pany devotes something under 1 per cent. of its profits, and the £80,000 to £100,000 a year spent by the General Electric Company of Schenectady. Mr. Fleming gives particulars of what is being done by each of some twenty corporations, but the list could easily be made very much longer. Most of these laboratories have sprung up in quite recent years; and their number is constantly increasing. The increase is not merely in number. It is as remarkable in its growing breadth. The laboratories of these firms undertake not merely the routine of testing of materials and products and the more or less empirical adventures after new products that was formerly the business of a works' laboratory. At the one end of the scale they carry out experiments on the discovery of new products and the elaboration of new designs into the full manufacturing scale, and the laboratory supplies the needs of the market as if it were itself a works, until they outgrow the capacity of its plant and call for a new works of their own. At the other end of the scale they undertake inquiries into questions of pure science, of the solution of which no one can see any industrial application. They keep men investigating such problems constantly and perseveringly, and give them admirably equipped laboratories for the purpose. This sort of thing is being done in works after works, and every year adds to their number and the elaboration of their equipment. All the time, in spite of the enormous sums that are being spent on what at first sight is not only unproductive work, but work which tends to subordinate the wholesome rule of practise to the fantastic and costly demands of laboratories, the thing pays. The fact that the habit has grown so far is good *prima-facie* evidence that it must pay, for American business houses do not fling good money after bad. But there is no need to depend on inference or *prima-facie* evidence. The individual experience of those who have tried it shows that in fact it has paid, and the air in America is thick with plans to extend the practise of applying science to help industry; for great as is the extent of what has been done already, it is only a tiny fraction of what in American industry there is still room and the intention to do.

Side by side with these corporations and firms three groups of institutions are working to the same ends. Mr. Fleming quotes a dozen or more separate industries with their trade associations, each of which is undertaking research for the common benefit of their members; sometimes in their own common research laboratories, sometimes in those of their members, sometimes through university or the Bureau of Standards staffs. An excellent instance of an important trade of which all members, great as well as small, have gained greatly by research work communicated to all alike, is that of the canners. The Canners' Association spends some £6,000 or £7,000 a year on its central laboratory, besides a good deal more on work done in the factories of individual members; and it is considered that the largest members have as much interest as the small in the results being made common to all, because the risk of the whole trade being discredited by imperfect production is thus minimized. Over a dozen universities and colleges, again, are now running laboratories devoted not only to investigations in pure science which may ultimately find a practical application, but to industrial researches for which the application is waiting as soon as the solution of the problems is found. In many instances such work is done not on the strength of foundations, but at the request and expense and for the benefit of commercial firms and other industrial bodies, such as railway companies.—London *Times*.

SCIENTIFIC BOOKS

Use of Mean Sea Level as the Datum for Elevations. (Special Publication No. 41.) By E. Lester Jones, Superintendent, U. S. Coast and Geodetic Survey, Washington, Government Printing Office. 1917.

This pamphlet presents a very strong case in favor of the adoption of a single datum for the elevations of the country in order to eliminate the confusion which results from the employment of arbitrary planes of reference.

There is scarcely any surveying or civil engineering which does not require that differences in elevation be determined by spirit leveling and in nearly all cases the absolute elevation of the bench marks above some plane of reference or datum is determined. Efficiency in operation frequently depends upon the datum selected. There are many other branches of science besides that of engineering in which absolute elevations are needed.

The selection of a fundamental datum is a matter of great importance. Only slight consideration leads one to conclude that the ideal datum for a nation is one which may be established at many places. The only one of this kind is mean sea level.

Mean sea level may be established within a very small fraction of a foot by continuous tidal observations for at least a year. It has been found from precise leveling observations that mean sea level, as established at different points on the open coasts, is at all such points in the same equipotential surface; that is, if there were no resistance of the water and wind to the movement of an object floating on the ocean, the object could be moved from one point on the coast to another without performing any work—there would be no lifting necessary. While this statement may not be absolutely true, yet it is so nearly the case that for all engineering and surveying purposes it may be accepted as rigidly true.

Mean sea level is used exclusively in the work of the Coast and Geodetic Survey and the U. S. Geological Survey. It is used to a certain extent by many other engineering bureaus of the government.

In December, 1916, the Coast and Geodetic Survey sent the following letter, or one similar to it, to the chief engineers of most of the large cities of the country, to the State Engineer of each state, and to the chief engineer of each of about 150 railroads in the United States:

As you know, one of the important questions of the United States Coast and Geodetic Survey is the extension over the country of a network of precise leveling which will give elevations of great accuracy, based upon mean sea level.

We believe that this precise leveling is essential in the surveying and engineering work done in this country by various public and private agencies. The network will enable engineers to use the sea-level datum on new projects and to reduce to this datum existing elevations referred to arbitrary datums. We believe that this country should eventually have but one datum, in order that all engineering and surveying work may be easily coordinated. We believe also, that the presence of various datums leads to much confusion and waste.

In order that we may get into closer touch with the needs of the engineering profession, I should be glad if you will let me know to what extent your state is basing the elevations of its road and other surveys and engineering works upon mean sea level; also whether the use of various arbitrary datums by counties, cities and private organizations within your state is a serious matter in the industrial development of your state.

Replies were received from many of the engineers to whom the above letter was written. The opinions expressed were almost unanimously in favor of the adoption of mean sea level as the datum for elevations.

The pamphlet under discussion contains quotations from many of the letters received by the Survey. One of the quotations, typical of most of them, reads:

So far as our experience has taught us there can be no question as to the desirability of a universal datum plane, and I think there can be no doubt in the minds of engineers engaged in municipal work that mean sea level is the only logical datum to adopt.

In your advocacy of an extension of such bench marks you deserve the support and cooperation of every engineer in the country.

Another reads:

We agree with you that it would be very valuable to the state if a system of levels could be established, and believe that such will need to be done in the near future in order to correlate the drainage, highway and other engineering work in the state.

It is realized by the members of the Coast and Geodetic Survey that much of the confusion in datums which now exist, is due to the fact that the precise level net of the United States was not extended in the past as rapidly

as it should have been. It, of course, was impossible, or rather impracticable, to extend a precise level net into areas through which railroads had not been run, for the expense would have been prohibitive. It may be that the Survey did not fully realize the necessity for having all engineering and surveying work on the same datum, but in recent years it has become fully alive to the necessity of having a single datum for the entire country, and it is consequently extending its precise leveling net as rapidly as funds available will permit.

While it is of value to the nation for various organizations and individuals to adopt and use mean sea-level datum for their elevations, the country will benefit still more if each organization doing extensive leveling will publish in pamphlet form the elevations and descriptions of the bench marks they may establish in order that other organizations and individuals may properly coordinate their levels. Engineers are urged also to use substantial bench marks in order that future work may be benefited by their preservation.

The amount of precise leveling which should be done by the federal government can not be foretold. It must depend upon the needs of the various organizations and individuals using the results. After a certain development of the precise level net which appears now to be absolutely necessary, the rapidity with which further extensions are made should depend upon the development of the country. But such further extensions should precede rather than follow such development, as is proved by the unfortunate condition of affairs in much of our engineering and surveying work, due to lack of precise elevations in the past, when such work was inaugurated.

This paper on mean sea level should, and no doubt will, do much good in furthering the universal adoption of mean sea level as the reference surface for all elevations.

The publication of such pamphlets by government organizations is to be commended, for they present facts to the public in an effective way which may otherwise be buried for years in valuable but more cumbersome government reports with which all of us are more or less familiar. William Bowie

PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES

The sixth number of volume 3 of the *Proceedings of the National Academy of Sciences* contains the following articles:

The stark effect in helium and neon: Harry Nyquist, Sloane Laboratory, Yale University. An improvement of Lo Surdo's method is applied.

New analyses of echinoderms: F. W. Clarke and R. M. Kamm, United States Geological Survey, Washington. A progressive enrichment in magnesia, following increase of temperature, is unmistakable.

On utilizing the facts of juvenile promise and family history in awarding naval commissions to untried men: C. B. Davenport, Station for Experimental Evolution, Carnegie Institution of Washington. A study with family charts of a number of naval officers.

The triplet series of radium: Gladys A. Anslow and Janet T. Howell, Department of Physics, Smith College.

The measurement of small angles by displacement interferometry: Carl Barus, Department of Physics, Brown University.

Mechanisms that defend the body from poliomyelitic infection, (a) external or extranervous, (b) internal or nervous: Simon Flexner, Rockefeller Institute for Medical Research. A report upon the results of recent experiments.

The occurrence of harmonics in the infrared absorption spectra of diatomic gases: James B. Brinsmade and Edwin C. Kemble, Jefferson Physical Laboratory, Harvard University. The discontinuities in the structure of these bands force the conclusion that the angular velocities are distributed among the molecules in the discontinuous manner predicted by the older form of the quantum theory, and the proved existence of harmonics is almost equally good evidence that the vibrational energy of the molecules is distributed in the same manner.

The loss in energy of Wehnelt cathodes by electron emission: W. Wilson, Research Laboratories of the American Telephone and Telegraph Company and of the Western Electric Company. The emission of the elec-