APPLICATIONS OF ELECTRONICS TO RESEARCH AND INDUSTRY

THE first Electronics Symposium of the Scientific Instrument Manufacturers' Association was held in the Caxton Hall, Westminster, during November 18–19. Mr. A. C. D. West, chairman of the Electronics Group of the Association, presided at the first session, and the proceedings were opened by Sir Edward Appleton, who expressed his belief in the great existing and potential importance of electronic techniques in industrial processes. He gave instances in which the introduction of such devices had secured savings of time and money out of all proportion to their cost. The Department of Scientific and Industrial Research had set up a small organisation to explore the field of potential application in industry and to advise on the design and supply of electronic equipments appropriate to the various particular problems they encountered.

The first paper in the symposium itself was by D. J. Mynall (British Thomson-Houston Co., Ltd.) on "Electronics in Computing". Present developments in automatic electronic computing machines can be classified as digital or analogic, according to whether they operate on numbers or on continuously variable quantities. The digital type, with its capacious 'memory' based on supersonic delay lines, cathode ray, or magnetic devices, has a very wide range of application, very great speed, and can give any desired accuracy; but its construction is correspondingly complex. Analogue computors, on the other hand, though generally simpler in construction, are inherently limited in accuracy. It was pointed out in the discussion that the larger types of electronic digital computor will open up new fields of pure and applied science, since they will, for the first time, make practicable the solution of problems which would otherwise need a prohibitive time for computation.

In the second paper, entitled "A Review of Frequency Measurement", by E. A. Rea Palmer and R. W. Darvill (Marconi Instruments, Ltd.), the relation between frequency, time and wave-length was discussed, and the customary division of the electromagnetic wave spectrum into bands was considered. Reasons were given for treating frequency measurement on a functional basis, the chief among them being that different accuracies are required in the various fields, which range from power engineering to ultra-high-frequency radio communications. Equipment can be divided into two groups: direct indicators with an accuracy not better than one part in 10^4; and comparison instruments in which the reference standard has a constancy better than one part in 10^7. The types of instruments appropriate to the various fields were enumerated, and some typical models were described and demonstrated. These included an 'electronic' meter of the limiter-counter type, for use at low frequencies, a high-precision comparison instrument for medium frequencies, a frequency synthesizer for high frequencies, tuned lines for very high frequencies and a crystal calibrator for the ultra-high-frequency band.

The first morning session concluded with a paper on "The Measurement of Small Displacements by Electrical and Electronic Means", in which R. E. Reason (Taylor, Taylor and Hobson, Ltd.) explained that transducers of high stiffness, such as piezo-electric crystals, are suitable for measuring force, while transducers of low stiffness, such as photo-electric or electromagnetic devices, are more appropriate for measuring position.

It was pointed out that electronic instruments, although capable of high magnification, are often unsuitable for workshop applications, where the requirements of low magnification, robustness and cheapness are more easily met by simpler electrical devices. On the other hand, certain types of application such as, for example, the measurement of surface finish, require electronic devices, since high magnification with very low stiffness is necessary. Some practical applications of electronic methods were illustrated by reference to various historical and commercial instruments.

Dr. A. J. Maddock took the chair for the afternoon session, which was opened by G. Syke (Baldwin Instrument Co., Ltd.) with a paper on the "Measurement of Ionizing Radiations". He described the operation of an ionization gauge comprising an ionization chamber, a capacitance or resistance, and a potential measuring device, the voltage across the capacitance or resistance being a measure of the dose or dose-rate respectively. Mr. Syke emphasized the advantages of negative feedback circuits in association with electrometer valves, and described several such circuits. Other instruments mentioned were those using vibrating reed electrometers, multiplier photocells, and Geiger–Müller tubes, the last-named being very suitable for detecting traces of radioactive materials. The principle of operation of the tube and its use with electronic pulse counters were described.

In the second paper, by W. Steckelmacher (W. Edwards and Co. (London), Ltd.), on "High-Vacuum Gauges", reference was made to instruments for measuring low gas pressures both in the research laboratory and in industry. For pressures down to 10^{-4} mm. of mercury, the Pirani gauge is valuable and may be used in a Wheatstone bridge network; alternative schemes making use of a thermocouple welded to the filament are available. The cold-cathode glow-discharge tube can be used in the range 5×10^{-3} to 10^{-5} mm. of mercury, an extension of the range to the low value quoted having been realized by the use of a magnetic field and a special electrode array which increases the opportunities for collision and thus augments ionization. Hot-cathode ionization gauges are effective at pressures down to 10^{-8} mm. of mercury under ideal conditions. They are similar in construction to ordinary triodes, but are used with the grid at a positive potential of about 100 volts and the anode at a negative potential of about 20 volts. For the most accurate measurement of very low pressures, the Knudsen gauge, which uses the direct principle of molecular momentum transfer, is recommended.

The McLeod gauge still remains the standard instrument, and may be used for pressures down to 10^{-4} mm. of mercury. The other types of gauges are calibrated by reference to the McLeod gauge, it being necessary at the lower pressure ranges to extrapolate readings. The indications of the McLeod gauge are subject to error when the system contains vapours.

One of the serious difficulties in the use of the ionization type of gauge is the reaction of the gauge on the system. In some cases the pressure in the vicinity of the gauge may be appreciably lower, in others appreciably higher, than the pressure in the rest of the system, depending on whether the gauge is producing gas or 'gettering'. The author indicated a possible error factor of 10, and concluded his paper with the statement that much work remains to be done to eliminate the difficulties at present confronting the accurate measurement of very low pressures.

In the next paper, on "The Radiosonde and its Applications", J. Foster Veevers (Salford Electrical Instruments, Ltd.) gave details of the processes and test procedures now adopted in the large-scale manufacture of the standard British instrument known as the Kew Mark II. This equipment, originally developed at the National Physical Laboratory and later modified by the Meteorological Office, is now in daily use for the collection of upper air data. To obtain a temperature accuracy of $\pm$ 1° F., a pressure accuracy of $\pm$ 5 millibars and a humidity accuracy of 10 per cent, great care has to be taken in the routine calibration of the instruments, and various special chambers have been constructed for this purpose.

On the second day of the meeting, emphasis was given to industrial applications of electronics, the chairman at this session being Mr. F. A. Downes.

In the first paper, on "Some Industrial Applications of Ultrasonics", D. O. Sproule (Henry Hughes and Son, Ltd.) pointed out that although a vast number of applications have been indicated in the literature, relatively few have so far resulted in devices of commercial value. The marine echo sounder was described and demonstrated, and extensions of its principle for industrial purposes were discussed, with particular reference to the location of flaws and the determination of the elastic constants of materials. The technique of non-destructive flaw detection was demonstrated, and the deduction of the elastic constants of a material from measurements of the velocity of propagation of both longitudinal and transverse vibrations was described. The process of grain refinement was outlined as a typical example of an application in which the objective is a permanent modification of the medium.

In the second paper, by G. S. Elphick, S. Y. Logan and A. R. Woods (Cinema Television, Ltd.), entitled "Metal Detection in Industry", an outline was given of the development of metal detection technique, from the war-time requirements of mine- and bomb-location to the latest industrial equipments currently in use. After summarizing present-day requirements, three detectors were described and the principles involved in their design were explained.

The first is a general-purpose detector of the regenerative type, for use in saw mills for locating metal in timber. The second is a variation of the first, and has been designed for pipe- and cable-location; while the third is a fully automatic industrial equipment in which frequency drift is automatically corrected. In this last instrument ferrous particles about $\frac{1}{16}$ in. in diameter or non-ferrous particles $\frac{1}{10}$ in. in diameter can be detected in materials travelling along a conveyor belt. This apparatus is finding increasing use in a wide range of industries as an inspection device, affording continuous protection for valuable plant, and an effective safeguard against the inclusion of metal in foodstuffs, pharmaceutical products, etc.

Introducing the third paper, on "Sound and Vibration Measurement in Industry", L. P. Corte (Dawe Instruments, Ltd.) stressed the increasing importance of noise control in industry, the first step towards which was the measurement of noise and vibration. He distinguished between the objective characteristics of noise, such as total intensity and the distribution of intensity with frequency, and the subjective characteristics such as loudness, pitch and annoyance. A range of instruments for objective measurements was described. A sound-level meter utilizing a piezo-electric microphone in conjunction with an amplifier and rectifier to measure the total intensity was described. In this instrument some account is taken of the characteristics of hearing, since the resistivity to low frequencies can be reduced at low intensity-levels in accordance with that of the ear.

A vibration meter was next described in which a piezo-electric pick-up is employed, of which the response is proportional to acceleration. A description was then given of an analyser which could be used with either the sound-level meter or the vibration meter. Finally, for the production of permanent records, a level recorder of the Neumann type was described, which gives a record on waxed paper on a decibel scale. A demonstration of the reproduction of the noises of trains, trams, etc., was much appreciated.

The chairman for the afternoon session was Mr. F. D. Hart, and a paper on "Electronics in Spectroscopy" was read by F. Holmes (Hilger and Watts, Ltd.). The development of direct-reading methods of spectrochemical analysis was outlined under the main headings of photocells, photomultiplier tubes, and thermopiles.

In Great Britain the lack of generally available photomultiplier tubes has caused attention to be directed to cæsium-type photocells; whereas in the United States complex and costly direct-reading spectrographs, based on photomultipliers, have been marketed. It is hoped that the supply position will be remedied by British manufacturers in the near future, although it still remains to be proved that the fundamental properties of this equipment offer any increase in accuracy over photographic recording for quantitative spectrographic analysis, and the advantage of speed of response may be illusory in view of rapid and localized fluctuations at the source.

For work in the infra-red region, a high-speed thermopile was described with a 90 per cent response within 15 milliseconds and an output of 50 microvolts per microwatt. A diagrammatic circuit of a direct-reading infra-red spectrometer based on this thermopile and a cathode ray tube was shown, and a separation of eight wave numbers at 10 μ was claimed.

The lack of suitable ratio recorders was emphasized as a drawback to the double-beam system, and an outline of a suitable phase-sensitive recorder shown.

The final contribution to the symposium was by J. Bell (Muirhead and Co., Ltd.), who described "Some Developments in Picture Telegraphy". This paper, which was concerned entirely with the British equipment manufactured since the end of the War, has already been referred to in *Nature* of January 22, p. 145. At the symposium Messrs. Muirhead and Co. exhibited fixed and portable equipments, together with samples of pictures actually transmitted over telephone lines.