"fully worked out on this small scale" of clocks and watches in the early 18th century. Yet Polhem's gear-cutting machine dates from 1729, and Rehe's gear-cutting machine, first described in 1783, had probably been used for cutting wheels for the silk-reeling works built by Boulton about 1780 for the East India Company. The gears for Rennie's Albion Mill (built during the period 1784–88) had epicycloidal teeth carefully chipped and filed to shape.

In short, the very able scholars who wrote the articles in this volume in many cases simply do not have—because they do not exist—the adequate monographic studies on which to build a scholarly history of technology.

Nevertheless, it would be worse than invidious were I not to point out the excellent qualities everywhere apparent in this difficult-to-write volume. It is organized into five parts, essentially matching the divisions of volume II, each of which contains numerous articles with short but useful bibliographies. As in the preceding volumes, the illustrations are accurate and germane, and the plates at the end of the volume are nothing short of magnificent. The reader will at once realize that much thought and searching has gone into the selection of the illustrative material, so important in conceiving of the history of man's relation with material things and objects. Perhaps the dominant theme throughout the work—or at least the notion most strongly reinforced for me—is that during these fertile two and one-half centuries, the period of the scientific revolution, what we often call pure science affected technology very little. This was still a craftsman's age, despite the tremendous conceptual upheaval that attended the downfall of scholasticism and the birth of modern science. Repeatedly our authors conclude that science, as we know it, began seriously to instigate technological changes only at the end of the 18th and beginning of the 19th centuries. This is perhaps a truism to which everyone would agree, but the authors in this project can do a great service by teaching us more of the details of this transition. For this and similar reasons we anxiously await the concluding volumes.

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Ionographie. Les émulsions nucléaires. Pierre Demers. University of Montreal Press, Montreal, Canada, 1958. 835 pp. + plates. Illus. $20.

Ionographie (which deals with the self-inscription of the path of fast charged nuclear particles traversing photographic emulsions) can be said to be the first comprehensive work on this important tool of modern nuclear physics. The title selected for this monumental work by Pierre Demers is perhaps apocalyptical, in view of the disturbing and restless age we are living in—"The Moving Finger writes; and, having writ,/ Moves on." In the English-speaking world the subject is usually referred to as nuclear emulsions, in an effort to differentiate the specially tailored photographic emulsions useful in the recording and discrimination of the tracks produced by the diverse fast-moving nuclear particles from the more common optical emulsions.

That alpha particles produced individual tracks in fine-grained emulsions, readily resolvable with the aid of the microscope, was known on the Continent as early as 1909. The technique, however, did not gain favor with experimentalists in the field of radioactive measurements until after the discovery of the neutron. This massive uncharged projectile racing through an emulsion will collide with the hydrogen nuclei of the gelatin and, at a given angle of incidence, will impart enough kinetic energy to the ionized nucleus so that it records a "proton-recoil track" in the recording medium.

The emulsion became an important competitor with the Wilson cloud chamber as a means of visualizing the path of charged particles during the early days of the Manhattan Project, when it became necessary to discriminate and elucidate the properties of the newly discovered fission fragments from the alpha particles emitted in the spontaneous decay of the uranium isotopes. Demers, as a member of the Canadian group, was particularly active in this field and was able to demonstrate, with the aid of his improved laboratory-made emulsions, that the normal binary fission process also occurred in an alternate mode, in which a high-energy alpha particle accompanied the two massive fragments originating from the neutron splitting of the uranium atom. Demer's researches on the preparation of concentrated emulsions containing as much as 90 percent of silver bromide, by weight, stimulated interest in the large-scale industrial manufacture of early nuclear emulsions such as the Eastman NTA plate and the Ilford series of B, C, D, and E plates.

The ready availability of these new recording media at the end of World War II led to a series of revolutionary discoveries by cosmic-ray workers, which in turn have altered our picture of nuclear structure. This simple tool led to the discovery of the pi mesons, the heavy primary component of the cosmic radiation, trident formation in the electromagnetic cascade, and the production of heavy "strange particles" in high-energy interactions. More recently it proved instrumental in elucidating the mode of annihilation of the antiproton and demonstrating lack of conservation of parity in π-μ-e decay processes.

This new volume, of virtually encyclopedic proportions, not only is concerned with the preparation and development of nuclear emulsions but also presents a lucid description of almost all applications in the field of nuclear physics and radiochemistry. Over 100 pages are devoted to a bibliography covering several thousand entries, with cross reference to points in the text where the subject matter is discussed. In general, the style of writing is reminiscent of Mellor's *Comprehensive Treatise on Inorganic Chemistry,* in which an effort is made to cover the literature completely. The bibliography appears to be complete to 1957, and Demers must have made considerable effort to extend his work even when it was in galley form, as some of the more important current papers of 1958 are also listed.

The first section of *Ionographie* is devoted to the manufacture of nuclear emulsions on a laboratory scale. While most readers will probably not attempt to "roll their own," a knowledge of the factors governing sensitivity will be helpful in understanding the shortcomings of commercially available products. This section of the book also describes the new Russian type P emulsions, which achieve a grain density of 60 per 100 microns of track produced by singly charged relativistic particles at the minimum of ionization. This is some three or four times greater than the sensitivity currently available in emulsions of American or British manufacture.

The volume covers the methods of normal and discriminatory development of both plates and stripped emulsions up to 600 microns in thickness. A more thorough treatment of specialized techniques permitting the processing of 2-millimeter-thick slabs would have been a useful addition to the book. Needless to say, the diverse ailments inherent in the technique—such as fading of the latent image, track distortion, gelatin blistering, and surface silver image corrosion—are given detailed treatment. A large section is devoted to the geometrical problems of plate exposure and evaluation of results. As an indication of the thoroughness of the treatment, even ancillary techniques, the details of which are often difficult to locate in the literature, are described in detail. Thus, the cosmic-ray worker will find methods for the measurement of atmospheric depth, details on the fabrication and launching of balloons, and meteorological data on wind directions for facilitating the recovery of the emulsion stacks. Demers can write authoritatively on these matters as he performed these operations in the field.

Physicists will find this volume useful in making range-energy measurements, evaluating particle momentum by multiple scattering techniques, and making charge identification by grain and delta-ray counting. The theory and systematics of alpha decay processes are considered in great detail, together with quantitative theory on the formation of alpha stars in emulsion. The evaluation of neutron energy spectra is particularly thorough. About one-third of this scholarly work is devoted to applications of the nuclear emulsions in high-energy physics, both with collimated beams of particles from accelerators and in the study of the cosmic radiation. By comparison, coverage of other types of applications, such as that in the fields of geology and histoautoradiography, while adequate in view of general principles developed in earlier sections, may appear scanty, occupying only 13 pages of fine-printed text.

In an age where individual scientists take pride in being expert on some small facet of nature, it is exhilarating to find a comprehensive work covering a broad vista of science skillfully integrated by a single mind. Demers is to be congratulated for his arduous efforts in providing a greatly needed, authoritative work on the use of photographic emulsions in nuclear physics.

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Effect of Radiation on Human Heredity. Report of a study group convened by the World Health Organization, together with papers presented by various members of the group. World Health Organization, Geneva, 1957 (order from Columbia University Press, New York). 168 pp. Illus. $4.

The purpose of the study group whose report is presented in this volume was, according to the preface, twofold: (i) to obtain the opinions of authorities on genetics from countries other than Great Britain and the United States, whose national committees on radiation hazards reported in 1956; and (ii) to probe certain untouched aspects of the problem of genetic hazards, especially "the lines of research which should be followed, in the light of our present knowledge, to increase our understanding of the genetic effects of ionizing radiations on man." At the meeting of the first International Congress of Human Genetics in Copenhagen during August 1956, a group of 20 highly expert investigators in various aspects of human genetics was assembled. The report actually comprises only ten pages of the volume, and while it will undoubtedly stimulate some research to bring about the solution of critical problems and to supply key information, and while it may serve to increase financial support of research in human and other branches of genetics, this section is hardly the most valuable or interesting part of the book. It is hard not to mimic those generals who are forever fighting the last war.

The volume contains a collection of a dozen papers, however, every one of which is worth reading and rereading. The happy juxtaposition of the first two papers (by H. J. Muller and T. C. Carter, respectively) spotlights one of the most controversial matters in genetics today—one that is related to the whole problem of estimating genetic damage and hazard. This is the problem of the frequency of deleterious mutant genes that are always, or almost always, harmful no matter what the conditions, in comparison with the frequency of mutant genes that are seriously detrimental only when present in a person in double dose (homozygous) and which, when present in single dose (heterozygous), may, at least under certain conditions, be selectively advantageous. If the first situation predominates, then most mutant genes are held in the population in simple equilibrium between input (mutation) and outflow (elimination through failure to be passed on because of death or infertility). But if the second situation obtains, the interplay of forces is far more complex and consequently less predictable. Muller adopts the former view; Carter, and after him Wallace, the latter.

R. M. Sievert, of Sweden, gives a masterly summary of known human exposures to ionizing radiation. One may note the fact that he had no premonition of the recently discovered zone of extremely heavy radiation at high altitudes, for the curves drawn in 1956 all flatten out at about 50,000 feet. The Swedish data in general are in good agreement with the conclusions of the British and American committees. J. Lejeune discusses the kinds of data needed and the practicability of detecting induced mutations in the offspring of radiated parents. There is wide misapprehension on this subject. Lejeune is properly cautious. Court Brown describes methods being developed for more accurately determining the genetically all-important gonad dose delivered by various types of exposure.

Measurement of the spontaneous mutation rate in man by direct and indirect methods, the effects of induced mutations, the differential sensitivity of human loci to radiation, and the load of abnormal genes per person in the population are topics discussed by L. S. Penrose. There follows the first report of the radiation readings in inhabited areas with particularly high background radiation, such as the region of monazite sands in Travancore. Gopal-Ayengar reports readings that are high, but hardly as high as rumor had previously made them. He estimates a total gamma dose of about 10 to 30 roentgens over the reproductive span of 30 years in that locality. The world will be understandably interested in the prompt investigation of the populations living on such soils. Is their genetic burden detectably higher than that of similar populations not so exposed to radiation?

Stevenson and Neel probe the difficulties and possibilities of error in estimating spontaneous mutation rates in human populations. Freire-Maia considers the effect of inbreeding in bringing more mutant recessive genes to the surface and exposing them more rapidly to selection. The frequency of genetic defect *manifested* in a population is *not* a simple function of the frequency of the genetically defective genes. Howard Newcombe, of Canada, completes the series of papers by describing the sort of vast genetic health registration of the population that is really needed if many of these problems are to be solved.

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Electronic Instrumentation for the Behavioral Sciences. Clinton C. Brown and Rayford T. Saucer. Thomas, Springfield, Ill., 1958. xiv + 160 pp. Illus. $5.50.

In 160 pages this book provides "a simplified presentation of basic electronic theory required for instrumentation problems." The volume is specifically oriented toward fields of experimental psychiatry, psychophysiology, and physiology where electronic instrumentation is required for stimulation or measurement.

The first chapter offers a brief, lucid discussion of the physical theory underlying electronic phenomena, followed by an elementary review of methods of electrical measurement. Tube types and basic circuitry are next considered. This section is followed by chapters on power supplies, amplifiers, oscillators, timing devices, and switching circuits. Valuable suggestions are made regarding input and output transducers, including devices for tracing and displaying physiological changes. There is commendable emphasis on various methods for the protection of human subjects of experimentation. A chapter is devoted to test instruments, with suggestions regarding kits available for their economical construction. Recommendations are made regarding specific instruments that are