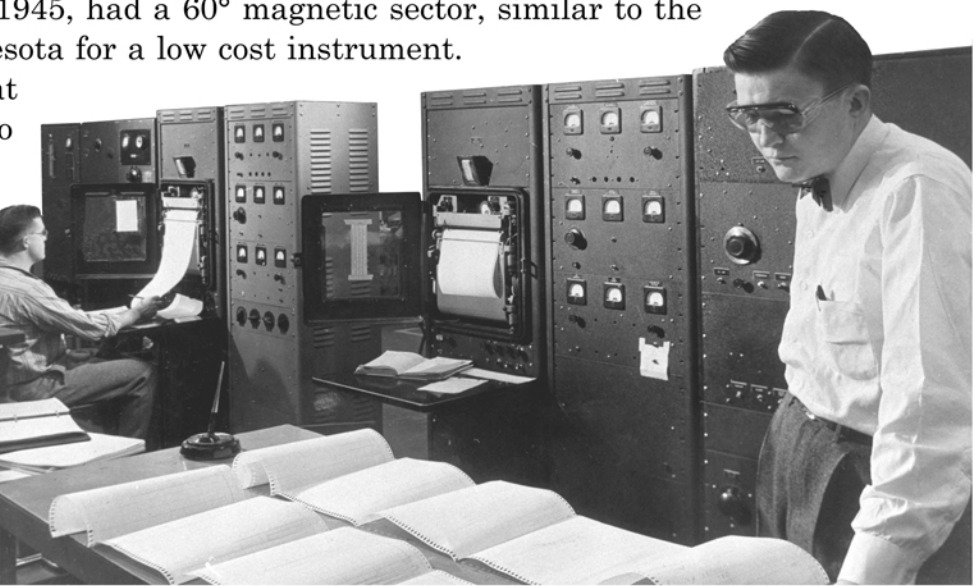
The meeting you are now attending can be traced back to the early CEC Users Meetings, the first of which was held in 1944 in Pasadena California. CEC had four instruments in the field by that time and it was felt that bringing the new customers together for training and exchange of information would be valuable, both for CEC and for its customers. General Electric and Westinghouse did likewise when they entered the market. However, it was felt that there were scientific issues that subtended the narrow focus of the Users Meetings and that a broader forum would be more useful. For several years, the Mass Spectrometry session of the Pittsburgh Conference served as this broader forum, but eventually the size and interests of the group fell outside the purview of the Pittsburgh Conference. The Conference on Mass Spectrometry and Allied Topics then met under the auspices of the American Society for Testing and Materials in 1953 and later evolved into the independent entity, the American Society for Mass Spectrometry in 1971.

Arranged by the Officers of  
ASTM Committee E-14

Today, *Thomson's vision* is realized in many different instruments by *scientists working* in fields far beyond *chemistry*; not only here *on earth*, but on *other planets*. He would be *proud*.

Other Companies Enter the Market

It didn't take long for other industrial companies with the resources, such as General Electric and Westinghouse, to enter the market with their own mass spectrometers. These instruments incorporated magnetic sector analyzers of varying geometries. The GE mass spectrometer, introduced in 1945, had a 60° magnetic sector, similar to the design that Nier<sup>4</sup> had developed at the University of Minnesota for a low cost instrument. The original instrument had an adjustable ion exit slit that could be manipulated from outside the vacuum envelope to change resolving power. Improved versions of this instrument were introduced in 1950 and 1952. As early as 1951, General Electric was investigating the Bennett radio frequency<sup>5</sup> and ion resonance mass analyzers as commercial instruments.



Fred McLafferty (foreground) and Herb Woodcock at Dow Chemical Midland Michigan ca 1950 with two Westinghouse mass spectrometers.



FOR ANALYZING GASES BY SPECTROMETRY  
Measurements of impurities in gas streams, certain analytical work in the rubber and petroleum industries, and other types of gas analysis are among the many applications of recording mass spectrometers of the latest type, one of which is shown here being inspected in the laboratory.

From General Electric Review 53(11) 1950, 10

General Electric would also withdraw from the mass spectrometer business by the late '50s, but companies in the United Kingdom, Germany and Japan would be more successful. Metropolitan Vickers Electrical Company marketed an instrument based on Nier's 60° mass analyzer in 1946. Successors to MetroVic competed in the market place with an expanding line of mass spectrometers over the decades since. Atlas-Werke in Germany was the incubator for another 60° magnetic sector instrument begun in 1947 under the Mes und Analysen Technik (MAT) nameplate. Similar to MetroVic, the mass spectrometer business succeeded through a series of different companies to the present day. The Japanese companies of Hitachi and JEOL began marketing instruments in the early '50s and 1963 respectively. CEC is no longer viable, but the market it created most definitely is.

1953

ASTM Committee E-14

First Annual ASTM E-14 Conference on Mass Spectrometry & Allied Topics in Pittsburgh PA

1954

CEC introduces fast scanning mass spectrometer with cycloidal mass analyzer

1959

CEC introduces high resolving power 21-110 mass spectrograph

1960

CEC is acquired by Bell & Howell

1961

Metropolitan Vickers MS8 mass spectrometer achieves resolving power of 13,500

1962

Metropolitan Vickers MS9 mass spectrometer introduced

1963

JEOL enters the mass spectrometry market with the JMS-01 high resolving power instrument

1964

GE introduces mono-pole mass spectrometer as a residual gas analyzer

1971

ASMS formed and meets jointly with ASTM E-14

1971

AEI (formerly Metropolitan Vickers) introduces MS30 double-beam mass spectrometer

1972

AEI introduces MS50 mass spectrometer (improved version of MS9)

1975

CEC is acquired by duPont

1979

CEC is acquired by Consolidated Vacuum Corporation

1981

Fast Atom Bombardment (FAB) described

1988

ASMS



## References

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- (5) Lawler, D. R. Analytical Applications of Mass Spectrometry. *The Ohio Journal of Science* **1952**, *52*, 146-150.