

most widely used
mass spectrometer
in the world



CEC's Type 21-103C is the world-standard for mass spectrometers. Over 90% of the API Catalog of Mass Spectra was obtained on this mass spectrometer. Used by virtually every major petroleum, petrochemical, and chemical testing laboratory, the 21-103C analyzes any substance having a significant vapor pressure at or below 350°C. It is the most versatile analytical instrument ever built—offers the greatest accuracy available (1%) and the highest reproducibility (0.1%). Mass range is from m/e 2 to m/e 700. Both a 5-trace recording oscillograph and a micromanometer are built in. While the mass spectrometer scans, data can be processed by a CEC Type 34-201 MASCOT Mass Spectrum Digitizer for direct computer introduction. For control analyses, exploratory analyses, purity determinations, research investigations and complex mixture analyses, the 21-103C is supreme. Ask for complete information from your nearby CEC sales and service office or write for CEC Bulletin 1800-X1.

CEC
Analytical & Control Division
CONSOLIDATED ELECTRODYNAMICS
PASADENA, CALIFORNIA • A SUBSIDIARY OF BELL & HOWELL
Circle No. 117 on Readers' Service Card
VOL. 34, NO. 6, MAY 1962 • 49 A

Reprinted with permission Analytical Chemistry

In J. J. Thomson's book, "Rays of Positive Electricity and Their Application to Chemical Analysis" written in 1913, he wrote "I have described at some length the application of Positive Rays to chemical analysis; one of the main reasons for writing this book was the hope that it might induce others, and especially chemists, to try this method of analysis. I feel sure that there are many problems in Chemistry which could be solved with far greater ease by this than by any other method." While this was clearly a prophetic vision, almost 30 years passed before it began to be fulfilled. Yes, there was a lot of mass spectrometry that occurred in the '20s and '30s, but it was almost exclusively devoted to the study of the isotopes of the elements, or exploiting isotopes as tracers in biological studies. With the exception of the work in the biological community in isotope ratio analysis, almost all of the other work was performed in the physics community. Chemists seemed little interested in Thomson's vision. With the introduction of Consolidated Engineering Corporation's 21-101 mass spectrometer delivered in December 1942 and installed in early 1943 at the Atlantic Refining Company in Philadelphia, the promise of mass spectrometry as an analytical tool for the chemist began to be fulfilled.



Consolidated Engineering Co., later Consolidated Electrodynamics Corp., was founded in 1937 by Herbert Hoover, Jr. as the engineering and manufacturing subsidiary of United Geophysical Co., a geophysical exploration company. Development of a mass spectrometer was started with the object of locating oil deposits by detection of hydrocarbon gases seeping from the ground. It was discovered that methane is ubiquitous in ground seepage gas, and that the detection of petroleum deposits by this method was impossible in the presence of methane. The commercial development of a mass spectrometer may have been abandoned except for the need to increase the speed of analysis of petroleum fractions in the distillation of aviation gas, then a critical commodity for the war effort.

The production of aviation gas required a lengthy eight hour distillation analysis to determine the light-end hydrocarbon content. It was thought that the analysis time could be very much shortened by mass spectrometric analysis, and CEC redirected instrument development to that application. After four years of work by five physicists under the direction of Harold Washburn, Director of Research at CEC, involving extensive developments in physics, electronics, and vacuum technology, the first 21-101 could scan a mass range from 16 to 72 daltons in 20 minutes and could be used to obtain a spectrum of a hydrocarbon gas mixture containing molecules with one to five carbon atoms.

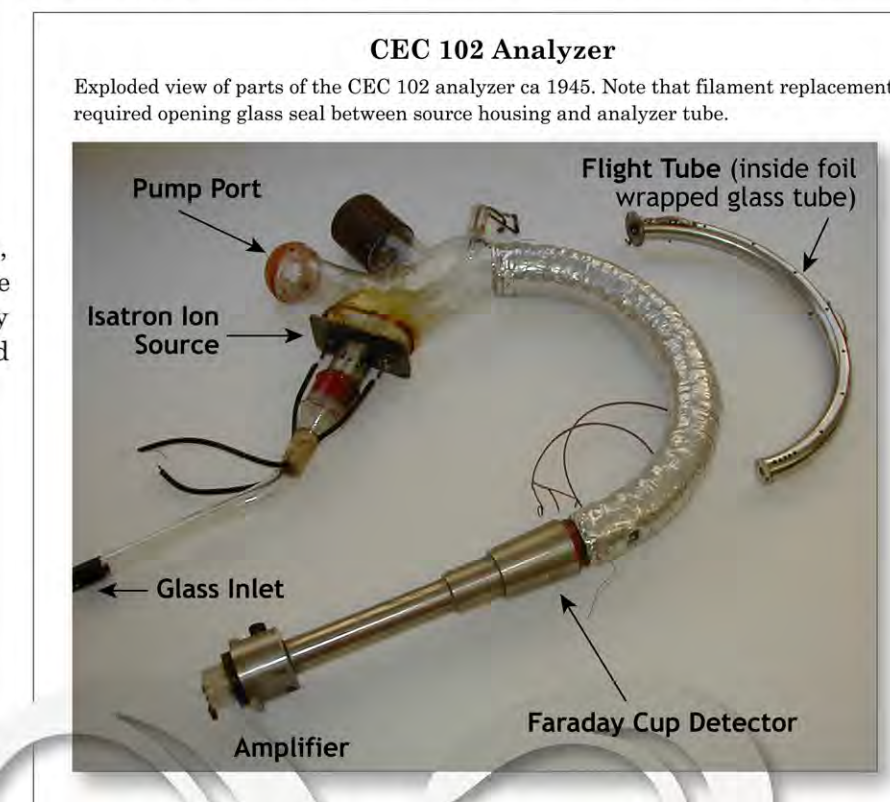
It was recognized that analysis of the spectrum for hydrocarbon composition, including isomer content, would require a complicated calculation involving simultaneous equations. A mathematician, Sibyl Rock, was brought into the group at CEC to develop a matrix analysis procedure. Complex samples required as much as two hours with the aid of a desk-calculator for complete analysis. Success of the mass spectrometer in the aviation gasoline application sparked interest among the other petroleum companies. They purchased subsequent instruments for petrochemical applications and in 1945 CEC marketed an improved instrument, the 21-102, correcting most of the problems, which were considerable, with the original instrument.

Not content with the performance of the 21-102, CEC continued research and development of the instrument under the direction of Clifford Berry and in 1950 introduced the 21-103, 21-103B and finally in 1953, the 21-103C. The 21-103 series of instruments were faster, more sensitive, and were designed to analyze more complex molecules, up to a maximum of 700 daltons compared to the 150 dalton mass range of the improved 21-101. The 21-103C dominated the mass spectrometer market in the U.S. until finally in 1963, CEC licensed foreign manufacturers to use the patents developed for the 21-100 series of instruments.

These instruments had a particularly long lifetime in the petrochemical industry. Since they were designed to perform quantitative analysis and 'sensitivity factors' for various hydrocarbons were recorded and monitored over periods of years, a database of sensitivity information of particular interest to the company was established. Replacing the CEC instrument with a newer one or an instrument from a different manufacturer meant re-establishing all those sensitivity factors and following them to ensure that the instrument was performing reproducibly. Further, most other manufacturers were not as interested in producing an instrument for quantitative analysis.

Consequently, the CEC 103C series of instruments would be working day in and day out for decades after the accountants had depreciated the asset. Typical is the instrument that Exxon Corporation placed in service in 1955 and decommissioned in 1996 when it was donated to the Chemical Heritage Foundation. From its introduction in 1942 until the last model 21-104 in 1970, over 200 instruments based on this Dempster, single focusing, 180° design were sold.

Dr Sam Hsu of Exxon was instrumental in the donation of this instrument to the Chemical Heritage Foundation. Thanks also to the Exxon Corporation for donating funds for shipping the instrument to CHF.



CEC 100 HISTORY

1937

Herbert Hoover, Jr. forms United Geophysical Corporation with Consolidated Engineering Corporation (CEC) as a wholly owned subsidiary to develop instruments for petroleum prospecting.

1938

Harold Washburn hired in 1938 as Vice-President for Research at CEC. Four physicists from California Institute of Technology join him in the Research Department to develop a mass spectrometer for commercial sale.

1942

First commercial CEC instrument, 21-101 delivered.

1947

CEC becomes a publicly held corporation. Mr Hoover disposes of his interest in the corporation.

1949

Harold Wiley takes over as manager of the Chemical Instruments Department of CEC which is organization that produces mass spectrometers and related accessories.

1950

21-103 mass spectrometer introduced.
Liquid introduction inlet introduced.
Capacitance micromanometer used for measuring pressure in sample inlet system.

1954

21-103C mass spectrometer introduced.
Heated batch inlet introduced.
Metastable ion suppression offered as an option.
Switchable collector slits offered as an option.

1955

Name changed to Consolidated Electrodynamics Corporation because some states required that a service engineer for an engineering company be a licensed engineer in that state.

1958

Mascot Digitizer introduced for real-time conversion of analog output to mass number and peak height.

1959

Chemical Instruments Department becomes the Analytical and Control Division with Harold Wiley as General Manager.

1960

CEC Corporation becomes a subsidiary of Bell and Howell Corporation.
Low electron energy ionizing voltage and total ionization accessories introduced.

1964

Wien filter/electron multiplier detector introduced.

1965

21-104 mass spectrometer introduced.
Direct introduction probe for solid samples.
Direct GC inlet to ion source.
Micrometer adjustable collector slit.
UV oscillographic recorder replaces photographic oscillographic recorder.

1968

CEC Corporation dissolved and becomes the Electronics Instrument Group of Bell and Howell.

1975

Analytical Instruments Division of Bell and Howell sold to the Instrument Division of duPont.