resolution system could be used for investigation of the external payload of an aircraft (for example, missiles carried under the wings), there are several other uses under active investigation. In particular, members of the Electrical Engineering Department of the University of Birmingham are working on a guiding device for emergency services which have to cross an airport in low visibility after an accident. It is clear that there is also tremendous scope for guiding devices as distinct from the more conventional uses of radar solely as a detector.

ELECTRICAL ENGINEERING

Efficient Induction Alternator

A NEW form of alternator without the disadvantages of conventional d.c. excited machines, and with a higher power output than inductor alternators, has been developed by Professor F. C. Williams and Drs G. W. McLean and D. Tipping at the University of Manchester (*Proc. IEE*, **116**, 8; 1969). The alternator is induction excited, with no electrical connexions to the rotor, but it produces magnetic fluxes in the stator alternately in opposite directions—a much bigger swing than induction alternators produce. Two experimental machines have been built and their "encouraging" performance indicates that this type of alternator should find wide application for high frequency generation. The hope is that the first commercial version of the alternator will be built by English Electric as an auxiliary generator for diesel engines.

In the new alternator, the stator carries the d.c. exciting current as well as the a.c. output coils, while the varying magnetic field is generated by the induced a.c. in the rotor. The d.c. winding in the stator slots forms a square wave distribution and an approximately square wave current is induced in the equally spaced rotor windings. (The rotor windings can alternatively be distributed so that a sinusoidal current is induced.) The flux density in the small air gap between stator and rotor can be divided into an average "d.c." component and a pulsating "a.c." component due to the induced rotor current. If the d.c. component is kept low, the resultant flux density will alternate in direction at a given point on the stator. In the experimental machine, the average flux swing was about four-thirds of the saturation flux.

In induction alternators, the flux does not change direction and the total swing is only about two-thirds of the saturation flux, so that the new machine has almost twice the power to weight ratio of inductor alternators. In conventional d.c. excited machines, the variation is twice the saturation flux, but the disadvantage here is that slip rings connecting the stator and rotor are required. The current that can be passed through each brush and slip ring combination is limited to about 100 amp and, if the magnetic fields are to be high enough, many turns are required for the rotor coils. This in turn causes heating problems which can limit output. Other difficulties arise when the alternator is used in environments or at speeds which quickly wear out the brushes and slip rings. In the new alternator, the rotor can be allowed to carry up to about 1,000 amp, so that the coil configuration can be a few turns of thick wire and the heating is not severe.

ELECTRONICS

Digital Methods of Measurement

from a Correspondent

IT is appropriate that the conference on digital methods of measurement, organized by the Institution of Electronic and Radio Engineers at the University of Kent on July 23–25, should have taken place during the recent Moon flight. Digital methods depend heavily on the integrated circuit which has been the most important product of a lively electronics industry, stimulated greatly by the requirements of space research. These devices, tiny silicon chips, about one tenth of an inch square, can contain up to hundreds of transistors connected so as to give logical building bricks—that is, functional units that perform the logical operations of "and", "or", "not" and complex combinations of these basic functions.

In digital systems, quantities are represented as a series of yes/no events rather than a continuously variable quantity. For example, a voltage instead of being represented by a pointer moving across a scale might, in a digital system, be defined as a number of ten bits, that is, an assembly of ten indicators which represents 2^0, 2^1 . . . 2^9 units. The limitation of the system is that the voltage can only have 2^{10}, that is, 1,024, discrete values. The advantages stem from the fact that all real systems contain noise—electrical disturbances—and these disturbances make uncertain the readings of a conventional analogue system. In a digital system, until the noise becomes large enough to cause confusion as to whether a signal is a "yes" or "no", the performance of the system is not degraded.

Three themes emerged during the conference. First, and most directly advocated by Professor P. B. Fellgett (University of Reading) the importance of putting the data into digital form as early as possible. Although this is technically desirable, R. V. Wall (Plessey Co., Templecombe) and other speakers felt frustrated by the difficulties in gaining acceptance for some of the newer transducers, which seem more accurate than the old, by the traditional sciences such as meteorology.

The second theme (introduced by L. Molyneux (University of Newcastle)) concerned the need for small computers (costing about £1,000) that could be incorporated economically into systems. In this way the action of the systems could be determined by program rather than by their detailed construction and the same "hardware" used in various situations leading to a low unit cost. As the cost estimate indicates, these machines, although satisfying the scientific label of computer in that they contain a stored program and can modify their action according to the results of the calculations, would be different from the generally accepted idea of a computer. Nevertheless, Molyneux suggested that the addition of simple peripherals (keyboard, printer, tape unit) would make them into a very suitable machine for teaching computing in schools, and in parts of technical college and university courses.

Finally, the conference considered communications. It is possible, and is becoming more and more the method of choice, to transmit telephone conversations by turning the signals into and out of digital form. The advantages, apart from those of digital systems in general, are that the digital signals are simple to multiplex or to send in parallel through one channel. A difficulty, as described by A. N. Ramsden (Marconi