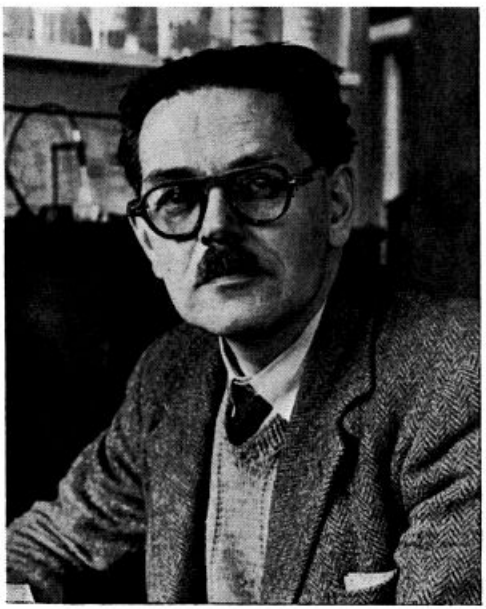
A. J. P. MARTIN AND A. T. JAMES AND THE DEVELOPMENT OF GAS CHROMATOGRAPHY

STANFORD MOORE*

The following is a Condensation of the introductory remarks given at the meeting of the Society of Cosmetic Chemists, New York City, May 10th, 1957.

YOUR Award Committee has chosen to honour to-day two scholars who have made a brilliant contribution to chemistry. The method of gas-liquid chromatography which A. J. P. Martin and A. T. James have introduced has increased the tempo of research and practice in a whole area of analytical chemistry. And they have done this by a combination of talents—of ingenuity plus practical know-how—which can be an inspiration to all of us—certainly it has been to me.

A. J. P. Martin is a born experimenter. I have heard that as a boy of eight he was already experimenting in his basement with distillation apparatus. From then on he has had a great love for making things mechanical,



Dr. Archer John Porter Martin—Nobel Laureate in chemistry and winner of the Society of Cosmetic Chemists Special Award for outstanding scientific literature. Dr. Martin and his co-author, Dr. A. T. James, are being honoured for their publications on gas chromatography.

* The Rockefeller Institute for Medical Research, New York City.

both at home and in the laboratory. He went to school in London, and thence to the University of Cambridge for both his baccalaureate and Ph.D. degrees. Somewhere during this period his natural bent for mathematics and physical chemistry developed. He majored in biochemistry, and he is also an expert and imaginative theoriser. In fact, one of the remarkable things about Martin is that he is so gifted in thinking in theoretical terms and at the same time he is so skilful in the shop and the laboratory.

In summarising the research which has led to the award to-day, and in turning to the career of A. T. James, I need to take you back briefly before the year 1949, when the collaboration of James and Martin began, and speak of the campus of the University of Cambridge in the late 1930's. At that time two graduate students on the campus happened to pool their resources to solve a common problem. A. J. P. Martin and R. L. M. Synge joined efforts on a project concerned with the separation of acetyl-amino acids by liquid-liquid extraction. After graduation, they both went together to take their first jobs with the British Wool Industries Research Laboratory in Leeds, and continued their collaboration there. In the course of several very fruitful years they hit upon the idea of carrying out liquid-liquid extraction using a gel to support one of the phases. They thus introduced chromatographic columns in which fractionation could be achieved by virtue of the different distribution coefficients of solutes between a mobile phase and a stationary liquid or gel-like phase. When the support for the stationary phase was cellulose in the form of sheets of paper, the ingenious method of paper chromatography was born, and I think that you all know that within a few years the method of paper chromatography described by Consden, Gordon and Martin became the most widely used separation technique in biochemistry. Adsorption chromatography had been widely used before for the separation of pigments and sterols, but Martin and Synge's concept of liquid-liquid chromatography rendered the chromatographic technique available for the separation of a host of water-soluble amino-acids, sugars, lower fatty acids, antibiotics, and other compounds of particular interest in biochemistry and medicine. Within remarkably few years the technique received the recognition which it well deserved when Martin and Synge were awarded the Nobel Prize in 1952.

But there was more to come. In Martin and Synge's initial papers in about 1940 they suggested that, in addition to using two liquid phases, a chromatogram could be operated with a *gas phase* and a liquid phase, and that this arrangement would have advantages for the separation of volatile compounds.

In the meantime, there were changes in jobs and interests, and this aspect of the subject did not receive attention immediately. Martin moved from Leeds to a position with the Boots Pure Drug Co., and Synge to the Lister Institute in London. Martin then moved to the Lister at about the

time that Synge moved on to an interesting post at the Rowett Research Institute in Aberdeen in northern Scotland, where he is now.

Dr. Anthony Trafford James—recipient of the Society of Cosmetic Chemists Specia Award for outstanding scientific literature. Dr. James and Nobel prize winner A. J. P. Martin share the 1957 Award in recognition of their publications on gas chromatography.

It was at the Lister Institute that A. T. James started out as an associate with Synge and then with Martin. James was born in Cardiff in South Wales, and moved to London with his family when he was a small boy. His schooling led him to University College, London, where he obtained the B.Sc. and Ph.D. degrees in Physical Organic Chemistry with Professors Ingold and Hughes. In England one of the honours open to a promising young scholar is the winning of a Beit Memorial Fellowship, which James did for the purpose of pursuing post-doctoral research at the Lister. And when Martin moved to England's large National Institute for Medical Research at Mill Hill, just on the outskirts of London, James went with him as his principal colleague. With this combination and this research atmosphere, plus a lot of ingenious but hard work, gas-liquid chromatography was converted from a ten-year-old idea of Martin and Synge's to a reality. Martin and James can tell you what gas-liquid chromatography is far better than I —but your Chairman has asked me by way of introduction to describe the discovery in general terms, and Martin and James can correct me or expand the description.

We are all familiar with the extraction of organic compounds from aqueous solution by ether. Gas-liquid chromatography operates on the principle of repeated extractions in which the two phases are a gas and a liquid instead of two liquids. A tube is packed with particles of an absorbent solid which holds a high boiling liquid as the stationary phase. For example, a sample of hydrocarbons to be separated is introduced at one end in vaporised form in a stream of nitrogen. The individual hydrocarbons are extracted from the gas phase in differing proportions depending upon their individual distribution coefficients between the two phases. The rates of travel of the constituents of the mixture down the tube are a function of these distribution coefficients. A spatial separation of the components is thus achieved as in other forms of chromatography, and the individual compounds are detected by measuring devices placed across the stream of nitrogen emerging from the delivery end of the tube. A key part of the equipment is the measuring device, and Martin and James have invented a gas-density balance that is more sensitive than any of the hot-wire analysers which, however, serve many commercial purposes. The speed of the method is remarkable. Many analyses of complex mixtures are complete in 30 minutes.

In this manner volatile compounds can be separated far more effectively than by simple fractional distillation, and gas-liquid chromatography is rendering obsolete, for many analytical purposes, the method of fractional distillation which we learned in school.

If you pick up a current copy of almost any journal of analytical chemistry you will find advertisements of machines for gas chromatography by the method of Martin and James. One of the largest markets is, of course, in the petroleum industry, where the method has revolutionised the analysis of gasoline and other hydrocarbon fuels. Martin and James worked the procedure out first for amines and for the esters of fatty acids, which are examples of only two of the many types of organic compounds that can be handled. Many of these are of biochemical importance, and it is in part the interest in the determination of organic acids in and on the skin that has attracted the interest of your Society in this method, together with the application to the analysis and preparation of perfumes.

Dr. James, as a member of the staff of the National Institute for Medical Research in London, is currently visiting the Rockefeller Institute here in New York. He came over at the special invitation of Dr. E. H. Ahrens, Jr., to set up the method for the study of fatty acids in human metabolism. He brought over equipment which Martin himself had made in London, and James has us watching in admiration as the automatic recorder runs off beautiful analyses in a matter of minutes.

Martin flew over yesterday for this occasion at your invitation. He is now a free-lance consultant who has a laboratory and shop set up as a part of his house near London. At the age of eight he was making things in his

basement—in his forties he is *still* making things in his basement, but with a remarkable career of accomplishment behind him, with a host of friends among his contemporaries, and he is still full of new ideas.

This, then, is a brief history of the men who I am very happy to see you honouring to-day—Dr. Archer Martin and Dr. Anthony James.

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The President of the Society of Cosmetic Chemists, Sabbat J. Strianse, in presenting the awards (see illustration), made the following citation :

"ARCHER JOHN PORTER MARTIN and ANTHONY TRAFFORD JAMES, in recognition and appreciation of your pioneering in the field of analytical chemistry, which resulted in the development of gas-liquid partition chromatography, a contribution which has opened new avenues of approach to the problems which are common to the cosmetic research worker and analyst . . .

"and in special recognition of the papers that you both have published to make this new tool available to all chemical workers . . .

"I hereby present you, on behalf of the members of the Society of Cosmetic Chemists, with these scrolls and these cheques awarded by the Society to reward and stimulate the publication of significant research work."

Dr. A. J. P. Martin replied as follows :

Mr. President, Dr. Moore, Members of the Society of Cosmetic Chemists, Ladies and Gentlemen :

I hope I can convey to you the pleasure and gratitude I feel in accepting the Special Award of the Society for 1957.

Nothing was further from our thoughts than the Society of Cosmetic Chemists when Dr. James and I began our work on Gas-Liquid Chromatography in 1950. Synge and I had suggested the method in 1941 in our first publication on partition chromatography, and I was surprised that no one had taken it up as I was confident that it would work. I had myself had no occasion to work with volatile substances. In fact, it took James and myself no more than six weeks to establish the basic conditions and obtain practically valuable results with fatty acids and amines.

We know the method is now of value to many fields of chemistry but we are grateful to the Society for this first public recognition.

Reply by Dr. A. T. James :

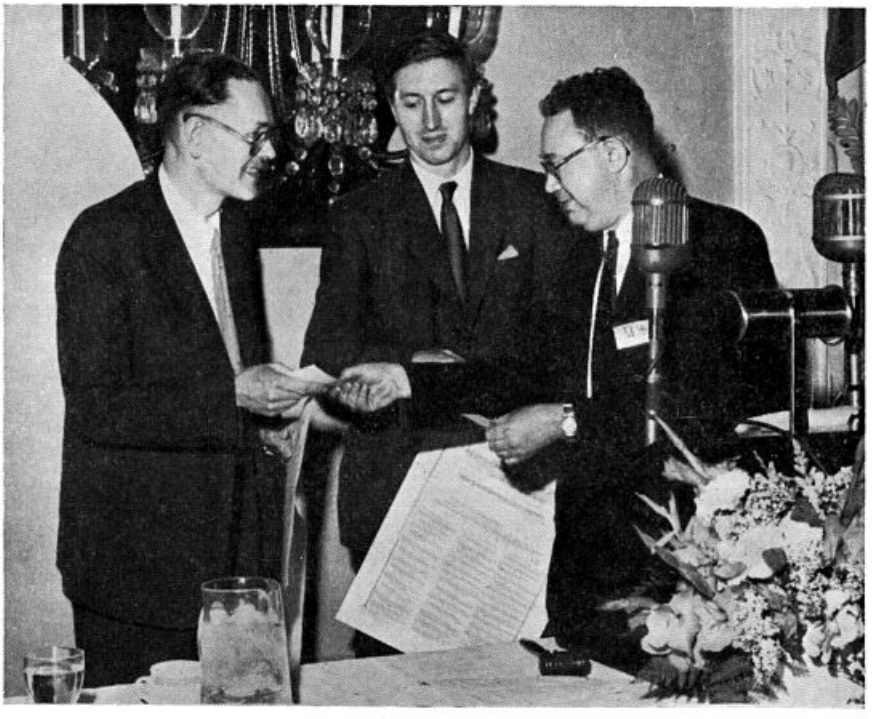
Mr. President, ladies and gentlemen, I am deeply conscious of the honour you have conferred upon me to-day and I wish to thank you for this munificent award. At first, I must confess, I was puzzled at the uses gas chromatography could be put to in the cosmetic industry but after some discussion

with members of your association I have learned a great deal. I myself have had little or no direct experience with cosmetics, but my experiences at second-hand have been more numerous and usually such that I can heartily recommend your products.

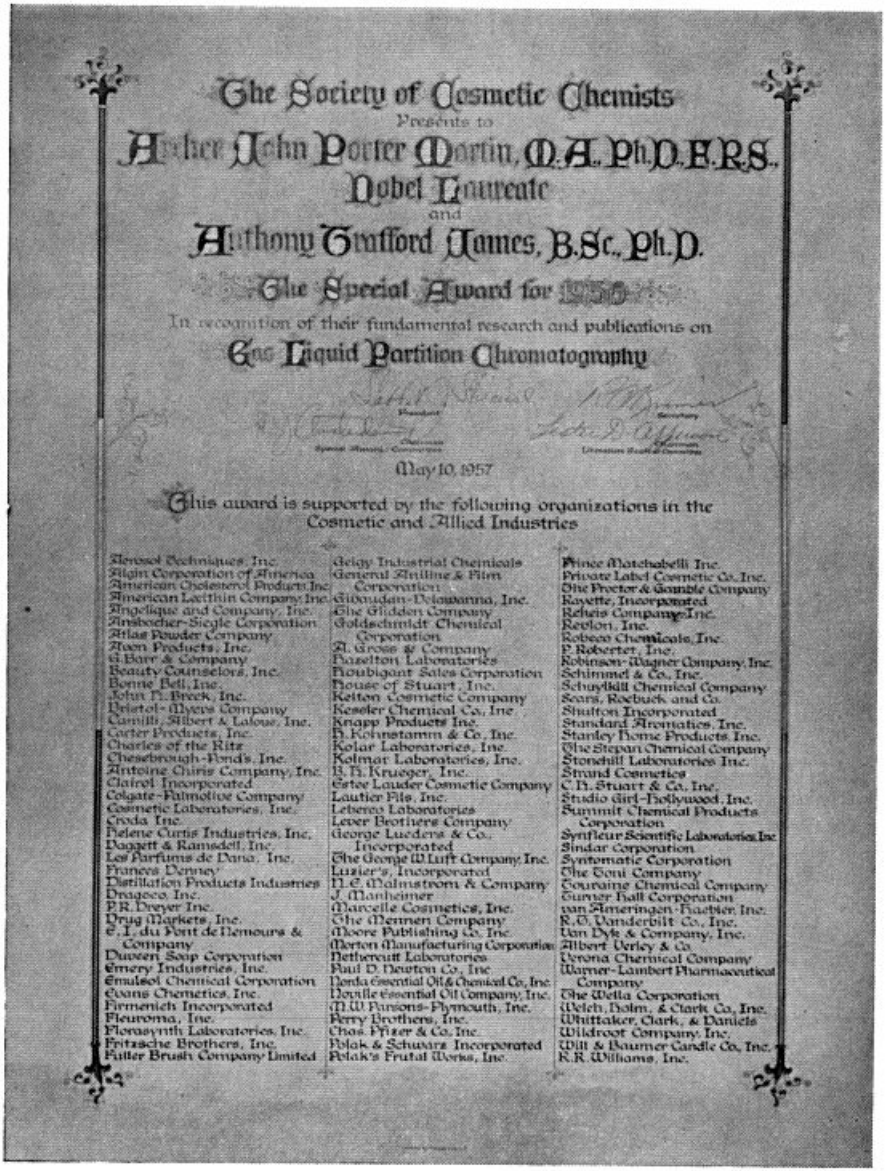
I think it is likely that your industry will be the first to use the gas chromatogram as a production tool for I have been told that 100 gm. of a pure perfumery substance isolated from a natural product is sufficient to make a great deal of perfume. Certainly production on this scale is easily attainable with the gas chromatogram.

I should also like to thank Dr. Stanford Moore for his most kind remarks, the more particularly since he is an exponent of chromatographic technique of international repute.

In conclusion I wish to express my most sincere thanks to you, Mr. President, the committee and the Association not only for this award but also for your hospitality and great kindness. Thank you.



Nobel Prize winner Dr. A. J. P. Martin (left) and his co-author, Dr. A. T. James (centre), accept the Third Annual Special Award of the Society of Cosmetic Chemists from Society President Sabbat J. Strianse (right). The distinguished British team shared the $1,000 prize for their basic contribution to cosmetic science—gas-liquid partition chromatography. They were honoured at a luncheon at the Hotel Commodore in New York, part of the Society's semi-annual scientific meeting in May.



The Society of Cosmetic Chemists

Presents to

Archer John Porter Martin, M.A. Ph.D. F.R.S.

Nobel Laureate

and

Anthony Trafford James, B.Sc., Ph.D.

The Special Award for 1956

In recognition of their fundamental research and publications on

Gas Liquid Partition Chromatography

May 10, 1957

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