

within the limits of the alloys studied, the constitution of the ternary alloys very closely resembles that of the binary alloys of aluminium and copper; manganese influences the properties of the alloys in a manner somewhat similar to that of aluminium, but at a different rate."

At the aluminium end the results have been less favourable. The most promising alloy appears to be one with 3 per cent. of copper and 1 per cent. of manganese, which in the form of a chill casting gave a tensile strength of 12 tons per square inch and an elongation of 13.5 per cent. on 2 inches. In the form of rolled bars, however, the authors say, "there does not appear to be any advantage in using the ternary alloys as compared with the alloys of aluminium with copper alone."

The remaining papers are as follows:—

(4) "Report on the Progress of the National Experimental Tank," by Dr. R. T. Glazebrook.

(5) "On the use of Mutual Inductometers," by A. Campbell.

(6) "Comparative Life Tests on Glow Lamps," by C. C. Paterson and E. H. Rayner.

(7) "On a Method of Counting the Rulings of a Diffraction Grating," by G. W. Kaye.

(8) "The Expansion and Thermal Hysteresis of Fused Silica," by G. W. Kaye.

In view of the extensive application of fused silica or quartz glass to physical and chemical operations, the last-named paper is of considerable interest. A curve is given from which the mean coefficient of expansion over any desired range between -190° C. and 1100° C. may be derived. From this curve it appears that two change-points exist, one at -80° C., the other at about 1000° C. As regards linear hysteresis, the author concludes, "Silica over a range of 0° C. to 400° C. has nothing to fear in comparison with either Invar or Jena thermometry glasses. . . . There is practically nothing to choose between the different kinds of fused silica." A silica standard metre is being completed at the laboratory.

H. C. H. C.

SPECIALISATION IN UNIVERSITY EDUCATION.

THE March issue of *The Johns Hopkins University Circular* contains an account of the celebrations in connection with the Commemoration Day of the University held on February 22. Dr. James Bryce, the British Ambassador to the United States, was the principal speaker, and in his address discussed the tendency to over-specialisation in university education. Mr. R. Brent Keyser, the president of the Board of Trustees, read a statement of the plans for the development of the new site for the University. Nine years ago, he said, at the time of the raising of the Million Dollar Endowment Fund of 1902, the University received also the gift of the Homewood property. This property, under the deed of gift, is to become the permanent home of the University when, in the judgment of the Board of Trustees, the interest and welfare of the University permit. A plan for development has been provided which will admit of growth and alteration to suit the changing needs of future years. To-day we have been given, he continued, means to accept the offer of 50,000*l.* from the General Education Board, and the total amount pledged, part of it already paid in, amounts to nearly 240,000*l.* With great wisdom, the General Education Board, the aim of which is to help the cause of education of the whole country, has provided that at least 100,000*l.* of this amount shall be retained as a permanent endowment, the income only to be used, so that the institution might not be crippled in its real work by the expenditures incident to large building operations, and by the greatly increased expense which will come from living in such an enlarged environment.

Mr. B. H. Griswold, jun., chairman of the committee on the endowment and extension fund of 1910, said 1500 gifts, ranging from one dollar to 20,000*l.*, totalling nearly 240,000*l.*, and substantially every dollar of it from Maryland, with the exception of the gift of the General Education Board and contributions of non-resident alumni, had been secured. Apart from the original gift of the founder and apart from all legacies, the citizens of Maryland and the alumni of the University, before the last appeal was

made and answered, had bestowed, by direct gift, upon the University since its foundation more than 600,000*l.* The exact amount contributed to date to the 1910 Endowment and Extension Fund is 238,635*l.* Of this sum, 50,000*l.* was given by the General Education Board, 48,000*l.* by the trustees of the University, 60,000*l.* was subscribed by the alumni, and the balance of more than 80,000*l.* was given by those to whom we have given the simple but honourable degree of "Friends of the University." A few special gifts may be mentioned: there is one of 4000*l.* to the department of romance languages, one of 2000*l.* for the Edmund Law Rogers fellowship, and 2000*l.* for the Hutzler library.

Mr. Bryce's address applies equally to British as to American universities, and it is here reprinted in an abridged form.

A remarkable feature of the thirty-five years over which we look back is the wonderful development of the various departments of human knowledge, and especially those which are concerned with the sciences of nature, into special branches, each of which has been tending to become more distinct from the others. So far from finding ourselves approaching the end of human knowledge, we find that the more we know the more remains beyond to be known, and that the realm of the unknown seems to be always increasing with every addition to our knowledge. It is as though the path which we are following were always diverging into a number of different paths which tend to separate from one another, and lead us into untrodden solitudes to which we see no end. Within the recollection of most of us, new branches of science have made good their place, and have become recognised as separate fields of inquiry, and along with this it has befallen that the great majority of scientific inquirers now, so soon as their general scientific education has been completed, begin to devote themselves to one particular branch of investigation and throw their whole energy into pushing it forward. A man is now not a "natural philosopher" in the old sense of the term, but belongs to some one of the specific branches into which natural philosophy has become divided. The same thing has happened in those practical arts which depend upon the application of science. They, too, have multiplied by division, and thus new practical professions have grown up, which were scarcely thought of forty years ago.

The same thing has of necessity happened in university education. We have now in all organised universities professors of a large number of distinct branches of knowledge, which were formerly lumped together as being one branch under one professor.

So also among the students the tendency is for those who have advanced some way to begin to devote themselves to one particular line of study and investigation. Both the teacher and the student are naturally fascinated by the prospect of discovery. The professor likes best to lecture upon the subject in which he is pushing forward his own investigations, and the student is able to find in them the most attractive field of experimental research.

This sort of specialisation has become inevitable, but there is a consequence attached to it which has seemed almost equally inevitable, namely, that part of the time which was previously given to general study, to a knowledge both of natural science in general and of other subjects, has now had to be devoted to this special study. The field of nature is unlimited. Human curiosity is unlimited. But human life and the capacity for using our time and our powers in the acquisition of knowledge remain within very narrow bounds.

Accordingly, the problem which to-day confronts us in all universities is how to find time both for these specialised studies, which have become so much more absorbing, and also for a survey and comprehension of the general field of human knowledge which is necessary in order to make the university graduate a truly educated and cultivated man, capable of seeing the relations of his own particular study to others and of appreciating the various methods by which discovery is prosecuted. This problem of reconciling special with general study, although most urgent in the sciences of nature, shows itself in what may be called the human subjects also.

However, the difficulty I am referring to arises chiefly

in the sciences of nature. These are now tending to overshadow all other studies, partly perhaps because the practical applications to which they are turned have become very numerous and of immense industrial importance for men and nations, and partly also because we are all fascinated by the progress of discovery, and are so eager to attain certitude that we are disposed to turn from those inquiries in which complete certitude is unattainable to those in which we can find an absolutely firm basis in the laws of nature; and it is in the natural sciences that the subdivision and specialisation of which I have been speaking has gone furthest.

Accordingly, the problem to which I have referred has two aspects. It raises the question of a mastery of the principles of the sciences of nature in general as against a highly specialised study of some one department in those sciences. It also raises the question of the respective claims of the study of physical science, or some branch of it, as against the claims of what may be called the human sciences, or, if you prefer it, human subjects.

What do we mean by general intellectual cultivation as opposed to special knowledge? Without attempting a complete definition—nothing is more dangerous than a definition—I will suggest a description. We mean such a knowledge of the main facts and distinctive methods of various branches of human knowledge as give a general idea of the relations of each branch to other branches, that is to say, of what truth and certitude mean in different departments of study, and what are the various paths by which truth may be reached or approached. If you asked me to indicate what this would include, I should make some such answer as this. In the sphere of natural science, it would include a knowledge, not necessarily wide, but sound and exact so far as it went, of some deductive science such as geometry, and of some science of observation such as a branch of natural history, geology, for instance, or some department of biology, or of such a science as chemistry. On the human side, it would include a knowledge of one of what may be called the abstract subjects, such as psychology or logic or ethics, and of one of the observational subjects such as economics or politics. It would include a knowledge of the principles of language, and of at least one foreign tongue, ancient or modern, preferably an inflected tongue; and, finally, it must include the record of human effort and development through the past, that is, history, which shows us how man has grown from what he was in the past to be what he is in the present, and holds out hopes of what he may be in the future. Without at least an elementary knowledge of these, no man is properly equipped for a life of study and thought, or for those branches of practical life which require a wide intellectual outlook. It is not necessary to-day, as it would have been fifty years ago, to argue that every educated man should have some knowledge of deductive science and of the observational and experimental sciences of nature.

Specialisation is not only inevitable for the progress of discovery, but in many minor ways excellent. It is a splendid thing for a great university like this to have among its professors men, each of whom is abreast of the highest development of some particular line of inquiry and knows how that line of inquiry ought to be prosecuted, so that it holds within its own walls, so to speak, an accumulated mass of various knowledge, representing what the world has yet attained. The scientific specialist makes interesting company—when I have a chance I always try to get beside him at dinner—because he is able to tell us what we seek to know of the progress of discovery in the growing sciences, and we have only to ask him to get at once, without the labour of consulting books, the latest results in the clearest form. The scientific investigator, moreover, seems to have, on the whole, the happiest kind of life that is now possible. Does he know how happy he is? Engaged in the discovery of truth, he has for his helpers all others engaged in the same pursuit, and knows that all his labours are working towards a noble and useful end. He is free from the vexations that beset the business man or the lawyer or the politician. If he has not a happy life, granted good health, it is probably his own fault, for what is finer than to be, as Bacon says, *minister et interpres naturae*?

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Admitting all this, and much more that might be said on behalf of specialisation, it is nevertheless right to present to you some dangers that seem to arise from the immense extension of the specialising tendency and from the predominance, in particular, of the study of the natural sciences to the exclusion of other subjects. The phenomena of nature may no doubt be slowly changing, and as we know that even among those bodies which we call the fixed stars the positions of the stars towards one another alter, so oxygen and hydrogen may be different now from what they once were, and the proportion of the elements in the compound bodies may alter. The sciences of nature are occupied with that which is permanent and unchangeable. They deal with those laws which we believe, so far as our knowledge goes, to be immutable, to have been operative in the past, and likely to be operative in the future, as they are operative now. He who is entirely occupied in studying these unchanging laws does not learn thereby how to deal with that which is mutable and transient. But the mutable and the transient include, not only most of what concerns our daily life, but the whole immense field of knowledge which covers the human subjects. The realm of ideas, beliefs, theories, feelings, institutions, habits, in fact the whole realm of human thought and conduct, belongs to the sphere of the transitory and changeable. In investigating this realm, we have to walk by methods which are not only not the same, but are even more difficult than those which belong to the sciences of nature. The investigation of probability is more perplexing and less satisfying than those inquiries at the end of which stands certain and immutable truth. Those who try to apply the same formulæ and methods to the human subjects which they apply to nature are in danger of failing, as Herbert Spencer, for instance, failed when he entered the field of history and that of political or social phenomena.

Sixty years ago people complained, and complained justly, of the narrowness of those, even of some eminent men, who had been trained entirely on the old scheme of education, which largely consisted in grammatical studies, and especially in a knowledge of the ancient languages. Men otherwise highly gifted and instructed who had been so trained often failed to appreciate the interest and value of the study of nature, and showed a strange incapacity to understand its methods. Francis Bacon has warned us against that absorption in a particular set of ideas, that prepossession in favour of one particular view which he classes among the *Idola Specus*, the phantasms of the cave which surround the man who sits in the dark recess of his own line of thought unilluminated by the light of the broad sky. So now the devotion to any special study, whether in the sphere of natural science or not, tends to narrow the mind and prevents the faculties from attaining their highest development. Many of the greatest discoveries have arisen from bringing together facts and ideas drawn from different regions the relations of which had not previously been discerned. The more you extend the range of knowledge, the more you increase the chances of such discoveries. Most of the great men to whom the progress of science is due were not trained as specialists, but had minds that ranged far and wide over the field of knowledge.

Someone has said that the chief end of education is to stimulate curiosity, to make a man ask about all things familiar or unfamiliar, the how and the why, to discover matter for inquiry in things which other people have passed over without thinking of the problems they suggest, to retain that activity and versatility and freshness which are the most characteristic marks of a forceful and creative intellect. Is it not wonderful how many things were overlooked in the past which now we feel to need investigation, and may there not be things now that ought to be investigated which we are passing over as familiar? The ancients must have noticed the difference in the aspect and structure of different kinds of rock, for instance. The differences between gneiss and limestone, between basalt and slate, stared them in the face. They saw fossil shells in the strata. But it did not occur to them to seek the explanation of these things, and geological science is not yet two centuries old. The wider the range of a man's interests, the more susceptible he is to ideas of many

kinds, the greater is the pleasure which life can afford him, the better can he contribute to the progress of the world both by stimulating others and by himself pointing out the way in which advances can be made. A university has to think, not only of forming specialists, but of making these specialists better by giving them a wide range of knowledge, and still more of sending out men who sustain the level of taste and insight in the whole community and are fit to be its intellectual leaders.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—A public meeting under the auspices of the University Eugenics Society will be held in the new lecture-room, Emmanuel College, by permission of the master and fellows of the college, on Monday, May 22, at 8.30 p.m. The Rev. Prof. Inge, D.D., Dean Designate of St. Paul's, will give an address on "Some Social and Religious Aspects of Eugenics."

OXFORD.—The preamble of the Statute exempting students in natural science and mathematics from examination in Greek passed Congregation on May 16 by 156 to 79.

LONDON.—Presentation Day was on Wednesday, May 10. The Chancellor (Lord Rosebery) presided, and an unusually large number of graduates were presented. A precedent was established this year by the presentation of cadets of the Officers' Training Corps who had gained War Office certificates or proceeded to commissions in the Army. The principal's report showed that the total admissions to the University in 1910-11 were 4255, compared with 4053 in the previous year; internal students, 4350, compared with 4185; and total candidates in examinations leading to degrees or diplomas, 12,681, compared with 12,787. The number of degrees or diplomas granted was 1222. Reference was made to extension of university professoriate, following the appointment of a large number of board of advisors. Among individual benefactions during the year, the most important were those of Sir Francis Galton for eugenics (40,000*l.*), Mr. Henry Dixon for scientific investigations (8000*l.*), Dr. Charles Graham for medical and pathological research (33,500*l.*), and Sir Felix Semon for laryngology (10400*l.*). The report also referred to the notable development of student activities—military, athletic, and social. Lord Rosebery, in a short address, appealed for more adequate accommodation for the central premises of the University and for increased financial support from the authorities and city companies.

It has been decided by the council of Armstrong College, Newcastle-upon-Tyne, to establish a professorship of philosophy at the college, and to appoint an additional demonstrator in physics.

The *Lancet* announces the appointment, by the Lord President of the Privy Council, of Sir Donald MacAlister, K.C.B., principal of Glasgow University, as his representative on the International Committee for Post-graduate Medical Instruction.

THREE scholarships in naval architecture have been instituted at the University of Liverpool by the General Committee of Lloyd's Register of Shipping. Each scholarship is of the value of 50*l.* a year for three years, and one will be vacant annually. The first election will take place this year.

Two cases of importance to persons taking part in competitive examinations were settled at the Bow Street Police Court on Saturday last. The defendants were tutors at a coaching establishment, and therefore debarred from taking part in the examinations of the Royal Society of Arts. Notwithstanding their ineligibility, they duly competed under assumed names and gained prizes. The Royal Society of Arts, being anxious that their examinations should be inviolate, and to make it clear to all that people are not allowed either by the rules of the society or the law to compete in examinations in a way which is detrimental to other candidates, took action in the matter, and they are to be congratulated on the result, the defendants being found guilty and punished.

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ACCORDING to *Science*, at its recent session the legislature of Kansas voted approximately 200,000*l.* for the next State Agricultural College at Manhattan for the next biennium. The funds provide for one wing of an agricultural building, with a detached laboratory for the cutting and curing of meats. The first wing of the new building is to cost 25,000*l.* Two more wings are to be added as the money is voted, each complete in itself. The legislature also provided a special fund for various objects, including money for experiments in the western part of the State in cooperation with the Federal Government; for soil surveys, also in cooperation with the United States Government; for experiments in producing improved wheat, corn, and other crops. The college has this year approximately 2500 students, more, it is said, than are enrolled in any similar institution in the world. The cost per student in this institution in 1910 was 21*l.*

WE learn from *The Belfast News-Letter* that the Library and Technical Instruction Committee of Belfast contemplate making a collection of kinematograph films of educational value for public exhibition in that city. Mr. F. C. Forth, the principal of the Technical Institute, a week or two ago gave a very successful introductory demonstration of the advantages of the kinematograph for teaching the character of various operations and movements that students may perhaps never be able to see for themselves, and which are but poorly represented by the simple lantern-slide. Among the films shown there were illustrated metallurgical works, a visit to Niagara Falls, cheese mites, a fresh-water hydra, rotifers, the circulation of protoplasm in the water weed, the circulation of blood in a frog's foot, chameleons feeding, toads fighting, and the development of a flower.

ON July 14 the King will open the new buildings of the University College of North Wales, which have been completed at a cost of about 112,000*l.*, exclusive of the site, which was presented by the citizens of Bangor. Of the total cost, rather under 10,000*l.* remains still to be collected, and the sums already received include 16,800*l.* from Carnarvonshire, 18,350*l.* from London, 1350*l.* from the staff, and 3500*l.* from old students. The quadrangle of buildings, which is flanked on three sides by the classrooms and offices, has been completed on the fourth side by the Great Hall specially presented by Sir Pritchard Jones. The removal of the arts classes to the new buildings has given increased accommodation to the science departments, and among the gainers the agricultural and forestry departments may be noted. That theory and practice are not always inconsistent is evidenced by the large number of prizes secured by the former department at agricultural shows.

THE council of the Institution of Civil Engineers has made arrangements to hold a conference on the subject of the education and training of engineers on June 28 and 29 at the institution. The subject-matter to be discussed at the conference will be dealt with in three groups, namely, general education, scientific training, and practical training. Among other topics which will receive consideration at the meetings may be mentioned:—the extent to which mathematical and scientific subjects should share with other subjects of literate education the attention of schoolboys who intend to enter later the engineering profession; the question of specialised entrance examinations for university and college courses of study in engineering science with a view to the curricula to be followed, and also of the inclusion in the latter of courses in modern languages; the relation of practical training to college study—whether, or to what extent, before, sandwiched, or after its conclusion; the position and uses of engineering laboratories in relation to education at college; the value of a university degree in engineering science in relation to professional competence; the requirements of practical training in works, with the necessary complement of scientific study; practical training in workshops or on works of construction, with special reference to training in the engineer's office; the relation of engineering employers and colleges from the point of view of the practical training of college students; workshop training as a preliminary to practical training in other branches of engineering.