REPORTS

THE ENGINEERING FOUNDATION

SEVENTY-THREE research projects involving an aggregate of $3,111,374 have been carried out by The Engineering Foundation since it was established in 1914 by Ambrose Swasey, the Cleveland manufacturer, "for the furtherance of research in science and engineering or for the advancement in any other manner of the profession of engineering and the good of mankind."

Notable contributions have been made to science, engineering, industry and the humanities during a twenty-five-year period characterized by profound change, according to a report made public by Dr. Otis E. Hovey, director of the foundation, in which it is stated that the opportunities for productive research are constantly increasing in number and scope.

"Researches have been assisted by funds appropriated from the income of the investments of the foundation to an amount of over $400,000. Cash contributions for certain projects have passed through the accounts of the foundation to an amount of nearly $500,000.

"In addition, other large sums have been contributed by the four founder societies of civil, mining and metallurgical, mechanical and electrical engineers and by individuals, corporations and industry. Likewise, the use of facilities made available by educational institutions and laboratories, and the expert supervision freely donated by many individuals have been of great value, but a large part of such service can not be expressed in an equivalent money value."

A ten-year research in the field of alloys of iron representing, in cash contributions and service, an outlay of $426,677 was among the chief activities. With the cooperation of eighty-eight manufacturers, research institutes, technical societies and federal bureaus, hitherto inaccessible world knowledge of steel and iron and their alloys has been assembled from scientific and technical literature of many nations. The results have been embodied in eleven monographs by a committee of which Professor George B. Waterhouse, of the Massachusetts Institute of Technology, representing the American Institute of Mining and Metallurgical Engineers, is chairman and director.

Dr. John Johnston, director of research of the United States Steel Corporation, says in this section of the report that "the justification for this undertaking is that by showing what is still uncertain and unknown, it provides a new starting point for supplying the engineer with the metal best fitted for each of his multifarious purposes."

Another research aided by the foundation is proceeding under the sponsorship of the special research committee on cottonseed processing of the American Society of Mechanical Engineers in the laboratory of the University of Tennessee, with the cooperation of the Tennessee Valley Authority. Large contributions of money, materials and services have been made as the work progressed, and the data developed give promise of large returns to the industry and the public. "A number of plants are now operating in America on the basis of new discoveries resulting from this research," Dean W. R. Woolrich, of the University of Texas, chairman of the committee, says in describing the work at the University of Tennessee. "The mechanical processing of cottonseed has been improved to a much higher degree of perfection—an improvement in this art that is most outstanding since the beginning of the twentieth century."

The results of an arch dam investigation, which included the building of an experimental dam on Stevenson Creek, about sixty miles east of Fresno, Calif., "have had a far-reaching influence on the design of dams, both arch and gravity," according to the report. The investigation developed instruments and methods of test which have been employed in practically all dams of recent construction.

Research in the fatigue of metals, sponsored by the foundation and the National Research Council, were carried out at the University of Illinois under the direction of Professor H. F. Moore. "The results of this work have been far-reaching, not only with respect to the factual data developed but in the stimulation of similar research work in the United States and several other countries. The work stands as the first of the later researches on fatigue phenomena, and has contributed greatly to our knowledge of the endurance characteristics of some of the most commonly used of the structural metals."

Other foundation researches which have contributed to the progress of science, engineering and industry embraced welding, personnel research, concrete and reinforced concrete arches, steel columns, earths and foundations, plastic flow of concrete, hydraulics, mining methods, blast furnace slags, barodynamics, thermal properties of steam, lubrication, fluid flow, effect of temperature on properties of metals, cutting metals, plasticity of metals, dielectric absorption and engineering education.

Ambrose Swasey made five gifts to the foundation amounting to $818,600. Gifts by Edward Dean Adams, Henry R. Towne, W. S. Barstow and Sophie M. Gondron amount to $131,600, and nine others have given $29,600. The book value of the endowment fund is given as $990,000. A bequest by E. H. McHenry, in the hands of executors during the life of two beneficiaries, was appraised in 1931 at $400,000.

"The purpose and scope of the foundation are broad,

and it was the hope of the founder that his gift would be the nucleus of a large endowment fund contributed by many persons and many organizations, thus making available ample income to support worth-while investigations which would advance science, the profession of engineering and the good of mankind."

The following general policy has been adopted by the Engineering Foundation Board: "The Foundation will concern itself with human as well as technical aspects of engineering problems of wide interest. Activities which will have as their main objectives 'the advancement of the profession of engineering,' whether by research or other means, will be given preference. The foundation will initiate new projects or will select from time to time projects presented to it which are deemed most likely to attain its objectives."

SPECIAL ARTICLES

ANTHELMINTIC ACTIVITY OF CRYSTALLINE PAPAIN

THE anthelmintic properties of certain plant extracts were recognized and made use of by some physicians as early as 1802, but the use of such extracts seems to have been neglected in recent years. Possible reasons for this were the inconvenience of handling the relatively unstable fresh juices and the ignorance of the fact that the anthelmintic properties were associated with labile enzymes. It was reported in 1802,[1] 1879[2] and 1881[3] that many physicians had successfully used the crude latex of *Carica papaya* or the papain obtained from it against ascarids, tapeworms, trichuris and hookworm lodged in the intestinal canal. The effectiveness of the enzyme was demonstrated beyond doubt. Although the anthelmintic value of ficin has been reinvestigated recently,[4, 5] the use of papain appears to have been completely forgotten. That large amounts of dried preparations of this enzyme are available is shown by the fact that in 1938 the United States imported 222,675 pounds of papain, according to the Chemical Division, Department of Commerce.

The present authors have reported[6] that bromelin of fresh pineapple juice can digest live Ascaris worms *in vitro*. In a search for other active plant proteases, it was found that a commercial preparation of papain (Merck) possessed strong worm-digesting activity. This finding is a confirmation of certain claims made in 1879.[2] A 0.7 per cent. solution of dried preparation in M/18 phosphate-phthalate buffer pH 5 digested *Ascaris lumbricoides* (obtained from hog intestines) almost completely in 17 hours, while a 0.07 per cent. solution also showed some activity. Since this preparation had been on hand several years, a fresh sample was analyzed and found to have approximately the same activity. *Macracanthorynchus hirudinaceus* (from hog intestine) was not digested by a 0.7 per cent. solution of either of these papain preparations, but was digested by fresh pineapple juice.[7]

It has frequently been suggested[8] that crude papain contains more than a single protease. It was therefore desirable to determine whether the worm-digesting activity of crude papain was attributable to papain itself or to some accompanying enzyme. To settle this question, pure crystalline papain[9] was tested on *Ascaris lumbricoides*. As may be seen from Table 1, rapid ulceration, followed by digestion of worm tissue, occurred in tubes containing 0.11 per cent. of crystalline papain, while digestion took place more slowly in weaker concentrations of enzyme. The crystalline enzyme was 14 times as active as the commercial preparations in worm-digesting ability.

TABLE 1

WORM-DIGESTING ACTIVITY OF CRYSTALLINE PAPAIN

Concentration of enzyme[1]	Observations on worms after		
	2 hours	7 hours	16 hours
Per cent.			
0	No change	No change	No change
0.005	" "	1 worm ulcerated, other 2 unaffected.	2 worms ulcerated, other unaffected.
0.02	" "	6–12 ulcers per worm.	All 3 worms badly ulcerated and partly digested.
0.11	Numerous ulcers on 3 worms; some digestion begun.	Worms badly ulcerated and partly digested.	All 3 worms completely disintegrated and well-digested.

[1] The enzyme was dissolved in 12.5 cc of 0.067 M phosphate-phthalate buffer, pH 5. One worm was placed in each test-tube (15 x 150 mm.) and the tube incubated at 40° C. All determinations were made in triplicate. The enzyme crystals had an activity of 11 units per mg. of protein N, determined by milk clotting (private communication from Dr. A. K. Balls).

Walti[5] has reported that crystalline ficin can also digest live ascarids *in vitro*. It therefore appears that the anthelmintic properties of the latex of Ficus spe-

[1] R. Sprengel, *Medicinisch chirurgische Zeitung*, 1: 353, 1802.

[2] A. Wurtz and E. Bouchut, *Paris Médical*, pp. 5–35, 1879.

[3] Anonymous, *Paris Médical*, No. 30, July 28, 1881.

[4] F. C. Caldwell and F. L. Caldwell, *Am. Jour. Trop. Med.*, 9: 471, 1929.

[5] A. Walti, *Jour. Amer. Chem. Soc.*, 60: 493, 1938.

[6] J. Berger and C. F. Asenjo, SCIENCE, 90: 299, 1939.

[7] Puerto Rican pineapples were used here.

[8] A. K. Balls and H. Lineweaver, *Jour. Biol. Chem.*, 130: 669, 1939.

[9] The authors are particularly grateful to Dr. A. K. Balls, of the United States Department of Agriculture, for a generous gift of crystalline papain.