and requiring a systematic scheme of education. Empirical methods of approach can no longer be considered adequate when our economic units are so large and their administration so complex, and it has become necessary to distinguish between the trained administrator who adopts a scientific approach to his problems, and the man who continues on rule-of-thumb methods. Administration may be defined as the co-ordination and control of all the specialized activities necessary to the effective operation of an industrial or other undertaking. Administration and specialist functions are closely interwoven in the senior positions of an industrial undertaking. While, for example, the managing director may be regarded as exercising 90 per cent administrative and 10 per cent technical functions, the works manager 66⅔ per cent administrative and 33⅓ per cent technical, the sales manager 60 per cent technical and only 40 per cent administrative, it is surprising how far down the scale some proportion of administrative function is involved.

The chief characteristics of modern industrial administration may be summarized as: functional division and devolution of responsibility, involving specialization and simplification; co-ordination of activities, involving the generation of the team spirit on a large scale; and the substitution of fact analysis for guesswork, involving planning, costing and budgetary control. The impact of economic forces has driven industrialists to seek higher efficiency through the improved technique of specialists in all these departments. Their next problem is to bring about a parallel improvement in the technique of administration itself.

Mr. Byng referred to the way in which the responsibility of the administrator has been enhanced by specialized research into the conduct of industry, and stressed the importance of advances in industrial psychology and the study of human relationships. If the art of persuading men to work willingly and harmoniously is lacking, the real effectiveness of the undertaking is seriously impaired, and even complete failure may ensue. Sound laws of administration cannot be laid down without a clear understanding of human motives and desires embodying the characteristics of the group-mind, the effect of tradition, the response to varying incentives, the real causes of unrest and the emotional reactions to regulations and discipline. Accordingly, the responsibilities of the administrative function for the efficient development of industrial and commercial enterprise, for the effective use of capital and labour, and for the creation of means by which the increased wealth due to technological improvements in industry can be utilized for the greatest benefit of all concerned, carry social and economic consequences of national and indeed international importance.

Mr. Byng also discussed the question of education for administration both through such organizations as the Institute of Industrial Administration and within the ranks of industry itself. Finally, he urged that administration may justly claim to be a vital factor in industry and to offer an almost unlimited field of usefulness for the highest grades of intelligence. Our industrial future depends largely upon our methods of selecting and training administrators, and the general recognition of the high function they are called upon to perform.

New Ultracentrifuge Installation at the Lister Institute

ON Tuesday, September 29, the Governing Body and the Director of the Lister Institute entertained Prof. The Svedberg of Uppsala and a number of interested physicists, biochemists and biologists on the occasion of the completion of the new ultracentrifuge plant. In welcoming the guests, Prof. J. C. G. Ledingham explained that in anticipation of Prof. Svedberg's visit to London on his way home from the Harvard celebrations, every effort had been made to put the finishing touches to the new installation. Dr. McFarlane, Lister Institute fellow in biophysics and a former pupil of Prof. Svedberg, had been almost entirely responsible not only for the design of the building to accommodate the new plant, but also for the supervision of the lay-out and assembly of all the accessory connexions, electrical, optical, refrigerating, etc., carried out by the Institute's engineering staff. Throughout the whole work, he had enjoyed the constant advice amd co-operation of Prof. Svedberg. The total cost of the installation, including the new building, was about £7,000, of which sum the Rockefeller Foundation had most generously contributed £3,400 in defrayment of the cost of the new machines.

The new laboratory is specially designed and equipped for investigations into the physical nature of very small particles, particularly protein molecules, but it is hoped also to extend its use to the study of the less well-defined entities such as viruses phages and antibody complexes.

The ground floor is largely taken up by two ultracentrifuges and their auxiliary machinery. Both machines, which were made in the workshops of the University of Uppsala to the design of Prof. Svedberg, have optical arrangements which make it possible to observe and photograph the contents of the rotating cell.

The smaller of the two machines is called the equilibrium centrifuge and is used for the determination of absolute particle size or weight. It runs at speeds up to 18,000 r.p.m. and usually for several days and nights continuously. The particles have then ceased moving, and a state of sedimentation equilibrium is set up, which allows of the calculation of absolute size from the final photograph.

The larger machine generates much greater centrifugal forces, up to half a million times gravity, and serves to throw down even the smaller protein molecules completely in a few hours. It is used to measure the sedimentation velocity constant of pure proteins and of the components of a mixture. In the case of native protein mixtures, such as blood serum, it is possible to centrifuge these without previous chemical treatment and to determine from the photographs the concentrations in which the component proteins are present.

The machine comprises a chrome nickel steel rotor of 7 in. diameter rotating inside a massive steel housing from which the air is evacuated and into which hydrogen is conducted at low pressure. The rotor is driven by high-pressure oil on the turbine principle, and the oil is also used to maintain the rotor at a constant low temperature. The usual speed is 60,000–70,000 r.p.m., and elaborate underground foundations are necessary to prevent the transmission of vibrations to the optical system. Owing to the position of the Lister Institute on a reclaimed bank of the Thames, it was necessary to drive piles to a depth of 40 ft. to support these foundations. The centrifuge is entirely controlled from an adjacent room in which temperature, speed, oil pressure, vacuum pressure, hydrogen pressure, etc., are measured and regulated with great accuracy. Photographs are taken every ten minutes through a window in the wall of the control room. Monochromatic light isolated from the mercury arc is used and the wave-length is chosen to suit the light absorption of the protein.

On the upper floor a roomy laboratory is provided for general chemical and physical investigations. A smaller room which is maintained at a constant temperature is intended for measurements of *p*H, conductivity, refractive index and cataphoresis constants. For measurements of the latter an optical system is set up, similar to those on the centrifuges, and this enables photographs to be taken of charged particles migrating in the electric field at a rate which is proportional to their charge. Two modernly-equipped dark rooms are provided, and in another room examination of plates is carried out and calculations made incidental to the various techniques in use.

The rooms in the new laboratory are supplied with compressed air, distilled water and refrigerated water, and are all electrically linked to a central distribution board from which they may receive various electrical supplies, including constant voltage D.C. of low and high voltage, and A.C. of variable frequency. Any room can communicate electrically with another through the main distribution board, and in this way remote electrical measurements may be taken rapidly without the need for transporting complicated apparatus.

Science News a Century Ago

Clarke's Magneto-Electric Machine

IN the *Philosophical Magazine* of October 1836 is a letter to the Editor from E. M. Clarke, of 9 Agar Street, West Strand, London, in which he describes his magneto-electric machine. The letter begins: "From the time Dr. Faraday first discovered magnetic electricity to the present, my attention as a philosophical instrument maker, has been entirely devoted to that important branch of science, more especially to the construction of an efficacious magnetic electric machine, which after much anxious thought, labour and expense I now submit to your notice".

Clarke's machine was designed primarily for physiological purposes. It had a permanent magnet of six laminations mounted vertically and an armature with soft iron cores wound with insulated wire, which could be revolved rapidly past the sides of the magnet poles. With what he called his "intensity" armature, which was wound with 1,500 yards of fine insulated copper wire, the effect, he said, produced "in the nervous and muscular system is such, that no person out of the hundreds who have tried it, could possibly endure the intense agony it is capable of producing; it is capable also of electrifying the most nervous person without giving him the least uneasiness". With his "quantity" armature, which was wound with fifty yards of thick copper bell wire, he could make the various experiments performed with a single pair of voltaic plates and could produce large and brilliant sparks by the light of which a person could read small print.

The Aurora Borealis of October 11, 1836

ACCORDING to *The Times*, shortly after 8 o'clock of the evening of October 11, 1836, "the Metropolis and its suburbs for miles around was thrown into a state of the greatest excitement by the northern hemisphere assuming a most awful fiery appearance, which seemed to indicate the existence of some dreadful conflagration in the north portion of the Metropolis. . . . Many of the fire engines were put into motion, and after scouring the northern parts of the City and suburbs in search of the supposed fire, it was at last discovered that the appearance of the sky had been caused by one of the most splendid of those remarkable phenomena known as the *Aurora Borealis*, or Northern Lights.

"From persons who had the opportunity of witnessing the magnificent spectacle from elevated situations, we understand there first appeared a large luminous arch, extending nearly from north to south, from which streamers appeared, very low. . . . Suddenly the whole hemisphere was covered with them, when the intensity of the light, the prodigious number and the volatility of the beams, the grand intermixture of all the prismatic colours in their utmost splendour, variegating the glowing canopy with the most luxuriant and enchanting scenery, afforded an awful, but at the same time the most pleasing and sublime spectacle in nature. . . ."

Braithwaite's Steam Floating Fire Engine

ONE of the most active mechanical engineers of a century ago was John Braithwaite (1797–1870), who with Ericsson constructed the locomotive *Novelty* which competed at Rainhill with the *Rocket*, and who with Vignoles laid out the Eastern Counties Railway. With Ericsson he constructed the first steam fire engine. In the *Mechanics' Magazine* of October 15, 1836, he described his "Steam Floating Fire Engine" for use on the River Thames. Though the superiority of the steam fire engine over hand-worked engines had been demonstrated at several fires in London, the London Fire-Engine Establishment, supported by various insurance companies, still clung to hand-worked engines.

The fire float of Braithwaite was a wrought iron boat 80 feet long, 13 feet wide drawing about 2 feet of water. It was fitted with a boiler "on Braithwaite and Ericsson's patent principle" and an engine of 30 horse power giving the craft a speed of about 9 knots. The engine could be coupled by gearing to either the paddle shaft or to double-acting pumps capable of discharging 4–5 tons of water per minute. In his communication to the *Mechanics' Magazine*, Braithwaite said that in spite of the various demonstrations he had given, the insurance companies declined to adopt his engine and "as things at present are I am minus about £3,500 by my invention".