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CHARLES EDWARD KENNETH MEES

1882—1960

A Biographical Memoir by

HANS T. CLARKE

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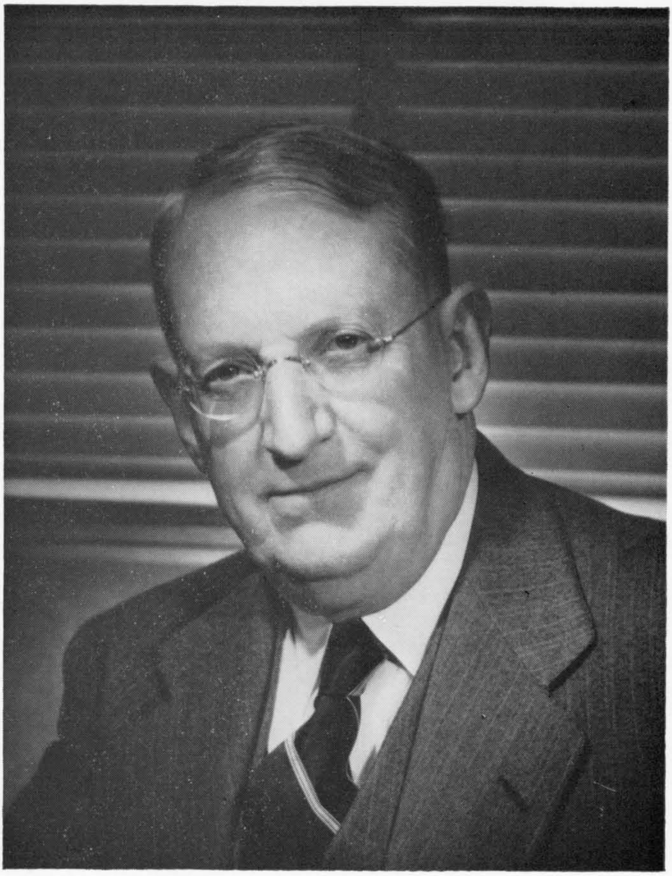
Biographical Memoir



C. E. Kenneth Mees

CHARLES EDWARD KENNETH MEES

May 26, 1882–August 15, 1960

BY HANS T. CLARKE

PRIOR TO THE INTRODUCTION of commercial photographic dry plates in 1877, and for many years thereafter, little attention was devoted to the nature of the photographic process. Abney had in 1874 studied the quantitative relationships between exposure to light, development, and the deposition of metallic silver from its bromide, but scant notice was taken of his findings. The significant contributions to the theory of photography made by Hurter and Driffield in 1890 were likewise long neglected. It was well into the present century when C. E. K. Mees and his school friend S. E. Sheppard revived the subject in a fruitful association, ended only by death, dedicated to research and development in the whole field.

Kenneth Mees was born in England on May 26, 1882, at Wellingborough, Northamptonshire. His father was a Wesleyan minister descended from a long line of clergymen of that denomination. As clerics of that church were customarily transferred to other pastorates every three years, the child's early development lacked firm roots outside his immediate family. By the time he was ten he had lived successively in Ipswich, Colchester, Hythe, and Barnet. He first went to school at the age of seven, having been taught the elementary subjects by his parents, and having already become an avid reader, largely of the religious and historical works available in his father's library.

In his privately printed personal memoir, "Myself and My Journey down the River of Time," he describes his early schooling as "little bits of history, little bits of grammar and English, a little arithmetic and, as was usual in England at that time, quite a little Latin grammar." It is clear that he did not enjoy this fare; he apparently had difficulty with classwork, and not until he was ten was it discovered that he was short-sighted. At the school which he attended at that age he was for the first time exposed to chemistry, and although it was badly taught it gave him a new and exciting experience, namely, the demonstration of a chemical experiment. This was the preparation of chlorine, which he was allowed to repeat with his own hands. The effect upon him was described in his own words: "By that time I had fallen in love, completely in love, with science. This was different from all the other stuff; it was about real things—things that you could touch and handle, that you could measure. I began to see at once, it seemed to me, what a marvelous thing science was."

Mees then went to Kingswood, a school established by John Wesley for the sons of Wesleyan ministers. It believed in classics and mathematics but did not really approve of natural science. It nevertheless had a laboratory and Mees persuaded the science master to give him the key to it in return for keeping it clean. Here he spent all his spare time, instead of in athletic activities for which he was physically and temperamentally ill adapted. He tells us: "This science became to me a sort of religion. I was brought up in a religious atmosphere; my father was a minister, my school was a religious school, I had lots of training in the Bible, and I am bound to say that I classified most of the Bible with the Latin grammar as a thing that had little relation to fact. But at the same time I saw a purpose in being on earth, and that was to increase knowledge."

Not content with this extracurricular laboratory experience, which far exceeded that afforded to his schoolfellows, Mees organized a laboratory in his home, where during the vacations he could pursue his passion for chemistry by experimentation as well as by reading.

At Kingswood the food was poor and the boy suffered from dyspepsia, soon complicated by rheumatism which he found (although this was before the days of pH) could be relieved by hot baths in dilute sodium hydroxide, whereas sodium carbonate was ineffective. In view of his condition his father transferred him, at the age of fifteen, to Harrogate College, a private school where the food was better and the rooms were warmer. Here his health improved; and though the instruction was inferior, the training that he had acquired at Kingswood and at home enabled him to pass without difficulty, in June 1898, the matriculation examination of the University of London. The family then moved to Croydon, Mees's father having been appointed chaplain of the Guards' depot at nearby Caterham. This made it convenient for the lad to attend St. Dunstan's College in Catford, a technical school for senior boys, as a day student. Here he continued his studies in the physical sciences and engineering. At the suggestion of the headmaster, C. M. Stuart, a chemist who had studied under Fittig, Mees undertook a study of the preparation of o-fluorobenzalmalonic acid. Since his adviser could spare practically no time for supervision of this work, Mees was compelled to struggle by himself. As a result of this experience, and probably also of his contempt for empiricism, many years passed before he could regard the practice of organic chemistry with patience, let alone sympathy.

At St. Dunstan's Mees met S. E. Sheppard, who had entered the school at the same time. The two young men, both gifted and academically unorthodox, naturally gravitated together, and after two years, in 1900, they applied for admission to University College, London, as prospective candidates for the baccalaureate of science with a major interest in chemistry. As in the opinion of Sir William Ramsay, the professor of chemistry, they had already completed all of the routine elementary laboratory work prescribed for the degree, it was decided that they be permitted ultimately to apply for the B.Sc. by research. They were apparently the first, and probably the the last, students of the University of London to graduate under this system.

Mees, with the support of a special scholarship, was put to work under the spectroscopist E. C. C. Baly, who assigned him the task of photographing the spectrum of the iron arc with a ten-foot Rowland grating. This was his introduction to scientific photography. In order to register the lines of low frequency the plates were sensitized by bathing them in Alizarin Blue. Of his efforts in this direction Mees writes: "Looking back on the results, I can only conclude I wasn't very good at sensitizing plates, and in view of my interest ever since in optical sensitizing it's curious how bad the plates were."

Though much of his time during the first year at University College was devoted to classwork in chemistry and physics, Mees had frequent contact with Ramsay, who had completed the isolation of the "noble" gases of the atmosphere and had turned to an investigation of radium emanation. Under Ramsay's leadership the department was highly active in research in various fields of chemistry and was an ideal place for a student eager to spend all his time in the laboratory, an ambition warmly encouraged by Ramsay, who strongly advocated the granting of degrees by research.

While at St. Dunstan's Sheppard and Mees had, as a result of having adopted photographic methods of recording details of apparatus in their school and home laboratories, developed an interest in the theory of the photographic process. The books on the subject ignored the physicochemical principles recognized at that time, and the only cogent contribution relating to photography in the scientific literature was that, referred to above, published by Hurter and Driffield in 1890. With Ramsay's approval the two students embarked on a repetition of that work with improved apparatus and the application of currently available methods of physical chemistry. They constructed a sensitometer consisting of an exposure machine with a calibrated rotating sector, an acetylene standard light source, and a Hüfner spectrophotometer for the measurement of optical density. With this they measured the intensity of the images produced on development after varied exposure to light and also the rate of development under standard conditions. The results of two years of work were accepted by the University for both candidates as theses for the B.Sc. degree, granted in 1903. Mees's subsequent appraisal of the investigation is characteristic of his lifelong objectivity: "Actually, of course, the research done up to this time was of very poor quality. It was really only an orientation of the field, but the work we had done in two years was sufficient to show us that much work could be done, and we felt that by then we knew how to do it. Again, we both suffered and gained by the fact that nobody around us knew anything about the subject and that we had to work out all of it. The general opinion at University College was probably that we were extremely eccentric and rather undesirable students."

Although eager to embark on an independent career, on the advice of his father and probably also of Ramsay, he continued his researches (in collaboration with Sheppard) with the aim of ultimately graduating with a Doctor of Science degree. Ramsay's laboratories, situated in the basement under the Slade School of Art, were incapable of housing the new, more efficient, and presumably bulky apparatus required for the program. An unusual measure was accordingly adopted: the two candidates were permitted to carry on their investigations in their own homes and the only supervision they were to have was to consist of annual visits to their laboratories by Sir William Ramsay. The parents of both men fortunately possessed adequate means for the equipment of a physics laboratory for Mees and a chemical laboratory for Sheppard. Mees installed a Hüfner photometer, especially constructed for him by Adam Hilger Ltd., and a sensitometer designed and built by himself, as well as efficient, thermostatically controlled apparatus for photographic development.

For the next three years the collaboration continued in the separate laboratories, the principal subjects being: repetition and amplification of the experiments of Hurter and Driffield; the kinetics of photographic development; the structure of the developed image; the chemical nature of the latent image; extension of the color-sensitivity of photographic emulsions into regions of longer wave-length; the theory of photographic fixation. The work involved elaboration of the methods of sensitometry which thereafter remained for many years as established standards. The results, published in a series of eleven papers in the *British Journal of Photography,* were incorporated into doctoral dissertations and into a treatise entitled *Investigations on the Theory of the Photographic Process,* published in 1907 by Longmans, Green & Co.

On the completion of their academic work Sheppard and Mees were recommended by University College to the 1851 Exhibition Fellowship Board for a research scholarship. This was granted, but as only one was available decision as to the recipient was made (rumor had it) by tossing a coin. In any case, the scholarship went to Sheppard, who spent the ensuing two years in advanced study and research in the universities of Marburg and Paris. The interruption—fortunately only temporary—of the collaboration presented Mees with the problem of how to earn a living.

He had until then planned to become a schoolteacher of science, but on the advice of Ramsay he decided to enter the field of industrial research. After some fruitless attempts to secure a post in an appropriate major concern he approached his friend S. H. Wratten, the manager of Wratten and Wainwright, a small firm engaged in the manufacture of photographic dry plates. Here is his account of his entry into this firm: "Instead of a job they offered to incorporate into a company and give me a share of the business for a small sum and at the same time make me a joint managing director with Wratten. I think it was a most extraordinarily generous thing to do to a youngster who wanted a job; I have never heard of it being done by anybody else."

His first assignment was to sensitize some plates by bathing them with the new isocyanine dyes made in Germany. Having had experience in the bathing of plates he knew that this procedure gave unsatisfactory results and suggested as an alternative that the emulsion be treated prior to being coated. The steps for this procedure had to be made in total darkness, but they went well and the method gave perfect results. After some further experimentation the "Wratten Panchromatic Plates," based on similar principles, were elaborated. As they were sensitive to the entire visible spectrum they made possible the adequate photographic reproduction of paintings, provided the appropriate color filters were used. To meet these needs, the Wratten filters, consisting of gelatin films containing dyes, were developed. Permanent forms of these filters were made by cementing the films between glass plates.

Mees had a very small budget for advertising, so he put most of it into booklets containing factual information about his firm's products. These proved so valuable to customers that before long he sold them at a price which paid for their production. The principle that such information constituted the most profitable form of advertisement for technical products remained permanently a cardinal tenet of his creed.

As time went on, Mees's efforts were increasingly devoted to management of the firm's business; he nevertheless continued his researches—mainly technological—but only in the evenings and on weekends. He devised a practical wedge spectrograph, convenient for the rapid estimation of density in absorption spectra when high precision was unnecessary, and a system for the determination of photographic resolving power, thereby contributing to the techniques of three-color photography. He also investigated the potentialities of many dyes produced in Germany for their use in color filters; the results of this study were embodied in 1909 in a publication entitled *An Atlas of Absorption Spectra.*

As an outcome of the pioneer technological researches a new type of photographic plate, called "Process Panchromatic," was produced. This had a higher resolving power than the original Panchromatic plates in relation to their speed and proved of value not only in commercial photography and photoengraving but in spectroscopy and astronomy. Mees consequently formed many contacts with workers in these fields, whom he was able to help by supervising the preparation of materials specially required for scientific purposes.

At the end of two years the company had put out a long line of new products and its business had increased by over 30 percent. However, it was making practically no profit. Mees therefore studied cost accounting at night, and before long a profitable basis had been established as a result of his studies. By 1911 the business of the company had quadrupled and it was earning a net profit of 25 percent on its capital.

By now a recognized authority in industrial research, Mees became a consultant to various groups, not only in the field of photography but in others as well. In 1909 he visited the United States to assist the American Bank Note Company on problems relative to counterfeiting by photography; in 1910 he advised the Cotton Powder Company of Faversham concerning the stability of nitrocellulose; in 1911 Nobel's Explosives Company employed his consulting services in connection with cordite. At Nobel's he learned much from W. Rintoul, its research director, about the organization of industrial research. A year later he was told by Willis Whitney, the research director of the General Electric Company, that organization should be avoided as far as possible and that research men should be allowed to run their laboratories with a minimum of interference.

While in the United States in 1909 Mees visited George Eastman in Rochester and was shown the Kodak Park works. Early in 1912 he was paid a return visit by Mr. Eastman, to whom he showed the Wratten plant and his small laboratory. The next day Mr. Eastman invited him to set up and direct a research laboratory for Kodak in Rochester. This invitation was accepted on the condition, immediately agreed to, that Kodak should buy Wratten and Wainwright. The terms were arranged without difficulty, and in April of the same year Mees settled in Rochester, immediately planned a laboratory building, and began assembling a staff of leaders in the various scientific and technological disciplines. The staff included P. G. Nutting (Physics) from the U.S. Bureau of Standards; S. E. Sheppard (Physical Chemistry); A. S. McDaniel (Inorganic and Analytical Chemistry) from the Bureau of Standards; J. G. Capstaff (Photography) from Wratten and Wainwright. The first three of the divisions named were at the outset without specifically assigned projects; the photographic division was planned to undertake the development of motion picture technology and color photography. The Research Laboratory also included small manufacturing divisions for the production of photographic plates and color filters which could be marketed under the Wratten name until their sales became large enough to justify their inclusion in the list of Eastman Kodak products. The building was completed and staffed by the end of the year. At first no division of organic chemistry was set up, an omission which Mees later ascribed to his obsession with physical chemistry.

Whitney's advice with regard to the autonomy of the divisional leaders was scrupulously followed and indeed amplified. Recognizing that these men would probably be inclined to devote their chief efforts to assisting the development of technical projects, Mees counseled them not to neglect the exploration of attractive problems of purely theoretical interest that might turn up, even though such work should appear to have no direct bearing on industrial needs. This enlightened policy was based partly on his opinion that scientific specialists can keep their tools sharp only by the constant stimulation of theory and partly on his expectation, confirmed by events in the General Electric research laboratory, that by-products of "pure" research may find valuable industrial applications.

A striking example of the effectiveness of this principle occurred some years later when Kenneth Hickman, a young physical chemist from London, was assigned the task of devising a procedure for the estimation of residual solvents and moisture in photographic film base. This led into the field of manometry, and with the availability of Langmuir's diffusion pumps it branched out into studies of molecular distillation. These in turn resulted in procedures for the isolation of vitamins from natural oils now operated by the interesting subsidiary company Distillation Products Industries.

The scientific work of the laboratory was reviewed in weekly conferences presided over by Mees and attended by the divisional leaders with their associates; at these the individual sections of the work were discussed in detail by the specialists and freely criticized by their colleagues. This system provided a constantly renewed structure for the planning of future work.

During the first few years the laboratory was financed on a day-to-day basis of need, approval of expenditures being obtained from the top management of the company, and only at the end of World War I was financial stability provided by an annual budget.

In the original negotiations Mees was accorded permission to publish results of the scientific work of the laboratory, ratification to be given by Mr. Eastman personally and not by any of the other divisions of the company such as the Legal, Patent, or Sales departments. The reason he gave for this was his apprehension that "they will all be afraid that a paper they don't understand will do harm and then will say No." This system has been entirely successful. All papers have been given communication numbers, and by 1956, when Mees retired, these had reached nearly 2000. At the end of each year a volume of abridged communications was published; that for 1960 is numbered 37. In 1915 a monthly abstract bulletin was organized to cover the results of researches of photographic interest published from other laboratories. A few years later a series of six monographs on the theory of photography began to appear.

When the laboratory was built, an excellent scientific library was installed and it has since grown continually. Systematic research began early in 1913 with a staff of about twenty, working mainly on the theory of the photographic process. In 1914 Mees elaborated a method of making emulsions suitable for X-ray photography; this was first applied to the production of plates and later of films.

In 1914 he recognized the advisability of incorporating into the research organization a division of organic chemical research. After some delay this was effected, in time for the new group to undertake the experimental manufacture (starting with the nitration of benzene, the only raw material then available in the United States) of the photographic developing agents hydroquinone and p-methylaminophenol, the importation of which from Germany had been cut off by the outbreak of war. Before long the work of the organic chemists was extended to the preparation of dyes needed for experiments in color photography and the manufacture of color filters. At the end of the war the organic laboratory began to supply the company's needs for photographic sensitizers of the isocyanine and related types, one of which, previously unknown, made possible a considerable extension of sensitivity into the spectral region of long wave-length. Later, this search for new sensitizers was continued more intensively and in separate laboratories by Leslie Brooker in Kodak Park and Frances Hamer of Kodak Ltd. in England, both of whom concentrated their attention on analogous dyes derived from benzothiazole. A technique for the evaluation of these was developed by Mees, who adapted them to the production of fine-grained emulsions of high speed, which made possible the improvement of photographic materials for use in spectroscopy and astronomy. This contribution to the two sciences was recognized by the National Academy of Sciences in the award to Mees of the Henry Draper Medal in 1936.

During World War I the Signal Corps of the U.S. Army urgently needed a supply of men trained in the various techniques involved in aerial photography. To meet this demand Mees established at Kodak Park a training school, which he placed in the charge of Lieutenant A. K. Chapman, a physicist, who made so notable a success of the administration of the transient group of officers and enlisted men that when the war ended Mees retained his services as head of a new department for the development of photographic apparatus. (Chapman finally became president of the company.)

By 1918 the complete cessation of the importation of research chemicals from Germany had seriously inhibited many activities in American academic and industrial laboratories. When specific reagents were essential they had to be synthesized, often at grievous cost of time, by investigators and their associates. This situation was uniquely met in the Chemistry Department of the University of Illinois, where during the summer vacations selected students were gainfully employed in the preparation of organic compounds required for the ensuing year. This effort could of course not nearly meet the national needs, and its director, Roger Adams, in a letter to *Science* expressed the hope that some major chemical manufacturing concern would undertake the work on a large scale. As this met with no response, Mees, after consultation with George Eastman, announced the readiness of the Kodak research laboratory to attempt the task. In June 1918 the Department of Synthetic Chemistry was initiated; since male university graduates in chemistry were immediately drawn into activities recognized as essential to the war effort, the new department was at the outset staffed by girls; though enthusiastic and industrious, they seemed unable to conduct more than two preparations simultaneously and were somewhat "accident prone," so whenever they departed they were replaced by men. The initial stages of the work were facilitated by the cooperation of the Illinois laboratory, for which the Kodak group acted as distributor. Raw materials were obtained from the stocks of manufacturers and were, when necessary, purified for research purposes. During the first twelve years of operation no attempt was made to do more than meet expenses without overhead charges; at the present time the department is self-supporting and operates on a scale undreamt-of in 1918.

Another chemical offshoot of the Research Laboratory, proposed in 1926 by Mees, was the division of Cellulose Technology, which was charged with the application of organic chemical methods to cellulose. This group, which started operations with two chemists and after forty years comprises a staff of well over a hundred, has been largely responsible for the fundamental information on mixed esters of cellulose.

Among the many other technical achievements initiated in the Research Laboratory and developed under Mees's guidance was the introduction of the Cine-Kodak apparatus (1923) and the Kodachrome color film. This last supplies a typical instance of Mees's courage and readiness to proceed along unusual lines. Leopold Mannes and Leopold Godowsky (known to their irreverent juniors in the laboratory as Leo the Man and Leo the God), a pair of professional musicians, both enthusiastic amateur photographers, had invented a novel process of color photography and had consulted Mees with regard to its technical exploitation. In the belief that the new sensitizing dyes developed in the Kodak laboratories could be of value to the proposed procedure, Mees invited the inventors to continue their experiments in cooperation with his emulsion research group. This collaboration was eminently successful; the resulting Kodachrome film (16 mm.) was placed on the market in 1935, together with a system for making color prints on white support and a negative-positive process termed Kodacolor.

In 1923 Mees was appointed director of Eastman Kodak Company and in 1934 he became vice president in charge of research and development. In 1956 he retired from this post and took up permanent residence in Honolulu. At their farewell session the Board of Directors recorded the following tribute: "Many others have done him great honor which we cannot enhance, but we alone can give our personal testimony of appreciation and gratitude for the inspiration of his genius and leadership in Kodak affairs, and for the heritage of high aims and great accomplishment which he has left to us."

Mees was an excellent lecturer and public speaker on scientific, technical, and philosophical subjects, being both gifted and careful in the presentation of well-established facts. In conversation, on the other hand, he frequently gave the impression of being willing to overstate a thesis for the purpose of startling his hearers into unexpected opinions. During his first years in Rochester some of his new colleagues found this unduly positive mode of expression hard to take; this reaction was, however, gradually overcome, for the breadth of his information and the general soundness of his judgment counteracted the antipathy which his manner aroused, and ultimately his advice was freely sought by his associates.

In 1943 he accepted an invitation from the University of California to give a series of lectures as Hitchcock Professor. The topics embraced in these lectures, relative to the development of science and its relationship to the history of society, were incorporated in a book entitled *The Path of Science,* published in 1946 by John Wiley and Sons, Inc. He was accorded two honorary Doctor of Science degrees: by the University of Rochester in 1921 and by Alfred University in 1950. Having retained his British nationality, in 1939 he was elected to fellowship in the Royal Society. In 1950 he was made a Fellow of University College, London, and having by then acquired American citizenship he was elected a member of the National Academy of Sciences.

During his student years, Mees's life in London opened his eyes to the prevalence of extreme poverty, and when he learned that one third of the population of the city consisted of members of families whose weekly income was less than one pound he became a Socialist and joined the Fabian Society. There he met what in his memoirs he described as "a group of intellectuals who were trying to organize things so that the socialists could take over the government of England." However, after many years he recognized that "when socialism was tried, it did not succeed" and that "there are better ways of dealing with poverty than the socialist way." He also came around to the view that whereas "the important thing was the acquisition of knowledge, perhaps the next most important thing was the application of the knowledge to industry" and that it would be "much better to increase the total amount of wealth than it was to redistribute it."

Another youthful tenet which he ultimately abandoned as a result of more accurate information and more mature judgment was that vaccination could give no protection against smallpox.

In his late thirties he was willing to admit, though only to close friends, the loss of his ability to subscribe to the doctrines of any organized religion. This change of view, being a purely personal matter, was never openly proclaimed, particularly as he clearly wished to avoid giving pain to his gentle and devout father. His freedom from racial prejudice and his intrinsic kindness were shown by his response to a remark containing the expression "Wop": "Oh, you mean a compatriot of Galileo and Dante?"

In 1909 he married Alice Crisp, with whom he shared forty-five years of happy married life. They had two children: Graham (1910) and Doris (1912). In 1951 he lost one of his legs by amputation as a result of a massive thrombosis. In his remaining years he used an artificial limb and even managed to drive his car. From Honolulu he wrote in a personal letter: "I considered building a little laboratory here and doing some experimental work, but my inability to walk prevented it. I am sure that while I should build the laboratory with enthusiasm, I should never use it. I can't stand well enough, and it isn't easy to do lab work without standing. Anyway, I find plenty of occupation. I see lots of people and am generally having a very good time."

His death, in Honolulu in 1960, came painlessly and without warning.

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KEY TO ABBREVIATIONS

Astrophys. J. = Astrophysical Journal
Brit. J. Phot. = British Journal of Photography
Colour Phot. = Colour Photography (supplement to British Journal of Photography)
Ind. Eng. Chem. = Industrial and Engineering Chemistry (previously Journal of Industrial and Engineering Chemistry)
J. Am. Chem. Soc. = Journal of the American Chemical Society
J. Franklin Inst. = Journal of the Franklin Institute
J. Opt. Soc. Am. = Journal of the Optical Society of America
J. Roy. Soc. Arts = Journal of the Royal Society of Arts
J. Soc. Chem. Ind. = Journal of the Society of Chemical Industry
J. Soc. Motion Picture Television Engrs. = Journal of the Society of Motion Picture and Television Engineers (formerly Transactions of the Society of Motion Picture Engineers, then Journal of the Society of Motion Picture Engineers)
Mech. Eng. = Mechanical Engineering
Phot. J. = Photographic Journal
Proc. Roy. Soc. London = Proceedings of the Royal Society of London
Sci. Am. = Scientific American
Trans. Ill. Eng. Soc. = Transactions of the Illinois Engineering Society

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