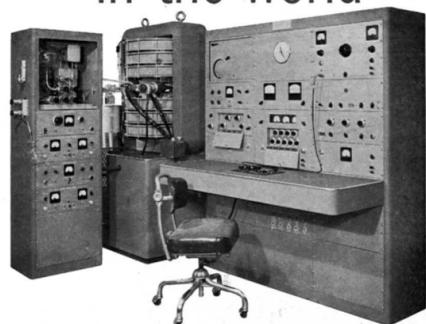


Consolidated Electrodynamics Corporation CEC 100 Series Mass Spectrometers

Charles Judson, University of Kansas
American Society for Mass Spectrometry

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.

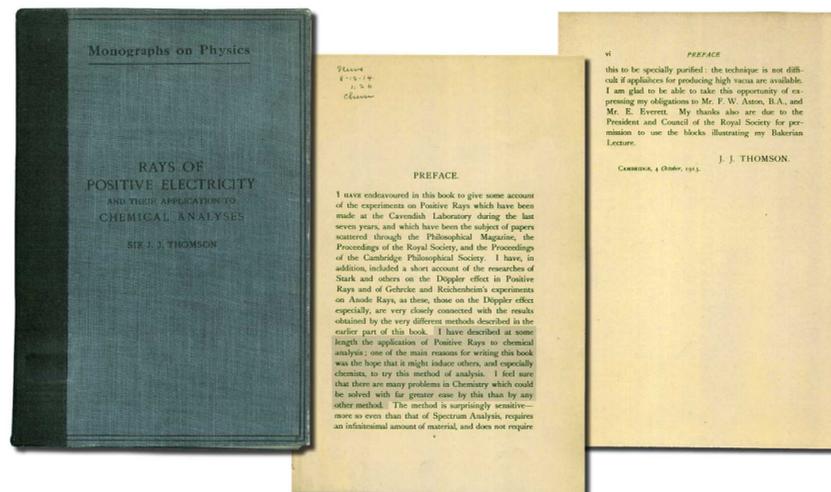
CEC
Analytical & Control Division
CONSOLIDATED ELECTRODYNAMICS
PASADENA, CALIFORNIA • A SUBSIDIARY OF BELL & HOWELL
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In J. J. Thomson's book, "Rays of Positive Electricity and Their Application to Chemical Analysis" written in 1913, he wrote "I have 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.

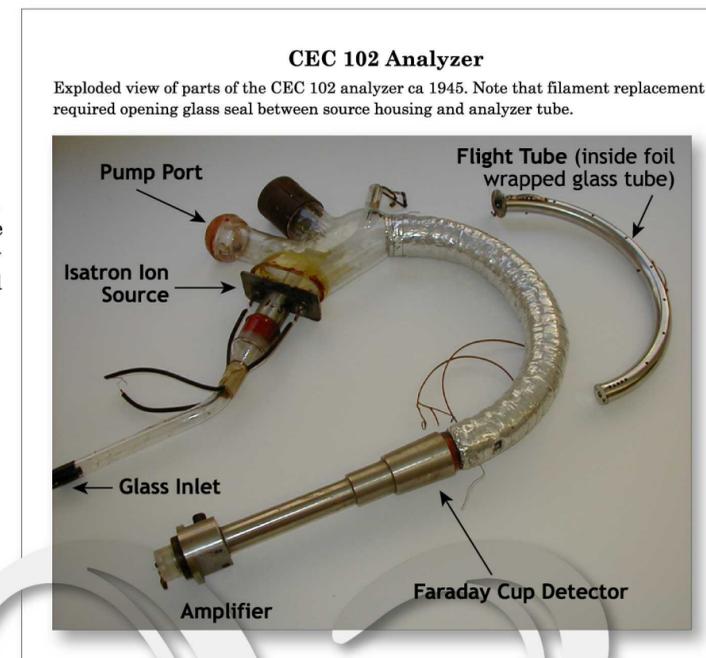


It was recognized that analysis of the spectrum for hydrocarbon composition, including isomer content, would require a complicated calculation involving simultaneous equations. A mathematician, Sibyl Rock, was brought into the group at CEC to develop a matrix analysis procedure. Complex samples required 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 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.

The instrument seen here is on loan from the Chemical Heritage Foundation (CHF) and is without the magnet and analyzer. This part of the instrument weighs about 6000 pounds and it was not feasible to handle an item this massive at the time it was acquired by CHF. It was placed in service in 1955 at Atlantic Refining Company and retired in 1996 from Exxon at which time it was donated to CHF. It was used extensively in the development of hydrocarbon type analyses of petroleum fractions from gases to middle distillates. One of the early pioneers of mass spectrometry, Ralph Brown, used this instrument while at Atlantic Refining

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. Thank you to the Exxon Corporation for donating funds for shipping the instrument to CHF.

CEC 100 HISTORY 1937 1938 1942 1945 1947 1950 1954 1955 1958 1959 1960 1964 1965 1968 1975

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

Harold Washburn hired in 1938 as Vice-President for Research of CEC. Four physicists from California Institute of Technology join him in the Research

First commercial CEC instrument, 21-101 delivered.

CEC becomes a publicly held corporation. Mr Hoover disposes of his interest in the corporation.
21-102 mass spectrometer introduced.
Off-House Analytical Corporation for petrochemical

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

21-103 mass spectrometer introduced.
Liquid introduction inlet introduced.
Special mass spectrometers

21-103C mass spectrometer introduced.
Heated batch inlet introduced.
Miscellaneous ion spectrometers

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

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

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

CEC Corporation becomes a subsidiary of Bell and Howell Corporation.

Wien filter/electron multiplier detector introduced.

21-104 mass spectrometer introduced.
Direct introduction probe for solid samples.
Direct GC inlet to ion source.

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

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