theory of point sets and of continuous functions. From that point on the book treats in more or less standard order the usual topics of the differential and integral calculus, with the exception that the proofs are placed on a more rigorous footing. These proofs are not always given in complete detail. They are deliberately curtailed in order to keep the essentials clearly in focus. In some cases the parts omitted are included in the exercises. For example, the derivation of the formula for the derivative of a function of a function, left incomplete in most text-books, is here carried to a point so near completion that the student can fill in the details. The book does not entirely solve the logical difficulties of the teacher resulting from the necessity of a choice in the order of topics. In some cases forward references are necessary. Thus the "Law of the Mean" is used on page 92, while it is proved on page 117.

The topics are concerned mostly with functions of one variable. There is, however, one chapter on double and triple integration. Also, partial differentiation is defined and used (in Chapter 4) to obtain the derivatives of functions defined implicitly. The book ends with two chapters on differential equations.

A problem which confronts the teacher of students who wish to make use of the calculus in the applied sciences is how to introduce the subject of integration early enough. The text under review solves it by introducing problems on inverse differentiation in with those on differentiation. The definite integral is introduced in Chapter 12, in characteristic fashion, with the proof that its defining limit exists for any continuous function! The author admits that the student, meeting the subject for the first time, might wish to omit such a proof. In fact, he points out that the traditional course "can be extracted from the book by omitting the proofs of theorems." In spite of the rigorous point of view, a lively and interesting style is maintained. Witness the term "principle of the flycatcher."

The reviewer regrets that the very useful exact remainder theorem for Taylor's theorem (expressing the remainder as a definite integral) is omitted here as in most standard text-books. He also feels that the utility of the book would be slightly increased if the statement of theorems were italicized.

This book presents the calculus as the teacher would like to present it to his classes, in logical order. We have hitherto assumed in this country that this most pleasant method of lecturing was not the most efficient way of teaching, that maximum enjoyment for the instructor might mean minimum enjoyment for the mediocre student. The author believes otherwise, that the present type of treatment should increase the student's enjoyment as well as his power to use the material. He bases his belief on his own experience as a teacher in this country, and on his acquaintance with young Europeans of the age of American sophomores. It is devoutly to be wished that he is right and that others who use the book will make similar findings.

D. V. WIDDER

IMAGE TRANSMISSION

Television—the Electronics of Image Transmission. By V. K. ZWORYKIN and G. A. MORTON. ix + 646 pp. New York: John Wiley and Sons, Inc. 1940.

THIS book is designed to condense and summarize in a readily accessible form the extensive literature which has already grown up in the field of television. The subject-matter is divided into four main sections. The first part deals with the fundamental processes and phenomena upon which the art of television is based. The second part discusses the general principles of television and the necessary relationships between the optical image and the transmitted radio image. The third portion deals with the individual components of the complete television system as devised in the RCA laboratories, and the fourth portion describes the equipment of the RCA-NBC television project. The first two sections will be of most interest to the general scientific reader, for in these parts are contained all that is necessary for a detailed understanding of the science of television as practiced to-day. The other two sections will be useful to those having an interest in the finer details of the subject.

The authors are to be particularly congratulated upon the extremely clear and concise exposition of the fundamental physical principles which occupy the first five chapters of the book. These chapters cover the emission of electrons from solids, fluorescent materials, electron optics and modern high-vacuum technique in the short space of 150 pages. Most physicists could read these pages with profit.

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REPORTS

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

MECHANICAL engineers throughout the United States and Canada are observing this year the sixtieth anniversary of the founding of their professional organization, the American Society of Mechanical Engineers, which to-day has 15,000 members and maintains headquarters in New York City and 71 school sections in va-

rious industrial areas. The story of the growth of the society coincides with the period in American industrial history in which the greatest mechanical developments have occurred, much of which have been made possible through the efforts of the society and its members, whose names would fill many pages. Their achievements cover a myriad of fields, chief of which are air conditioning, aeronautics, electric machinery, engineering research, metals, fuels, hydraulic turbines, internal-combustion engines, machine tools, naval improvements, ordnance material, petroleum, plastics, printing presses, pumps, railroads, scientific management, steam power, textiles and woodworking machinery.

It was on April 7, 1880, that 80 mechanical engineers organized the American Society of Mechanical Engineers, which had an initial membership of 189. As early as then, the founder members promulgated the present objectives of their engineering organization, which are to promote the art and science of mechanical engineering and the allied arts and sciences; to encourage original research; to foster engineering education; to advance the standards of engineering; to promote the intercourse of engineers among themselves and with allied technologists, and severally and in cooperation with other engineering and technical societies to broaden the usefulness of the engineering profession to industry, community and world. As officers of the new society, there were elected by those present a representative group of engineers, headed by President Robert Henry Thurston, pioneer educator in mechanical engineering. In 1883, Frederick Remsen Hutton, professor of mechanical engineering at Columbia University, became the first regular secretary, a part-time position that he held until 1906.

The early history of the society reflects the earnest endeavors of its slowly increasing membership to organize for the purposes enunciated by the founder members. Meetings were held, papers and discussions were presented and published and standards for material specifications and codes for recommended practice in a number of fields of testing were undertaken. Shortly after the turn of the century, a new spirit began to manifest itself in the organization. The rapid spread of membership throughout the country and the realization by engineers in many industrial centers that great benefits would result from local organizations culminated in 1904 in the establishment in Milwaukee of the first local section of the society. This movement led to the organization of others, until to-day there are 71 such groups in the United States and Canada.

The splendid gift by Andrew Carnegie of an engineering societies building in New York City, dedicated in 1906, gave impetus to widening influences and brought with it a realization that greater obligations had been placed upon the society. With the occupancy of the new headquarters in the building and the appointment of Calvin W. Rice as full-time secretary, a second period of growth began.

This second period of development was marked by the increase in the society's activities and their diversity, and a rapid growth of membership. Cooperation with other engineering bodies, in this country and abroad; more frequent meetings; the broadening of the field of professional interest; realization of the obligation of service in civic and social progress; increased activity in standardization, research, codes of recommended practice and safety; greater activity in local sections and student branches, the first of which was authorized in 1908 and to-day number 117 with 6,500 student members; and more extensive and more diversified publications have been some of the fruits of this growth. In 1919, from a recognition of the ever-broadening technical interests of the society's members came the 16 professional divisions under whose auspices the professional work of the society in the various branches of mechanical engineering is now carried on. National meetings, each devoted to a single subject but drawing participants from the country at large, were instituted to augment the more general meetings of the society in various cities in which all divisions take part and the local meetings, which are arranged entirely by local sections.

In this period were begun certain technical activities which have materially benefited industry and the general public. Boiler explosions are a rarity since the society undertook to prepare and continually revise a "boiler code," which has become law and the standard for 24 states, the Hawaiian Islands, Panama Canal Zone, two Canadian provinces and 18 cities, in the design, construction and operation of boilers and pressure vessels. As a further means of safeguarding human life, the society has sponsored other safety codes, such as those for elevators, already adopted in several states and a score of cities, hoists, compressed-air machinery, pressure piping and conveying equipment. To determine whether an engine or machine is delivering its rated horsepower or capacity, the society has set up for the guidance of engineers "power test codes" to be used in testing compressors, heaters, internal-combustion engines, fuels, pumps, steam engines and turbines, refrigerating systems, steam locomotives and other auxiliary apparatus.

At the beginning of the period, the society added research to the list of its technical activities. Unaffected by commercial considerations or influence and interested primarily in the advancement of knowledge of mechanical engineering, the society has sponsored research on fluid meters, feedwater studies, management, cutting of metals, mechanical springs, effect of temperature upon properties of metals, woods of the

world, gearing, bearings, hydraulics, steam tables, elevators, welding and lubrication. Another important function of the society is its service to the engineering profession and to industry in the sponsorship of dimensional standardization in the field of mechanical engineering, beginning with pipe threads and including bolts, nuts, rivets, screw threads, couplings and hundreds of other items. This last activity has made possible mass production in the automotive and other fields, which in turn have provided the general public with cheaper automobiles, household appliances, typewriters, airplanes and similar articles.

The pattern of the third period of the society's development, now in progress, appears to be characterized by a growing concern for the education and training of the engineer and his professional development and status, for engineering as one of the learned professions, and for the opportunities and obligations of public service, which involve economic and sociological as well as ethical, educational and financial considerations. The vital problems, personal, professional and national, raised by the world-wide depression of the 1930's, have already influenced and given direction to this third period, which is roughly coincident with the secretaryship, held since the death of Dr. Rice in 1934, by C. E Davies.

To enhance the status of the engineer, the American Society of Mechanical Engineers is maintaining its high technical and cultural standards for entrance to the society; cooperating with educational institutions in the maintenance of high standards of engineering education; requiring a high standard of ethical practice by members of the society; aiding in the adoption of a high standard of attainment for the granting of the legal right to practice professional engineering; fostering among engineering students the study of philosophy and history, tradition and achievements, duties and social functions of the engineering profession; encouraging the personal and professional development of young engineers; and supporting activities looking to the increased employment of engineers and seeking new opportunities for engineering service. The usefulness of the organized engineering profession is being increased by cooperating with other engineering and technical societies; encouraging a high standard of citizenship among engineers; encouraging engineers to participate in public affairs; cooperating with governmental agencies in engineering matters; and fostering a better understanding by the general public of the value of engineering as evidenced by the achievements of engineers.

L. F. Z.

SPECIAL ARTICLES

UNIFORMITY OF THE PAIN THRESHOLD IN MAN[1]

THE aim of these studies was to ascertain: To what extent the variable distress experienced by different persons during similar pain stimuli is dependent upon differences in perception (the pain threshold), and to what extent on differences in reaction to pain.

Earnest efforts in the past[2] have been made to deal with this problem, but a definite answer has been delayed because of the absence of an accurate method of ascertaining the pain threshold. A suitable method has been described by Hardy, Wolff and Goodell,[3] who have made accurate measurements of the pain threshold and have demonstrated its stability in three subjects. The day-to-day variations over a period of almost a year, despite varying moods and vicissitudes, caused a deviation from the mean no greater than ± 12 per cent. However, the pain threshold may be altered by various factors. Thus, pain in one part of the body raises the pain threshold in other parts. Also, chemical agents such as acetylsalicylic acid and the opiates are capable of appreciably raising the pain threshold, on which fact rests part of their therapeutic usefulness.[4]

To investigate the variability of the pain threshold in a population under average conditions of well-being, 150 subjects of different ages and both sexes were tested. The results of this more comprehensive study of the pain threshold form the topic of this communication.

METHOD

The apparatus[3] for measuring the pain threshold is shown diagrammatically in Fig. 1. The light from a 1,000-watt lamp was focussed by a condensing lens through a fixed aperture 1.8 cm. in diameter onto the blackened forehead of the subject for exactly three seconds. The intensity of the radiation was controlled by means of a rheostat. The subject reported on his sensation, and if no pain was experienced the procedure was repeated every 30 to 60 seconds until he just felt pain at the end of the exposure. The intensity of heat at this point was measured by a radiometer and considered to be the minimum stimulus for pain. This

[1] From the Russell Sage Institute of Pathology in affiliation with the New York Hospital and the Departments of Medicine and Psychiatry, Cornell University Medical College, New York, N. Y.

[2] E. Libman, *Jour. Am. Med. Asn.*, 102: 335, February 3, 1934.

[3] J. D. Hardy, H. G. Wolff and H. Goodell, *Jour. Clin. Invest.*, 19: 649, July, 1940.

[4] H. G. Wolff, J. D. Hardy and H. Goodell, *Jour. Clin. Invest.*, 19: 659, July, 1940.