a certain number of the individual members of the stock. The investigator has worked with patience and carefulness; his most feasible practical suggestion is the permanent custodial care of the feeble-minded Jukes.

(4) In a clear and courageous essay Adelyne More points out the advantages of a deliberate reduction of the birth-rate. Only thus can women secure independence; it is the chief way of reducing infantile mortality; it is the only way by which struggling parents can attain economic security; it forms part of the prophylaxis against venereal disease; and it is the most effective way of ensuring the cessation of war. "An undue fecundity promotes international pugnacity of precisely the kind which was operative in bringing about the present war." In a slashing preface—admirable in its exposure of our Anglo-Saxon false shame—Mr. Arnold Bennett deals, somewhat too cavalierly, we think, with the hygienic, religious, political, and industrial arguments against the use of contraceptives. He does not consider the ethical difficulties—perhaps transitional, but already real enough—involved in being able at will to evade the natural consequences of sexual intercourse, nor the social difficulties involved in the unequal birth-rate in different sections of the community, and in the likelihood that birth-control would tend to be adopted most among thrifty, far-sighted, controlled, and "individuated" types, of whom a progressive nation wishes more, not fewer. J. A. T.

ENGINEERING EXPERIMENT STATIONS.

A MEMORANDUM prepared for the Governor and the General Assembly of the State of Illinois, concerning the work of the College of Engineering and the Engineering Experiment Station of the University of Illinois, has lately reached us. It is partly a statement of the work of the college, which gives degrees to more than 200 engineering students annually, with photographs of some of the large engineering works executed under the direction of its graduates, and partly an appeal for a large extension of its buildings. It is pointed out that the growth of a State in population, wealth, and influence depends chiefly on its success in the development of engineering industries.

It is known that the "State universities" of the United States have engineering laboratories more largely staffed and more completely equipped than those in this country, and that they carry on research work very directly associated with industrial needs. Lately there has been a movement to develop these as "experiment stations." In the case of the Illinois University the control is vested in the heads of departments of the college; the ordinary equipment of the laboratory is used, but there are nine investigators devoted to research work and fourteen research fellows who give half-time to research. All results are published and 106 bulletins have been issued.

In a short account of the more important researches carried on, it is stated that Prof. Talbot's tests of reinforced concrete have supplied information on which standard practice has been based. They are well known in this country. In the case of iron alloys, researches have been made with an electric furnace permitting melting *in vacuo*. These, it is claimed, have led to the production of iron alloys having magnetic properties far superior to anything hitherto known—for example, specimens with a permeability seven or eight times higher than any other alloy. A new law bearing on steam-engine practice has been discovered by Mr. Clayton, connecting the form of the indicator expansion curve with the quality of steam in the cylinder. This makes it possible to predict the economic performance of an engine from the evidence of the indicator diagram. Prof. Goodenough has deduced values of the constants for steam which, it is stated, give the means of calculating steam tables of far greater accuracy than any hitherto published. Prof. Parr has devised a new low-temperature process of carbonisation of the non-coking Illinois coal of great importance, with the advantage that valuable by-products are recovered.

The building programme put forward will involve an expenditure of nearly 1,000,000*l*., exclusive of land and equipment. In the last two years the expenditure of the college has been 152,000*l*., and the budget for the next two years is 300,000*l*. Some account is given of the Massachusetts Institute of Technology, now incorporated with Harvard University, which has purchased land and erected buildings and provided equipment at a cost of 1,400,000*l*.

The most important experiment station in the United States is, no doubt, the Bureau of Standards—a Federal institution which has relations with many industries, and receives from the Government 125,000*l*. annually. A remarkable development is the Mellon Institute attached to the University of Pittsburgh. There any industry can endow a fellowship for a specific research. The University selects a suitable investigator and provides the laboratory. When results are obtained a small unit factory is established near the institute and the process worked on a small but commercial scale. The annual expenditure is 30,000*l*.

PROF. EMIL VON BEHRING.

IN NATURE of April 26 a short chronological survey was given of the career of Emil von Behring, whose death was recently announced. In the early eighties of last century, whilst a military surgeon at Bonn, Behring commenced a series of investigations which ultimately led him to the discovery of anti-toxins. This work merits fuller notice than could be given to it within the limits of a paragraph in the Notes columns of NATURE.

The fact that white rats were generally immune against anthrax, whereas ordinary wild

rats were susceptible to the disease, had excited the curiosity of bacteriologists. With the view of discovering the cause of the resistance of white rats, Behring tried the effect of their serum upon anthrax bacilli *in vitro,* and found that anthrax bacilli were killed by a short sojourn in fresh serum. This observation, together with those of Nuttall upon the similar properties of the fresh serum of man and several animals, formed the foundation of the humoral theory of defence against the invasion of microbes into the animal body.

In 1888 Behring went to Berlin and became an assistant to Koch at the Hygienic Institute. There he was associated with Loeffler and Kitasato, who had recently discovered the microbes causing diphtheria and tetanus respectively, diseases apparently brought about by the local multiplication of the organisms and without the penetration of the bacilli into the body generally. These were important steps in the interpretation of zymotic disease, and indicated that microbes manufactured soluble poisons which, being absorbed, acted upon the cells of the nervous system and other essential organs. The demonstration of the accuracy of this interpretation followed in 1888 when Roux and Yersin grew diphtheria bacilli in broth, removed the bacteria by filtration through unglazed porcelain, and produced the characteristic effects of diphtheria with the sterile filtrate. To this bacillary poison they gave the name "toxin."

Following up his earlier researches, Behring, by repeated small inoculations of certain microbes, immunised animals against large doses, and showed that their serum possessed the property of destroying *in vitro,* in an enhanced degree, the microbes to which they had been accustomed.

The psychological moment for the discovery of anti-toxic immunity had now arrived, and in 1890 Behring and Kitasato announced the discovery that an animal, immunised against tetanus and diphtheria by graduated injections of killed broth cultures of these microbes, produces in its blood substances which are capable of neutralising the toxic actions of these bacteria. They also showed that an animal previously injected with the serum of such an immunised animal withstood an otherwise fatal dose of bacilli or toxin, and, further, that when treated with the serum, even after symptoms had developed, it could be cured. To the substance in the serum of immunised animals they gave the name "anti-toxin." These fundamental observations were carried a stage further by Behring and Baer, and the serum tested on children with favourable results.

The importance of the initial discovery by Behring and Kitasato was at once seized by Emil Roux, the present director of the Pasteur Institute, who, in collaboration with Louis Martin, developed a method for its practical application which has been changed in little else than detail up to the present day. They immunised horses and were thus able to produce anti-toxic serum in quantity. In collaboration with their colleagues at the Paris hospitals, a trial of the new remedy was made in such a manner and upon such a scale as to place the serum treatment of diphtheria upon a firm basis by 1894.

During the last twelve years Behring's scientific activity had been for the most part directed to the problems of the immunisation against and cure of tuberculosis in man and animals. Behring started with three theses. The first is that the bacilli of human and bovine tuberculosis are but varieties of the same organism; the second is that infection, in the case of both man and animals, takes place in early life *via* the alimentary canal, and that phthisis is a sequel to such intestinal infection; and the third is that few humans or bovines escape infection before becoming adult. The first and second of these views, although receiving support in some quarters, have not been generally accepted, and the assertiveness, unsupported by evidence, with which they have been expounded by their author has not conduced to their receiving even so much attention as they deserve. Assuming their correctness, however, it is obvious that prophylactic immunisation, if it is to be effective, must be undertaken in early life. Behring attempted this with cattle, using attenuated human tubercle bacilli, but the results were not commensurate with expectations.

The treatment of children with any form of living tubercle bacilli being impracticable, Behring endeavoured to prepare extracts of killed bacilli which might possess the desired properties. The difficulties of inquiries in this domain, and their possible value to humanity, can scarcely be exaggerated, and it is a matter for regret that Behring's efforts therein should have been shrouded in a certain mysteriousness which is inimical to the best interests of science. A product of tubercle bacilli called "tulase" was evolved, which, according to the author, immunised animals against living tubercle bacilli and was effective in the treatment of tuberculosis in man. The exact nature and methods of preparation of tulase have not been made known beyond the statement that it is produced by the prolonged action of chloral hydrate upon tubercle bacilli, and is different from tuberculin. As, however, no results of this remedy have been forthcoming, and as several years have passed since it was introduced, it has presumably proved disappointing.

From 1895 until shortly before his death Behring was professor of hygiene in the University of Marburg, and director of the Hygienic Institute. For his discovery of anti-toxin he was awarded in 1895 the prize of the Académie de Médecine and Institut de France, and he had many distinctions conferred upon him by learned societies. In 1901 he received the patent of nobility, and in the same year was awarded the Nobel prize.

C. J. M.