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complemented his technical degree with a business degree from Harvard and in 1937 at the age of 34, he formed two corporations for oil prospecting; United

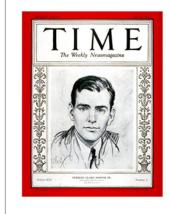
Geophysical Corporation and Consolidated Engineering Corporation. The first was a company that did fieldwork, exploring for oilfields with various instruments; the second was a technology company formed to design, create, and build the instruments needed for oilfield exploration.



Prospecting for Oil

United Geophysical Corporation survives today with offices throughout the world. Despite changing hands over the years, the company continues prospecting for oilfields, primarily with seismographic equipment pioneered by Hoover, Jr. He had over a dozen patents for seismological equipment for oil prospecting.

1929



Man of the Year

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.



1940 Harold Wiley joins CEC

CEC delivers first production 21-101 mass spectrometer to Atlantic Richfield in Philadelphia

First Annual Users Meet ing for CEC 21-101 customers in Pasadena CA

1943

letropolitan Vickers in the UK contracts to construct a 90° magnetic sector instrument (MS-1

sells both CEC and UGC and they go

CEC markets

introduces a 90 magnetic sector

1945

delivers MS-1 to

Physics Department at Liverpool University

1946

21-201 Consolidated Nier isotope ratio mass spectrometer

magnetic sector for

1947

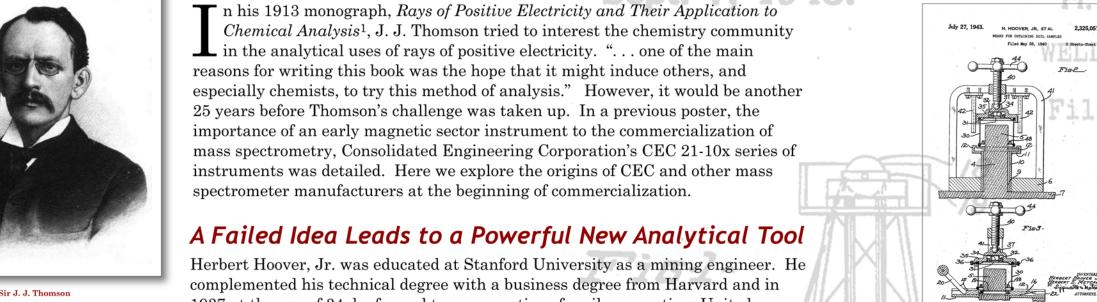
John Beynon charged

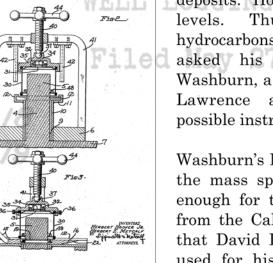
Clifford Berry working at CEC

1948

CEC markets improved 21-103C instruments

1950





deposits. However, any trapped hydrocarbons were likely to be present at trace levels. Thus a sensitive and rapid means of analyzing soil for these hydrocarbons, such as methane, propane and butane was needed. Hoover, Jr. asked his Research Director, Harold Washburn, a recent doctoral student of E. O.

It was assumed that volatile hydrocarbons trapped in soil and mud from well

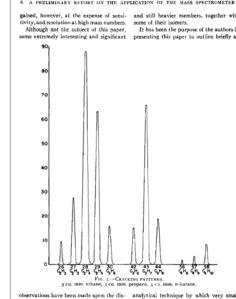
drilling operations would provide evidence for the existence of subsurface oil

Lawrence at Berkeley, to investigate possible instruments for the task

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

made on light hydrocarbons. Results were promising enough that Hoover, Jr. and Washburn presented their mass spectrometry data at a meeting of the American Institute of Mining and Metallurgical Engineers at New York in February of 1940. At the end of the paper, the authors stated,

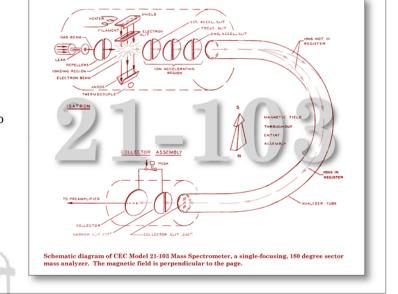
"No discussion of the geological significance of this work has been included. This aspect of the work is being carried forward actively on a purely experimental basis and will be reported upon later."



ervations have been made upon the dis-nand quantities of various hydro-bon and other gases in soil samples, said borehole cores. In the control of the control of the qualitative and quantitative determi-qualitative and quantitative determi-tion of the paraffin series, including thane, ethane, propane, butane, pentane.

21-101 Mass Spectrometer

The instrument was based on the 180° design of Dempster² 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.





A. J. Dempster describes 180° magnetic sector

Walker Bleakney describes electron ionization

H. C. Hoover, Jr. forms Consolidated Engineering Corporation (CEC)

1937

Harold Washburn joins CEC as Director

1938

in marketing capacity A. O. C. Nier describes

60° magnetic sector

improved 21-102

General Electric introduces the 60 magnetic sector

with building a mass spectrometer at Imperial Chemical Industries in Great Britain Atlas-Werke begins construction of 60°

Infortunately, 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" 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			E.F. Viley 1-19-46		
		Major Oil Records only				
	Showing the ref	imeries which o	are now using	the CEC MS		
		Call	Cornia			
Con	many	City	Crude oil	Cracked gas- oline capacity	277P+	
*0	eneral Petroleum	Terrence	65,000	6,000	80	
•2	ichfield Oil Corp.	Vateon	70,000	13,000	Омер	
*5	hell Oil Company	Vilmington	44,000	16,900	90	
	tendard Oil Company	11. Segundo	95,000	28,000	Comp.	
•s	tandard Oil Company	Richmond	132,000	19,000	Comp.	
. 2	exas Company	Vilmington	40,000	13,700	sc	
**	idewater Associated	Awon	60,900	48,500	Comp.	
th.	aion Oil Co.	Oleum	40,000	6,200	Comp.	
*0:	nion Oil Co.	Vilmington	60,000	10,000	SCA	
	Maye MS-6 Do not h	M-T0 HS-3				
		Illinoi	le.			
3 3	mell Oil Company	Yood River	85,000	79,000	SCLA	
70	exas Company	Lockport	50,000	18,000	SCLA	
	BATTO MS- 0 Do not	have MS- 2		-		
		Indian				
•s:	inclair Refining Co.	M. Chicago	55,000	14,000	Comp.	
•51	andard 011 Co.	Whiting	132,000	48,000	Comp.	
	*Have MS- 2 Do not	have NS- 0				

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

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 spectrometrist. 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**

> > 1963

Other Companies Enter the Market

Tt 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 **L** geometries. The GE mass spectrometer, introduced in 1945, had a 60° magnetic sector, similar to the design that Nier⁴ 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 frequency⁵ and ion resonance mass

The Westinghouse instrument was also introduced around 1945 and used a 90° magnetic sector which could be scanned. Only a dozen or so Westinghouse LV Mass Spectrometers were sold and they abandoned the business within a few years of instrument introduction.



Fred McLafferty (foreground) and Herb Woodcock at Dow Chemical Midland Michigan ca 1950



analyzers as commercial instruments.

FOR ANALYZING GASES BY SPECTROMETRY

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.

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.



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

CEC introduces fast scanning mass spectrometer with cycloidal



CEC is acquired by

1960



1961

Metropolitan Vickers MS8 mass spectrometer power of 13,500



1962

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



GE introduces monopole mass spectrom eter as a residual gas ASMS formed and AEI (formerly Metromeets jointly with politan Vickers)

introduces MS30 double-beam mass

AEI introduces MS50 mass spectrometer (improved version

1975

CEC is acquired by duPont

CEC is acquired by Con solidated Vacuum Cor-

1979

Fast Atom Bombardment (FAB) described

1981





1988

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