Thermocouple devices have also been developed to similar efficiencies, but operating at lower temperatures. The old-fashioned metallic thermocouple is limited to low efficiency by excessive heat conduction, but semiconductors with poor heat transmission characteristics have revolutionized the field. The best material at present available is bismuth telluride doped with selenium and antimony to give negative and positive thermoelectric coefficients. A large number of these units can very conveniently be connected in series electrically and in parallel for heat flow. The efficiency is 5 per cent per 100 deg. C. temperature difference, but the maximum operating temperature is limited to the region of 250° C., above which the efficiency falls and the material is degraded. It is believed that an extension to 400° C. might be possible with special precautions. Lead telluride in alternate *n* and *p* type form is used in *Snap*. It has a lower efficiency for a given difference of temperature, but can be used at higher temperatures. The initial efficiency is quoted as 10 per cent, but after a half-life it falls to 5–6 per cent with an output of 3 watts. The initial power output is not directly quoted, but with 3,000 curies and 10 per cent efficiency it should be in the region of 10 watts. This would be consistent with an output after 140 days of the order of 2·5 watts, a factor of two down in power of source and a further two for reduced efficiency. There is insufficient information to determine why lead telluride was used and not bismuth telluride. It could be that bismuth telluride came a little too late, and the higher efficiency per 100 deg. C. is not a very important factor ; or there might be a more cogent reason for the high temperature of the source connected with a difficulty in achieving a low temperature of the base in an artificial satellite.

Several other alpha-emitting isotopes might in theory be substituted for polonium, but it is unlikely that the natural or the trans-uranium elements would be available in sufficient quantities. The American press release suggested using the fission products $Ce^{-144}Pr$ (half-life 285 days) having a total beta-energy of 3·3 MeV. Here the compactness of the gadget must be sacrificed. Sources of high-energy beta-rays of this activity will be accompanied by a considerable bremsstrahlung background of X-rays which would require appreciably heavy shielding.

Apart from a better and cheaper supply, no great developments can be expected from the radioactive side of these generators. The methods of conversion, on the other hand, are the subject of considerable research, and new and improved alloys can be expected to raise the temperature of conversion and the efficiency. The stimulus for this work comes, however, from the more important possibilities of direct conversion of reactor heat or waste heat to electricity.

THE INDIAN INSTITUTE OF SCIENCE, BANGALORE, INDIA

GOLDEN JUBILEE

By Dr. S. BHAGAVANTAM
Director

THE Indian Institute of Science, which marked its golden jubilee by a special meeting on February 2, owes its existence to the far-sighted vision of the well-known philanthropist, the late Mr. Jamshetji Nusserwanji Tata. Unfortunately, the founder did not live to see the fruition of his idea, and it was left to his two sons, the late Sir Dorab J. Tata and the late Sir Ratan J. Tata, to carry out their father's wishes, with the active support of the late Lord Curzon, the then Governor-General of India, and Sir K. Sheshadri Iyer, who was at that time Dewan of Mysore. Mr. J. R. D. Tata, who is president of the Court of the Institute, opened the jubilee proceedings ; the guests included the President of India, H.R.H. the Duke of Edinburgh and the Governor of Mysore.

The Institute may be deemed to have come into formal existence on May 27, 1909, the date of the vesting order of the Government of India. The first batch of students was, however, admitted only in 1911 with the Departments of General and Applied Chemistry and of Electrical Technology commencing to work. The Department of Organic Chemistry was added soon after. The Department of Biochemistry was opened in 1921 and that of Physics in 1933, when Sir C. V. Raman took charge as director of the Institute.

To the first director, Dr. Morris W. Travers, the distinguished chemist, and his colleagues, the Institute owes its sound foundations. Dr. Travers was succeeded by Sir A. G. Bourne (1915–21), Sir M. O. Forster (1922–33), Sir C. V. Raman (1933–37), Sir J. C. Ghosh (1939–48), who has just died (see p. 645), and Prof. M. S. Thacker (1949–55). I took charge in March 1957.

The Institute functions as an autonomous body in accordance with a scheme formulated by the Government of India under the Charitable Endowments Act. Its authorities include the President of the Republic of India as its *ex-officio* Visitor, a Court, a Council, a Finance Committee, a Board of Management for the endowed properties, a Board of Holding Trustees for the other properties, the Senate, the Faculties and the Director. The Director is the Chief Executive and Academic Officer of the Institute.

The Quinquennial Reviewing Committee, 1955, recommended that in place of the diplomas that it had been so far conferring on its students, the Institute should be enabled to confer degrees on them. On the orders of the Visitor, the Institute is now deemed to be a University under Section 3 of the University Grants Commission Act of 1956 for the purposes of that Act and is conferring the degrees of B.E., M.E., M.Sc., Ph.D. and D.Sc. instead of diplomas.

The accompanying figures (Table 1) give an idea of the Institute's expansion since its beginning.

Being in possession of well-equipped laboratories and as the leading postgraduate institution of the

Table 1

Year	Receipts (rounded to nearest thousand) Rs.	Expenditure (rounded to nearest thousand) Rs.	No. of students	No. of members of staff
1911	20,68,000	15,99,000	24	6
1919	3,24,000	3,41,000	73	7
1939	6,58,000	6,08,000	187	20
1947	32,06,000	36,67,000	221	50
1953	58,65,000	54,14,000	373	123
1958	64,05,000	66,64,000	561	157

country for advanced instruction and research in science and engineering, the Institute took up for investigation during the Second World War a large number of schemes of research sponsored by the Council of Scientific and Industrial Research, the Indian Council of Agricultural Research, the Indian Council of Medical Research and the Governments of Madras and Mysore. During that period, the Institute planned and established a Department of Aeronautical Engineering. When the War was drawing to a close, a further four-year expansion programme was launched with grants sanctioned by the Central Government. Under that programme, the Departments of Metallurgy (1945), Internal Combustion Engineering (1945), and Chemical Technology and Chemical Engineering (1951) were established ; and laboratories for research in fermentation technology, food technology and pharmacology were set up. For the training of power engineers, a Department of Power Engineering was established in 1947 with laboratories for electrical, mechanical, civil and hydraulic and high-voltage engineering. A Section of Economics and Industrial Psychology, including industrial relations, and affording facilities for research in these subjects, was also started in the same year.

In 1955, under a scheme for the development of facilities for technical education, additional post-graduate courses in automobile engineering (1956), foundry engineering (1956), soil mechanics and foundation engineering (1957), electronic engineering (1956), ultra-short and microwave engineering (1956), line communication engineering and acoustical engineering were provided. Further facilities for research in technical gas reactions, physical metallurgy, hydraulic machines, internal combustion engineering, electrical measurements and measuring instruments, transmission, distribution and network practice have been added. Recently, a Department of Applied Mathematics and a Section of Industrial Engineering and Administration have been established.

The Library of the Institute is one of the best scientific and technical libraries in India.

The Institute publishes a quarterly entitled *Journal of the Indian Institute of Science*, containing original papers by the research workers of the Institute.

A noteworthy feature of the Indian Institute of Science is the objective itself with which it was founded, namely, for the provision of advanced instruction and the conduct of original investigations in all branches of knowledge that are likely to promote the material and industrial welfare of India. The broader the objective, obviously the more difficult will it be of fulfilment. However, the facts that we started with good foundations and established at a very early stage traditions of research in pure sciences like physics and chemistry, that we added later, and at appropriate times, specialized branches of technology like power engineering, metallurgy and aeronautics, and also that we did not quite neglect mathematics and even the humanities are, in my opinion, the principles that helped us to face our task and make its fulfilment come as near the ideal laid down by the founder as possible.

During the past fifty years, the Institute has grown to be one of the foremost centres of scientific research and advanced instruction in India. A large low-speed open-circuit wind tunnel of 9 ft. × 14 ft. test section was inaugurated during the recent jubilee celebrations. This tunnel is the only one of its kind in India, and will offer increased instructional and research facilities in aeroplane design. A modern a.c. network analyser, again the only one of its kind in India, has been in use for some time now in connexion with studies relating to power systems in the country. We are planning to put up and equip a modern acoustical laboratory to serve the purpose of training, research and testing in all branches of acoustics. There are many other lines of development which are not mentioned here for want of space. The Institute's contribution to the instructional aspect is reflected in the fact that more than three thousand of its alumni are now occupying positions of importance and responsibility all over the country in their fields of specialization. The research work done at the Institute has opened a new vista for generations of Indian scientists and engineers who go through its portals. Many young men and women from different parts of the country now eagerly look forward to joining the band of workers at the Institute.

The Institute is, to a high degree, autonomous in character. In the past, we confined ourselves to research and training, largely at the postgraduate level, and we propose to retain this feature in the years ahead. Thus we are able to direct our technological and scientific resources to carefully chosen specific purposes. We hope that against this background the Institute and those associated with it will have a great part to play in promoting the progress of India.

OBITUARIES

Sir J. C. Ghosh

Sir Jnan Chandra Ghosh died suddenly at the age of sixty-four at his Calcutta residence on January 21. I had been closely associated with him for some fifty years.

Sir J. C. Ghosh was a leader in physical chemistry when he was the professor and head of the Chemistry Department of the University of Dacca, which he joined in 1921, being appointed in London by Sir Philip Hartog, the first vice-chancellor of the University. He served this University loyally for twenty years and with conspicuous success as a teacher and research worker. By his devotion to science and his kindly nature, he attracted many young men and initiated them into scientific research. This seems to have been the best period in his career in the service of science and education.