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MARCH 1967 5s

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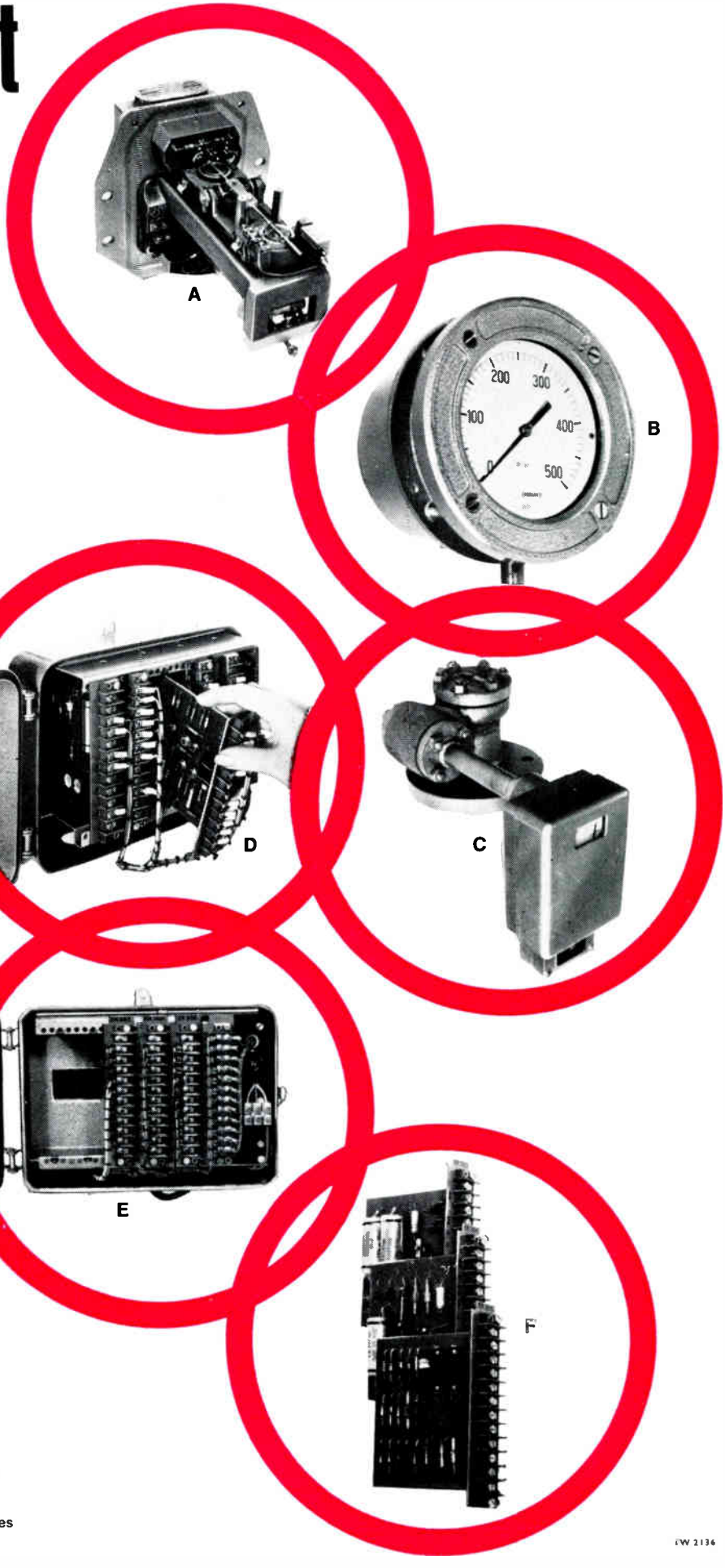

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Incorporating **British Communications and Electronics**

COMMUNICATIONS AUTOMATION INSTRUMENTATION CONTROL

Contents March 1967

VOLUME 5 **NUMBER 3**

continued overleaf

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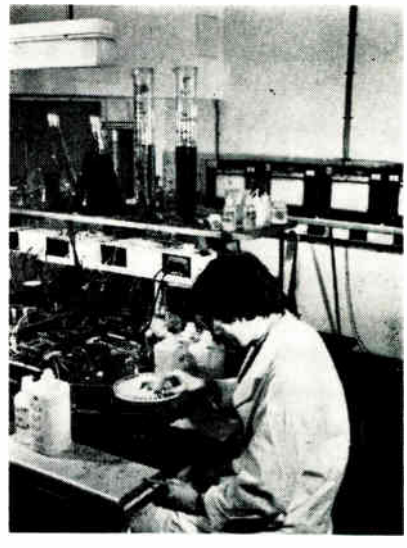
COMMUNICATIONS AUTOMATION INSTRUMENTATION CONTROL

Contents *continued*

Features

Electronic Batch Counter Supplement

This 16-page pull-out supplement describes electronic batch counters and gives complete details of those available. **The supplement faces the inside back cover.**

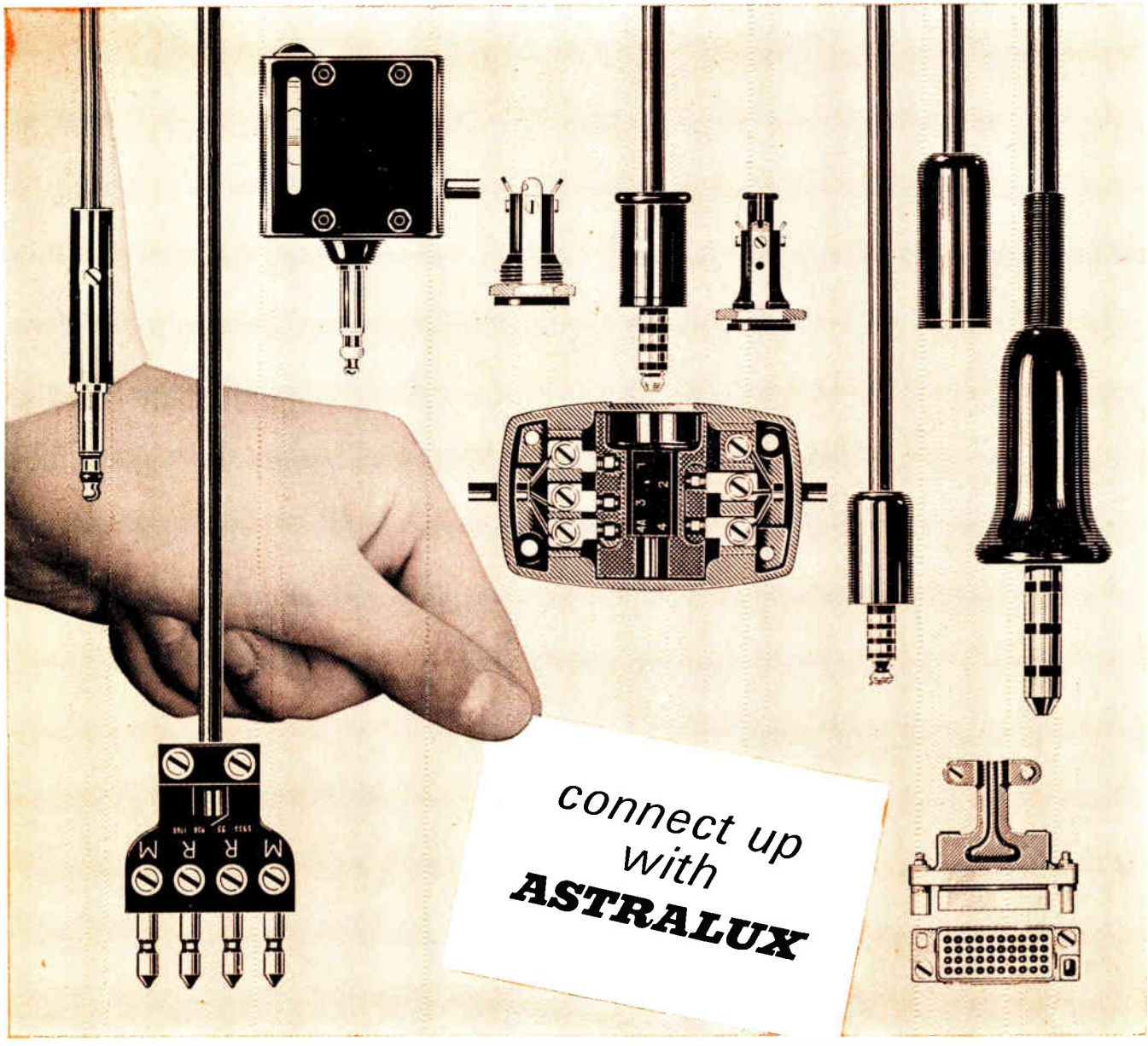


OUR COVER

This month's front-cover picture shows a corner of the chemical pathology laboratory at the Royal Postgraduate Medical School, Hammersmith, where mechanical equipment (foreground) is being used to analyse blood-plasma specimens automatically. Readings are displayed on chart recorders (background) and, by means of an analogue-to-digital converter, are recorded on punched paper tape for input to an NCR/Elliott 4100 computer, which calculates the test results. An article on a number of applications of computers in the hospital field appears elsewhere in this issue.

NEXT MONTH

Video mapping techniques for air traffic control are continually being improved. An article in the April issue describes one of the latest developments—selective moving target indication. Another article presents the findings of an independent and comprehensive survey on the application of closed-circuit television in industry and commerce.



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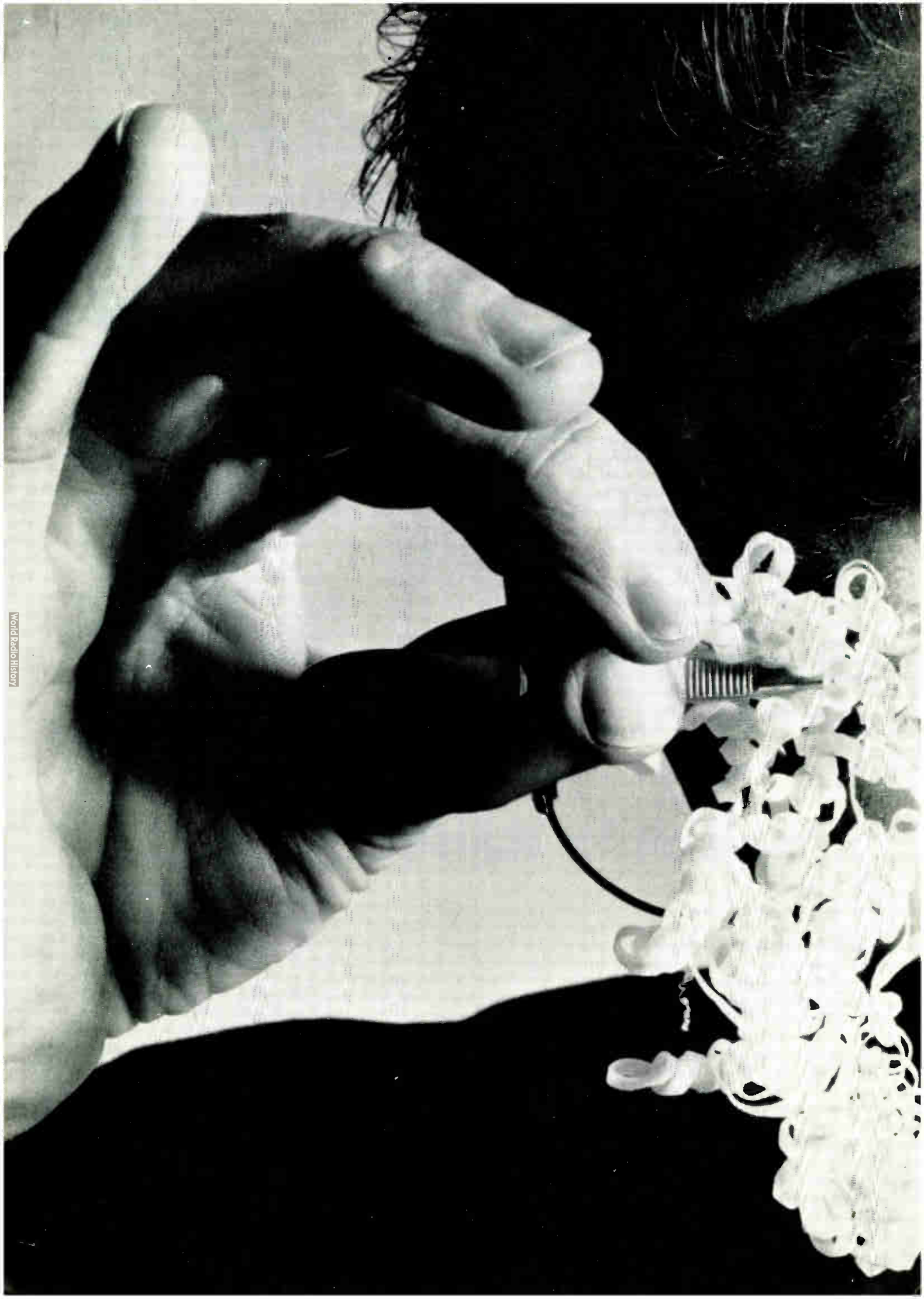

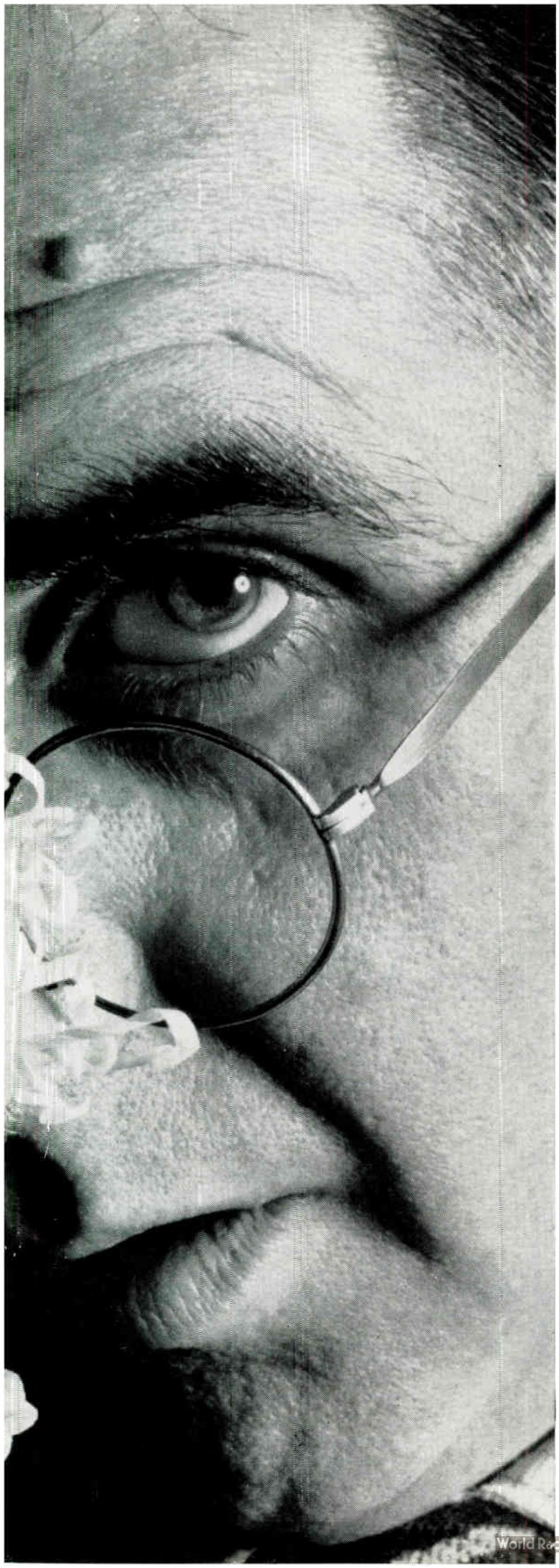

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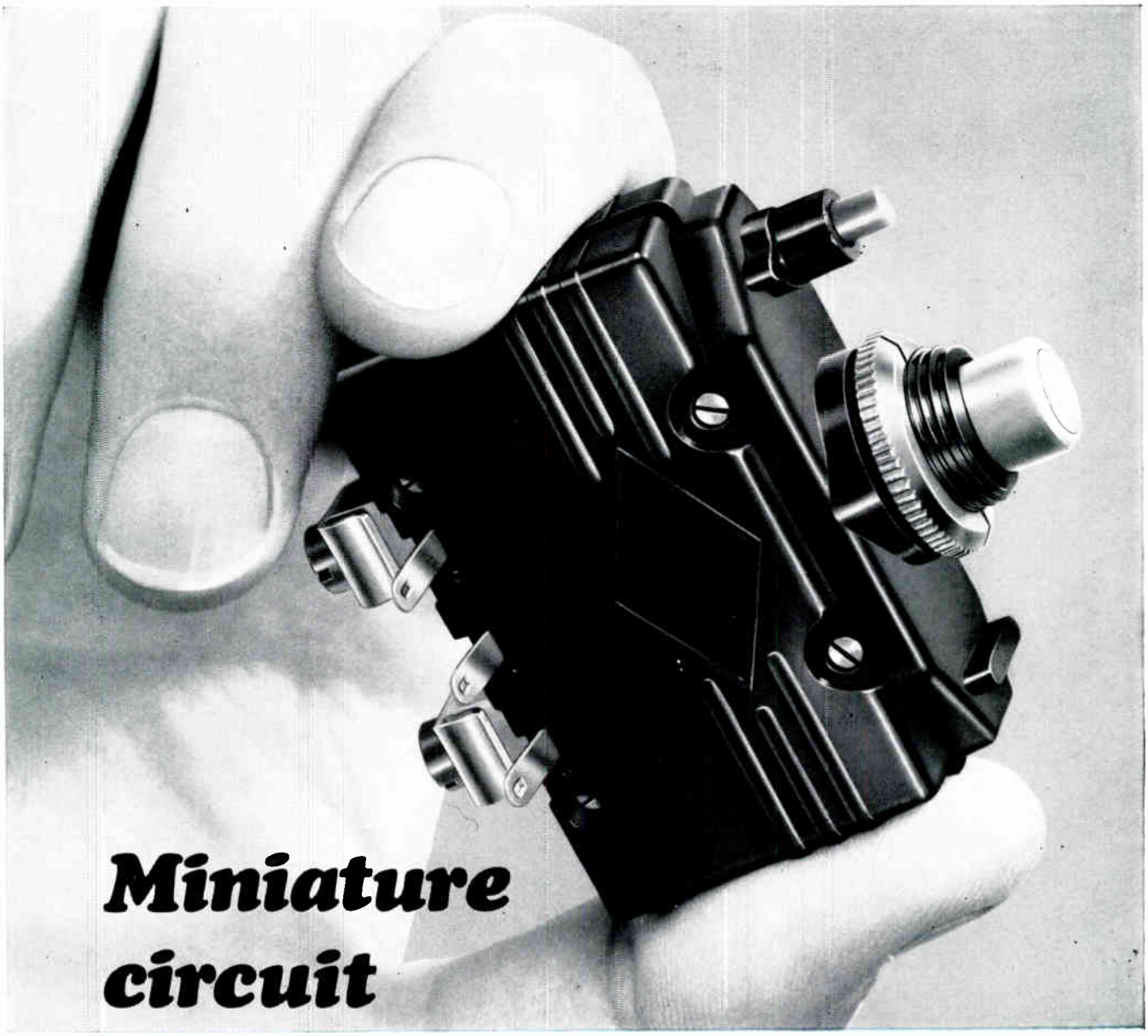

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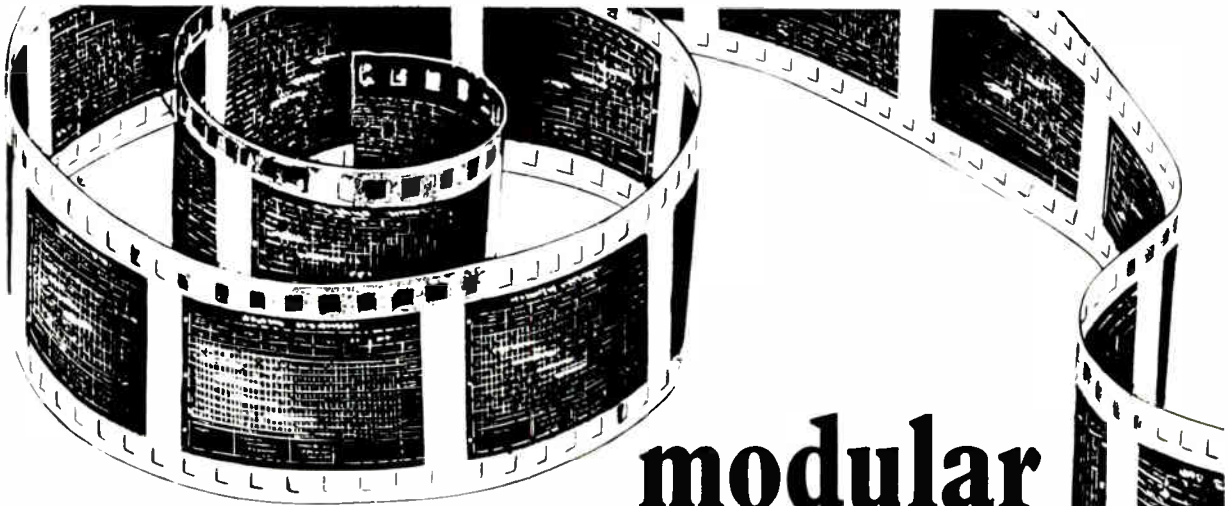

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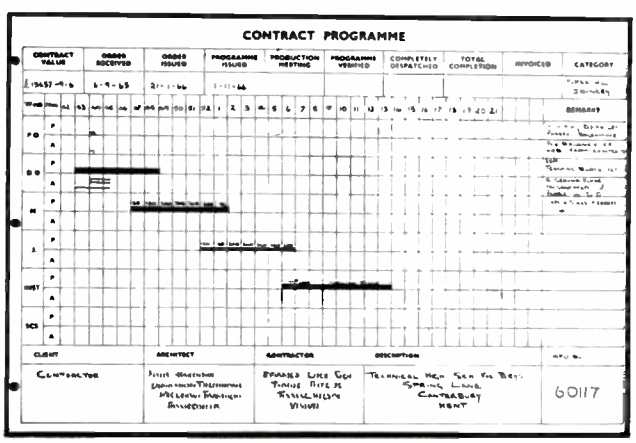

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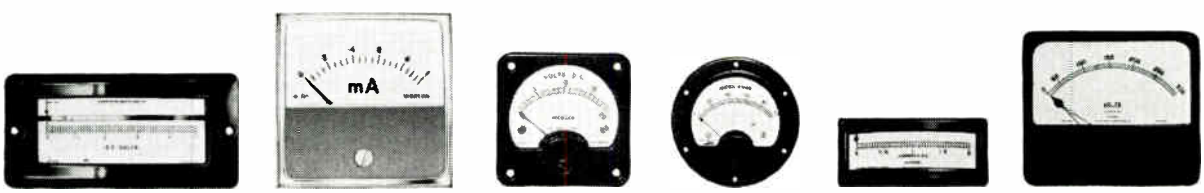

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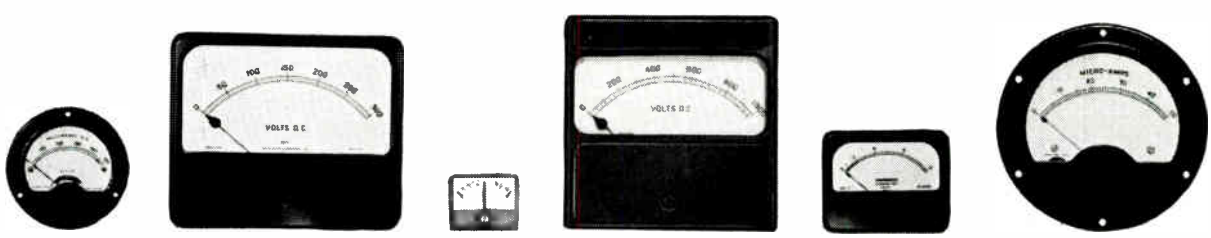

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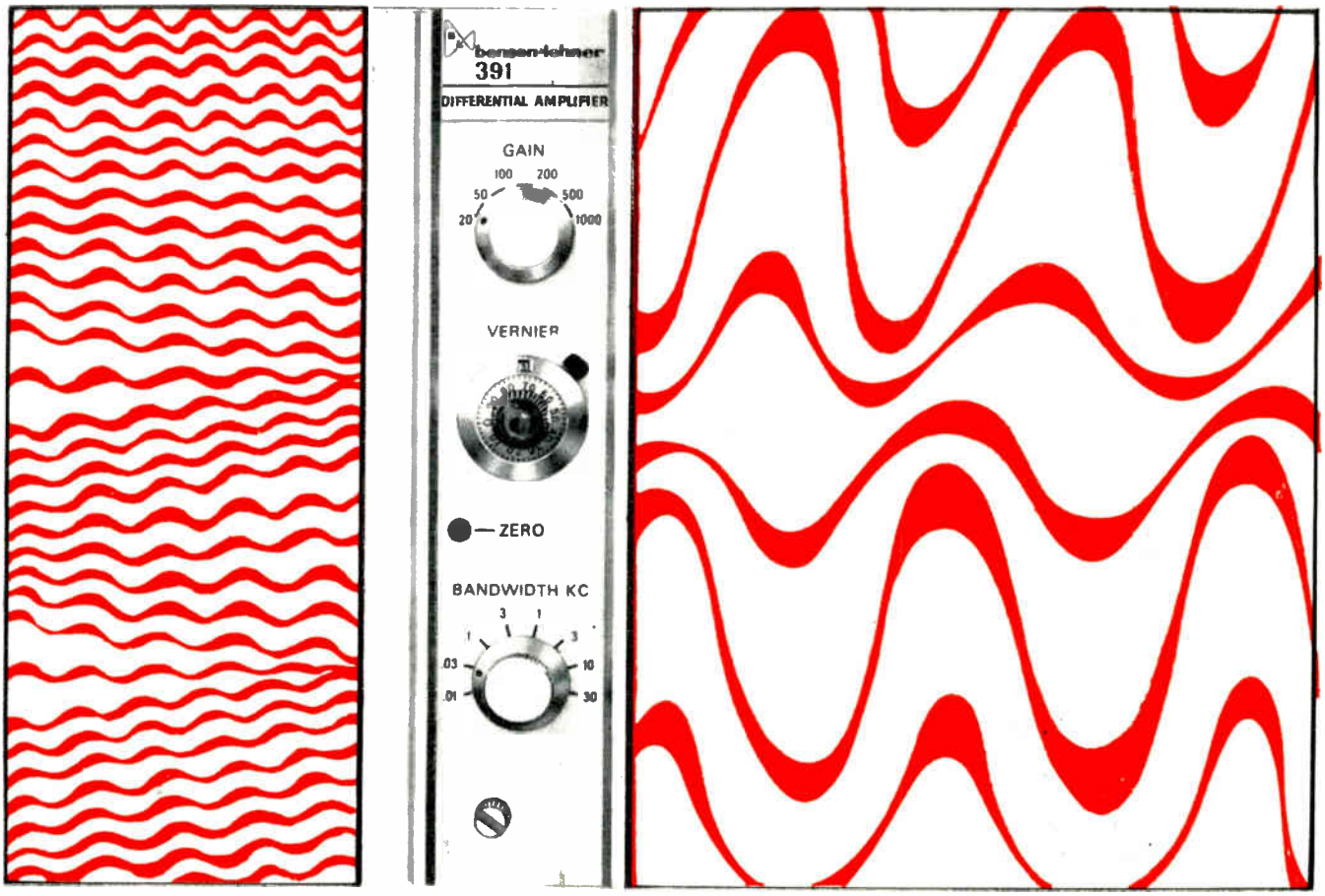

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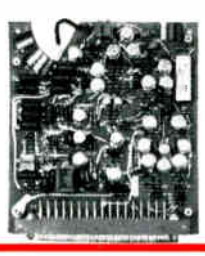

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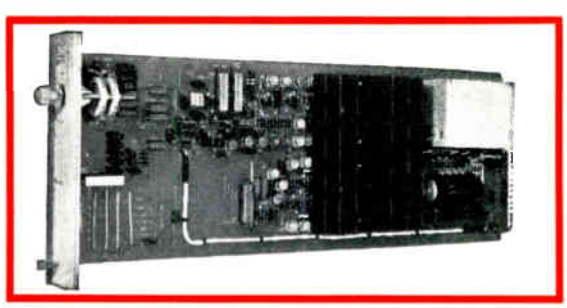

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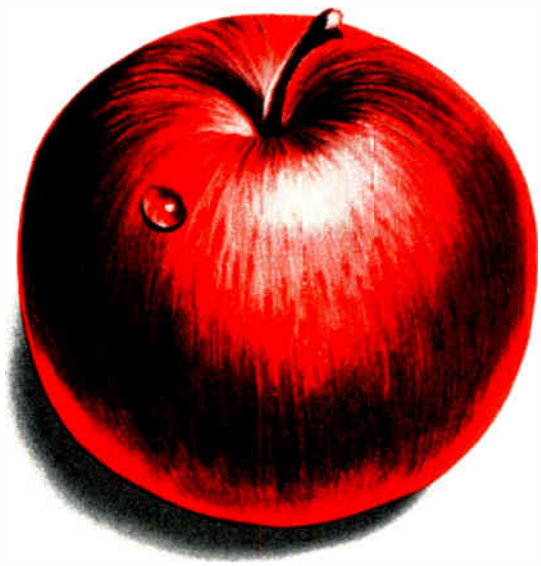

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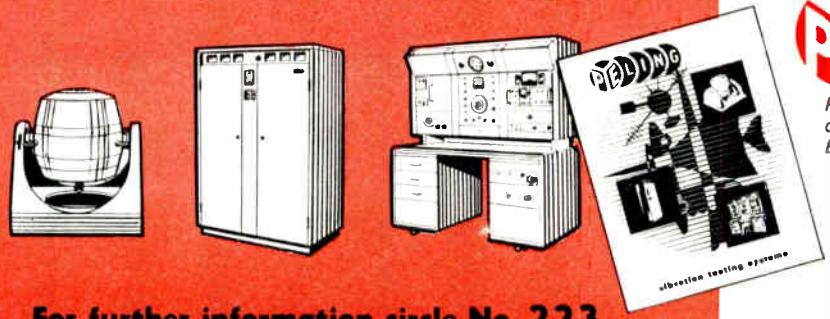

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AEI ELECTRONICS

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Automation and Medicine

The social function of automation in our society is often overlooked or ignored by those who see in its application only the de-humanization of the individual or group. This month's Medea 67 exhibition and associated symposium at Earls Court should help to put such a belief into proper perspective, for it will provide many striking examples of the ways in which technological advances in engineering and automation have been assimilated into that most humane of professions—medicine.

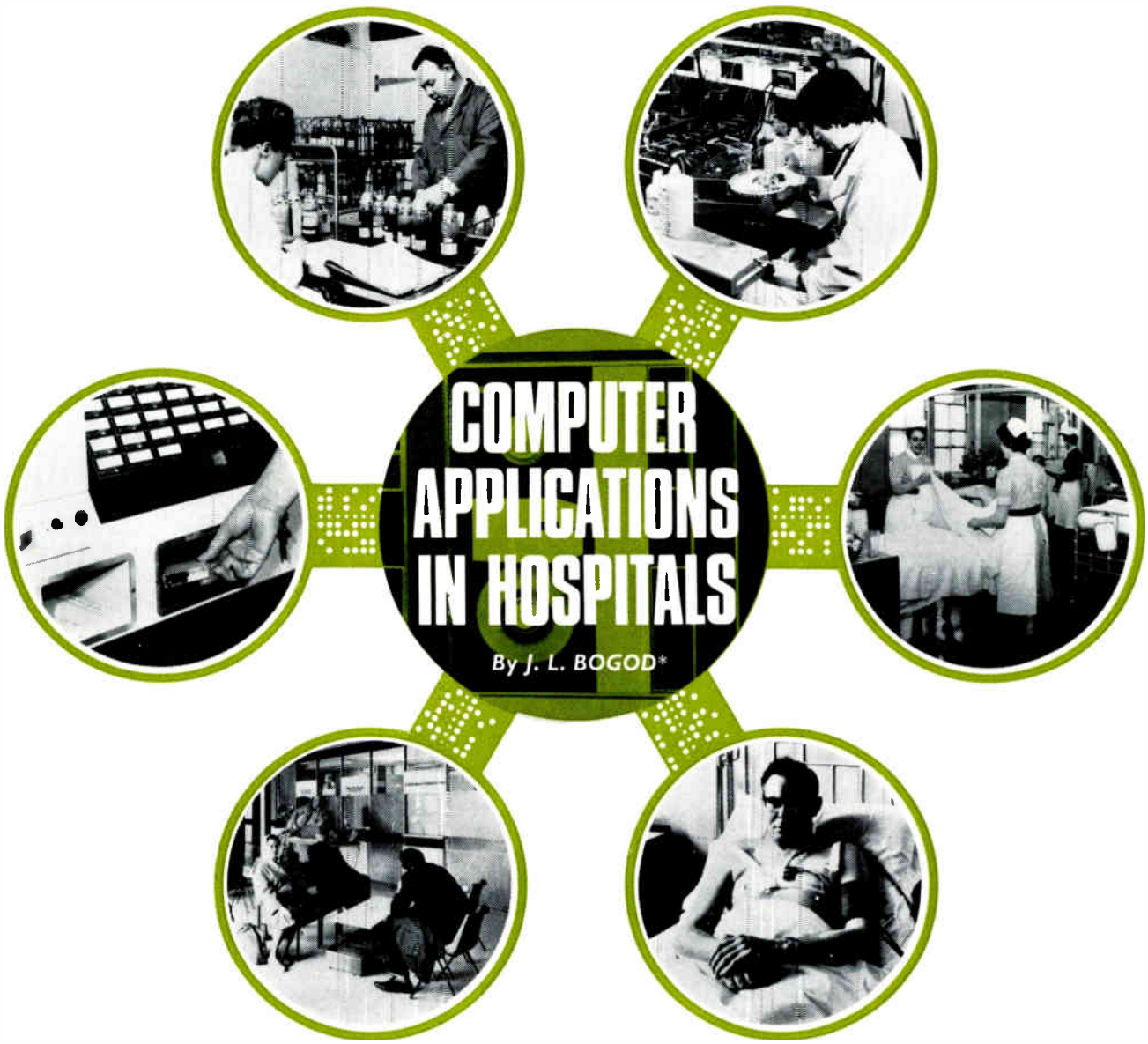
Furthermore, it will give an invaluable opportunity to doctors and surgeons on the one hand and electronic and engineering specialists on the other to exchange information and discuss each other's problems and requirements. The two professions have not been slow in the past to realize the advantages to be derived from a close co-operation between their disciplines (as is evidenced by the two medical automation advisory centres that are already operating in London and Edinburgh) but there is still scope for much further progress.

The extent to which medicine is embracing the latest concepts in electronics will be apparent by reading one of the articles in this month's issue. It describes some of the applications for computers in the hospital field, where both administrative and clinical practices may well be revolutionized by what have hitherto been regarded as purely industrial or commercial techniques. The vital need for improving hospital efficiency, without interfering with the delicate and personal relationships between patients and medical staff, is increasingly being met by the introduction of electronic equipment, the potential of which is perhaps only now being fully realized.

Much of the pioneer work in this field has already been undertaken in America, though research is now actively being carried out on both sides of the Atlantic into such medical aids as automatic patient monitoring and computer-aided diagnosis, treatment and drug dispensing. That Britain does not lag behind in her response to the challenge is confirmed by the comprehensive computer-based medical centre that is at present being developed in South London. This will eventually serve a whole community of many thousands of individuals with a centralized medical service which will integrate all hospital functions into a unified system. The centrally-filed medical histories of every patient attending the centre will be immediately available to doctors, who will be equipped with television/typewriter consoles to call up information.

All these activities and progress reflect well upon a profession that is often unjustly accused of being slow to move with the times, and it is encouraging to confirm that engineers fully understand the necessity for their equipment to supplement the doctor's functions and not try to replace him. Such a substitution of machines for human beings would be impossible in any case.

The real benefits from introducing automation into medicine can only be gained, however, if sufficient funds, facilities and incentives are provided. Manufacturers of electronic equipment can only afford to carry out their R. and D. in areas that show commercial viability, and so it behoves the government to invest generously in enterprising schemes which must, in the long run, make enormous economies in our health and welfare services. If such grants are not forthcoming, then the nation may well pay dearly for its procrastination.



In the hospital field, doctors and administrators alike are recognizing the benefits that a computer can bring to their work, and many of the problems being encountered and solved are similar in nature to those met in industry. This article describes some of the applications on which development work is currently being carried out, and also takes a look at future prospects.

COMPUTERS have been in use in hospitals in this country for some time, but in general they have been very small machines used principally for financial purposes such as the calculation of payroll and expenditure analysis. This is probably because, in the past, computers have been regarded as economic tools which must pay for themselves directly with the economies they make.

Now it is becoming realized that, with the increasing power of modern equipment, computers can be used for purposes which only show benefits in the long term, carrying out tasks which previously could not be done at all because either sufficient man-power was not available or they could not be justified economically.

Apart from financial work, applications may be divided broadly into clinical and administrative, but there are many areas where the two overlap. In developing these applications, it is important to be aware of the links between them, since future developments will undoubtedly lead to the control of a total hospital-information system based on the use of a computer.

Administrative Applications

A number of administrative applications are at present being developed, some of which are described here.

Nurse Records and Allocation

The staffing of wards is organized by making use of fully-trained nurses together with student nurses at various stages of their training. The three-year training course for student nurses requires that, in addition to group training, they also should spend specified periods in each ward. As

* English Electric-Leo-Marconi Computers Ltd.

there may be over 1,000 nurses in a large hospital, it can be seen that the administrative problem of ensuring that an adequate service is given to patients, while student nurses gain all their necessary experience, is very complex. Programs are now being written which will produce lists of ward duties that allocate staff to activities under rules laid down by the administration, thus saving a great deal of work at present carried out by senior nursing staff.

Nurse Dependency

Closely allied to the last problem is that of nurse dependency. In this application, the system is designed to measure the workload on nurses in a ward. Patients need a varying amount of nursing care depending on their condition, and as it has not in the past been feasible to measure the amount of care required, the workload in different wards of the same hospital used to become unbalanced. The reason why it had not been feasible was because the work and time required to produce the results would have produced them too late to be of any value; furthermore, there are also some complications resulting from the operation of 'tied-bed' systems.

With a system currently being developed, a nurse spends a few minutes each day completing a form which lists the patients and certain facts about them which affect the amount of care they need. These forms are read by an automatic document reader, which feeds the information into a computer that calculates and prints out the workload in each ward. Consequently, those responsible for patient admissions can quickly tell which wards are most suitable for incoming patients. The benefit of this system is not a financial one but can be measured by a better service to patients and the removal of unnecessarily heavy loads on nursing staff.

Patient Admission and Appointment Scheduling

The allocation of beds is a problem area which is being examined in 'patient admission and appointment scheduling'. Over a period, a hospital will provide medical attention to a very large number of patients, and each patient, whether external or internal, will make use of a number of services provided by the hospital; these may be medical specialist services such as those of the X-ray department or pathology laboratory, or they may be administrative services such as the use of a bed and the assistance of the almoner. The problem then is to allocate demands against limited resources of time, people and equipment in the best possible way. The complex inter-relationship of these demands means that normal techniques usually result in an inefficient, and hence uneconomic, use of these resources. A computer system would have the following initial objectives:

Maintain an appointment system for out-patient clinics and clinicians, with due regard to the resultant load on other facilities of the hospital.

Record all basic information about the patient at the time of initial contact with the hospital, such information then being used to originate case sheets, test requests etc. and ultimately form the basis for a computer-held patient record.

Assign patient numbers and bed occupancy, which if carried out on a real-time basis should result in increased bed occupancy; if linked with nurse dependency, a more efficient utilization of nursing facilities could be made as well.

Hospital Pharmacy

The Hospital Pharmacy, which is responsible for holding stocks of drugs and issuing them in response to doctors' orders, is another department which would benefit from the use of a computer. Orders for drugs (usually handwritten) are made at all times of the day, and the volume of these orders, which is already very large, is increasing. A computer system would involve the sending of such orders, by means of an on-line typewriter in the ward, via the central processor to the pharmacy; the order could then be either printed out or displayed on a visual-display terminal. A logical development of this system would be to collect and store orders transmitted from the ward, sort them into ward requirements at specific time intervals, and present to the pharmacy a composite order with items to be despatched at different times. In addition, if patients' records were to be held on-line, checks could be made that the drugs ordered did not conflict with known allergies or other treatment. Under the present system, there is a danger that orders may be misread and the wrong drug or quantity supplied, or that (all unwittingly) a doctor may prescribe a drug to which the patient reacts unfavourably. The computer system described would go a long way towards eliminating the major causes of such errors—the lack of information in a readily accessible form; it would also be a source of statistical information for stock control and drug-utilization studies.

Blood Transfusion

In the blood transfusion service, fresh blood is taken from approved donors at intervals, stored, and then issued to hospitals to replenish stocks (see Fig. 1). Different blood groups have to be treated separately and, in addition, whole blood must be used within a comparatively short space of time. As it is necessary to have all types of blood available at all times, the supply chain of donor to storage to hospital must be kept constantly flowing. The system is further complicated because donors must be given reasonable notice as to when their services will be required, and only a proportion of donors respond to the request to attend a blood transfusion clinic.

By holding the records of donors on-line to a computer, together with stockholding information, a program can be run daily which will carry out the following tasks:

Process the day's results.

Update shockholding figures according to the day's issues and receipts.

Calculate the quantity of each type of blood which will be needed in, say, three weeks' time.

Select donors, bearing in mind the anticipated percentage of non-acceptances.

Print 'call-up' cards for sending to donors.

This system would thus deal with the flow of blood supplies into the Regional Transfusion Service, and it could be extended to cover the issue of stocks and stock control in the hospitals themselves.

A blood-bank system at present in operation serves 29 hospitals in California, and has enabled economies to be made in blood, time and money. By keeping track of the location and age of all units of blood held at all hospitals participating in the project, the computer is able to provide blood-bank management with up-to-date reports concerning blood usage. In consequence, realistic stock levels are established, losses due to the 'outdating' of blood are minimized, and future requirements can be estimated.

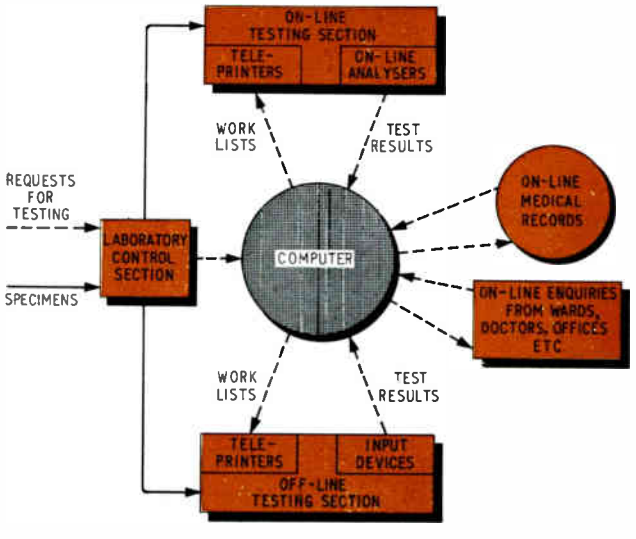
Fig. 1. Here, a scientific officer of the National Blood Transfusion Service is shown checking bottles of blood in an issue room, prior to their dispatch to a hospital blood bank. (Picture supplied by the Ministry of Health)

During the first year of the system's operation, the losses of blood due to outdating were cut from 13% to 4%.

Each of the 29 hospitals in the scheme reports daily on its stock of blood, including such information as identification number, blood which has been reserved for a specific purpose and transfused blood. This data, together with that supplied by the central bank as to stocks on hand and delivered, is processed overnight; reports are thus available in the morning for blood-bank management to plan the day's activities. The daily inventory report lists every unit of blood at every hospital, and shows the days remaining until it is outdated, whether it has been reserved, its identification number and its type; below this is shown a summary giving totals of each type of blood available at each hospital.

As a result of this system, much better utilization of resources has been made and, in particular, a more reliable service has been given to patients without increasing the amount of blood being brought into the system from donors. With the development of modern techniques in surgery, there is an ever increasing demand for blood, but there is never enough to meet it; this system has gone a long way towards balancing the supply with the demand.

Fig. 2. A diagrammatic representation of the work flow in a computer-based pathology laboratory, showing (dotted lines) the links required for its integration into a total hospital-information system



Dietary Control

In a number of hospitals and hospital groups in America, dietary control is carried out by means of a computer.

The hospital dietician has the task of designing, at minimal costs, menus that are satisfactory in nutritional content and appeal to the patients. The nutritional content of raw ingredients is virtually fixed and so the nutritional value of a dish can be calculated from a recipe; the ingredients may alter for reasons of cost or availability, however (e.g., fresh vegetables instead of frozen), in which case the nutritional value may change also. The task of balancing the various factors in menu planning is one which takes a great deal of time and effort, and in the system which has been developed at the J. Hillis Miller Health Centre at the University of Florida, a computer carries out this work for the dietician.

The system calculates raw food needs, and then selects from some 1,680 standard and therapeutic menu combinations the best nutritional balance, at the lowest possible cost, for an assortment of patient needs and preferences; it also provides step-by-step instructions to the kitchen staff. At lunch time, each patient is handed a selective menu for the following day's meals; he marks the items he requires, and the menu is then collected and transcribed for computer input. The computer produces requisitions for stores issues, and provides totals of all menu items for

the kitchen staff; cards showing each patient's selection are also produced to enable individual trays to be made up.

It has been estimated that if all Florida hospitals were to subscribe to the system by on-line links, they would make a saving of some 25% in their food and labour costs.

Clinical Applications

Clinical applications may be sub-divided into two groups; analysis of tests and patient monitoring.

Pathology Laboratory

In the first group, we shall consider the problems in the pathology laboratory, where there is a rapidly increasing workload of sample testing combined with a shortage of technical staff. The majority of routine tests are now carried out on automatic testing equipment (see front-cover picture) and, in general, the results of these tests are produced in the form of graphs; these have to be carefully interpreted and this is a time-consuming operation. Furthermore, in many cases, these results need to be compared with previous results to determine significant trends, and this raises the problem of record retrieval.

The system needed to deal with this work, and thus free technical staff from routine clerical labour, requires a small computer which will convert the output of the testing equipment to digital form, and then interpret the results; the results also need to be printed out and stored for subsequent comparisons and statistical analysis.

If a hospital has a large multi-programming computer, this work might be carried out on-line by means of intermediate equipment linked direct to the central processor. In this way, the automatic equipment carrying out the tests would be peripherals of the computer complex. Alternatively, if real-time work on results were not required, it would be necessary only to link intermediate equipment, producing the results on punched paper tape; this would subsequently be fed to the central machine in order to produce the results of the tests and make the necessary calculations and comparisons (see Fig. 2).

A considerable amount of research work is being carried out in this field, and at the Post-Graduate Medical School, Hammersmith, a system has been developed which can accept the output from several 'AutoAnalysers', convert the results to digital form, and then punch the coded information on to paper tape.

Patient Monitoring

The term patient monitoring refers to the constant watching over the condition of a patient so that action can quickly be taken if there are any significant changes. Such treatment may be necessary during the course of operations, during the immediate post-operative period, or when the patient is critically ill or under severe shock.

For the monitoring of critically-ill patients, it is necessary to have an experienced nurse in constant attendance who, in addition to watching for changes in condition, will take regular measurements of such variables as temperature, pulse and respiration rate. The heavy load on nursing facilities means that only a very limited number of patients can receive treatment of this kind at any one time. Also, it is often necessary to know immediately when a change in the patient's condition occurs, and a nurse who is taking measurements at intervals of time may not be aware of such changes immediately they occur.

Equipment is now being developed (see Fig. 3) which will measure the various parameters representing the condition of a patient (the electroencephalograph and electrocardio-

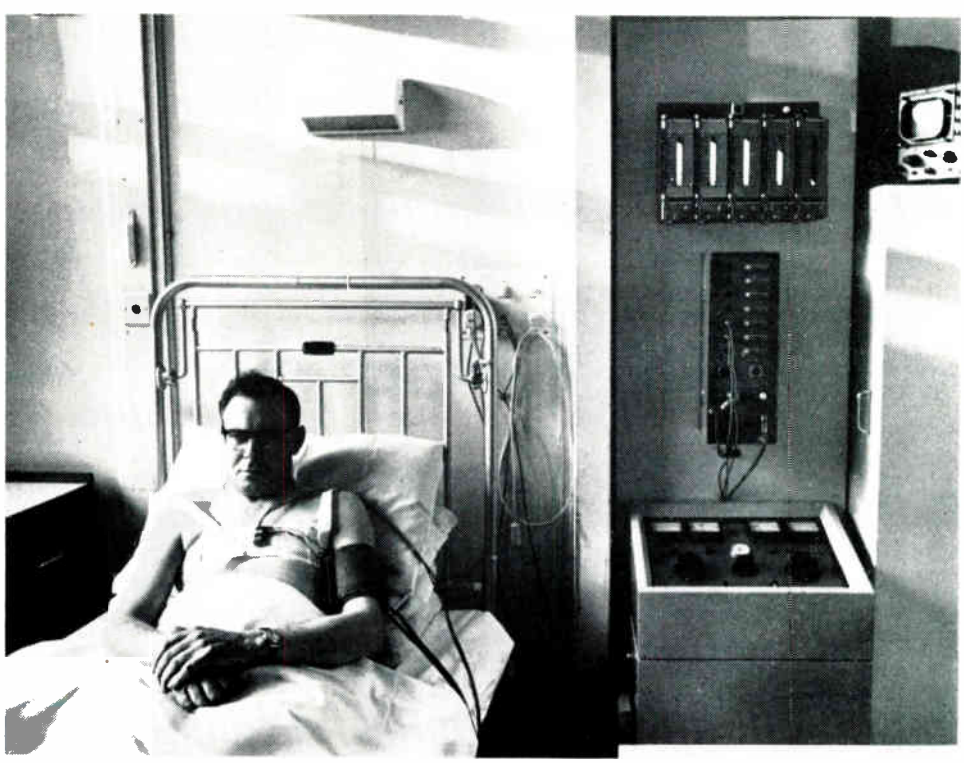


Fig. 3. A 'Monitron' patient-monitoring system (developed by the Medical Research Council and T.E.M. Instruments Ltd.) is shown here being demonstrated at Crawley Hospital, Sussex. The chest strap contains special electronic sensors that feed equipment (right) with information on such conditions as temperature, pulse rate, respiration and blood pressure. The equipment gives a constant indication of a patient's condition (which can be recorded over a 24-hr period) and sets off an alarm should it become serious

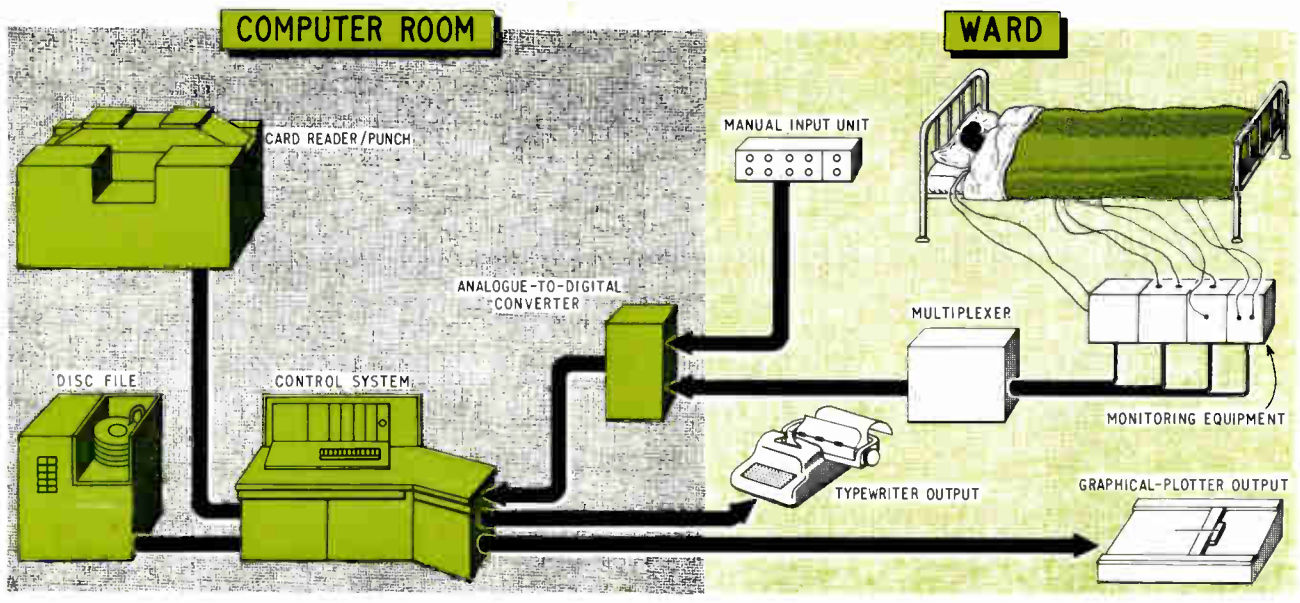


Fig. 4. A diagrammatic representation of a computer-based patient-monitoring system

graph have, of course, been in use for many years), though the output from such equipment normally requires interpretation by medical staff. It is in this interpretive task that a computer can assist the physician.

In a typical computer system (see Fig. 4), a number of critically-ill patients will be physically connected to a variety of measuring instruments; these in turn will be connected to a central processor, which will receive the analogue signals from the instruments and transform them into digital form. Within the computer, the various measurements will be compared with 'permissible' values, and variations in readings will also be analysed. When an abnormal result occurs, a warning will be given to the attending medical staff who will be able to take immediate action. Using such a system, it will not be necessary for each patient to have a nurse in constant attendance, and the risk of delay in dealing with an emergency will be reduced considerably. Thus, with the same medical facilities, it will be possible to give intensive care of a better quality to more patients.

As an example of an actual computer-based patient-monitoring system, we may cite the 3,500-bed Los Angeles County General Hospital, where a special ward has been established as a shock research unit. This unit is con-

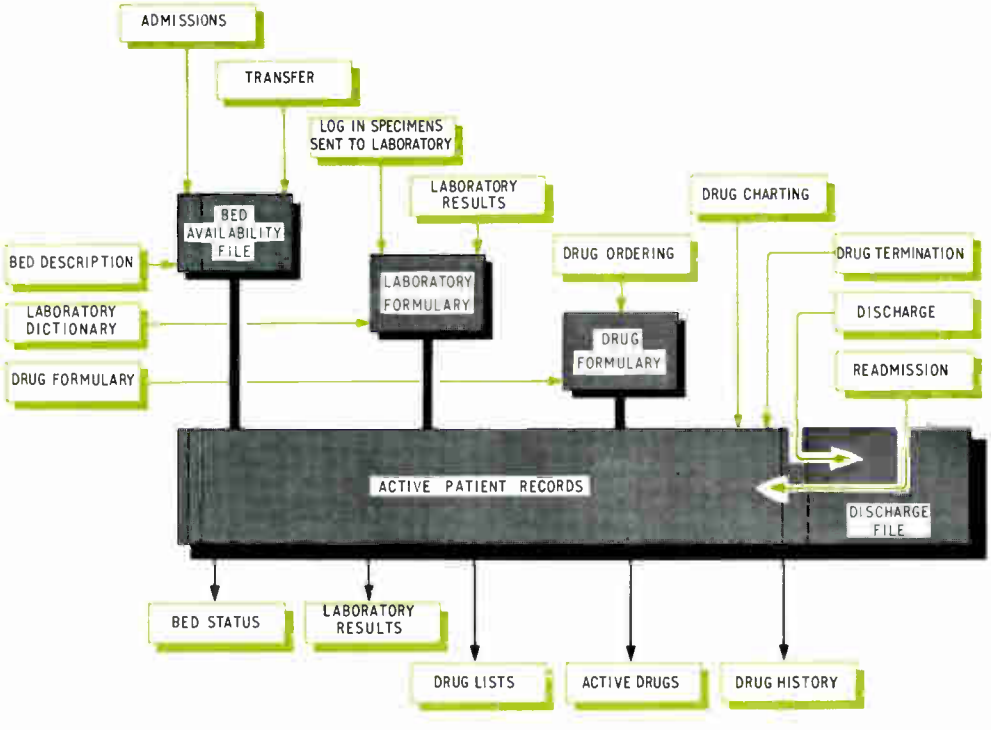


Fig. 5. This block diagram shows how the programs in the hospital-information system at the Massachusetts General Hospital are interlinked. The rectangles at the top represent the program functions that affect the contents of the files, whereas the rectangles at the bottom represent those that retrieve information

cerned with patients suffering from circulatory shock—a condition characterized by low blood pressure, low blood flow and an extremely unstable circulatory system. The mortality rate from this condition is high, and research is being carried out in order to determine how a computer can assist in improving the monitoring and care of such patients.

The computer has been programmed to perform the following functions:

Routine periodic monitoring and logging of 11 input measurements for body activities that can be directly sensed.

Automating procedures to determine the variables in those activities that cannot be directly sensed (the computer records and calculates 25 variables).

Checking the variables to see that they fall within preset limits.

Acting as a highly-accurate timer of the relationship between the electrocardiogram and points of interest on the arterial pressure pulse.

Controlling the urinometer.

The research staff are experiencing many problems in the development of this system. For example, the method of output is by means of a typewriter and a graph plotter in the ward, and this equipment is noisy and may be disturbing to patients under shock. (On at least one occasion it has been necessary to disconnect the equipment because of this problem.) One solution being considered is the use of projection displays, but it has been found that these are generally expensive, bulky and not wholly satisfactory. There is clearly a great demand for the development of electronic equipment in this area.

Hospital-Information Systems

Many of the applications described in this article may be interlinked to form a total hospital-information system. Such a system would be built around patients' medical records, and would provide control of the information which circulates in a hospital.

A number of hospitals in America have for some time been involved in the development of systems of this kind, and one of the most advanced projects being undertaken is at the Massachusetts General Hospital, which has the following aims:

To increase the rapidity and accuracy of collecting, recording, transmitting, retrieving and summarizing patient-care information.

To decrease the amount of routine clerical work required of the nursing staff.

To arrange and consolidate information for more effective and efficient utilization by the medical staff.

To store large amounts of complex medical information and contribute to clinical research by facilitating rapid and easy retrieval and analysis of the stored information.

The system involves the use of typewriters, which are on-line to the computer and situated in wards, the pathology laboratory, the pharmacy etc. Medical staff may communicate with the computer in a 'conversational' way in order to retrieve information or to initiate action, and the procedure described above under the heading *Hospital Pharmacy* is just one example of how this system is being used.

There are three groups (or cycles) of procedures currently in use at the hospital, and these are the admissions cycle, the laboratory cycle and the medication cycle. The admissions cycle includes programs dealing with the admission, transfer and discharge of patients, while the laboratory cycle has programs concerned with the entering of laboratory results into the system and the generation of reports on the various wards; the medication cycle contains programs that relate to the ordering and charting of drugs, patient history with respect to drugs, and ward notification of drugs to be given. Fig. 5 shows how the various programs and files interact with each other.

Conclusion

This article has briefly described some of the ways in which computers are being or may be used in hospital work. A hospital is a place in which people receive a great variety of services, all of which impinge in some way on each other. These services are all centred round the patient, and the more co-ordination there is between them, and the more efficiently they run, the better will be the treatment and thus the health of the nation.

Computer-Based Retrieval of Medical Literature

Some ten months have now passed since the computer-based medical-literature analysis and retrieval system (MEDLARS) was inaugurated at Newcastle University; during that time, the number of information searches that have been conducted has increased from four to over twenty per week.

MEDLARS is operated jointly by the National Lending Library for Science and Technology (N.L.L.S.T.) and Newcastle University for the benefit of all medical research workers, requests for searches from sources outside the university being collected and edited by the N.L.L.S.T. At present, the system is being operated for a trial period without charge to the users, the computing expenses being met by the Office of Scientific and Technical Information; a decision is soon to be taken, however, on the value of the service and whether search fees will be imposed in the future.

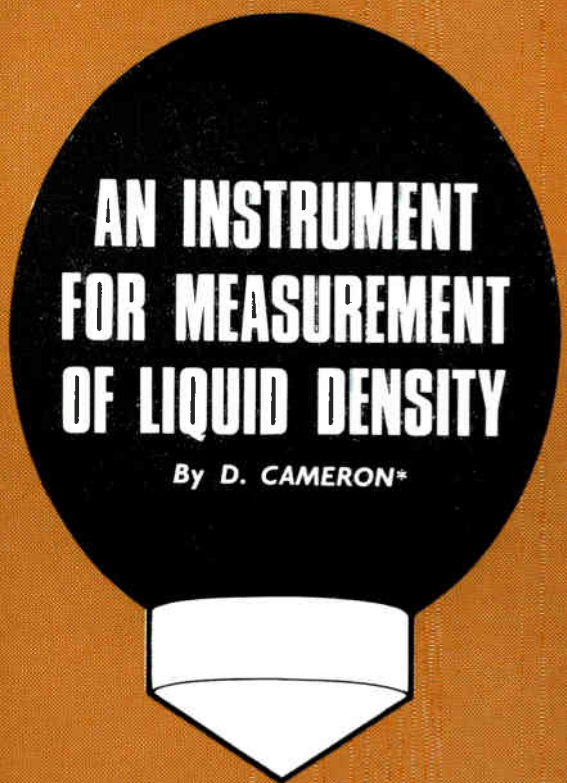
Information for the system is prepared by the American National Library of Medicine, where a team of indexers study papers published in some 2,800 different medical journals and assign terms (from a list containing over 7,000 items) to describe accurately the contents of each article. Every month, this coded information is recorded by computer on magnetic tape and a copy is sent to Newcastle. There, the university's English Electric-Leo-Marconi KDF 9 computer has been specially programmed to provide comprehensive and rapid search facilities, thus providing enquirers with information relevant to their research very soon after it has been published.

Over 400,000 article references are already recorded on the MEDLARS tapes, approximately 15,000 being added each month. Search details are fed to the computer in three parts, the first giving the subject title, the search reference number and sorting instructions; a 'request element definition' (RED) list is then entered, which details the terms that the computer must consider when selecting article references. Finally, a search statement is fed in which defines how the terms given in the RED list should be combined to distinguish the required articles from those covering related subjects.

The output from the computer is in the form of a list of all those articles that contain relevant information; more than 100 titles may be produced on this list, which is returned to the research worker for his final selection.

AN INSTRUMENT FOR MEASUREMENT OF LIQUID DENSITY

By D. CAMERON*



Accurate density measurement of process liquids is often a critical factor in the production of both liquids and solids, for it enables precise control of the concentration of liquids to be effected. This article describes the operation and applications of one particular instrument (the Sangamo specific-gravity meter) that has been designed for measuring liquid densities in laboratories and industrial environments.

IN the past, accurate liquid-density measurement has either been carried out—at best—as a routine laboratory task, or other factors (such as electrical conductivity or refractive index) have been used to obtain a measure of the concentration of solutions. The specialized nature of these alternative methods is obvious, but liquid-density measurement has been found to be the most versatile indicator of concentration.

Laboratory methods of liquid-density measurement are well known and mainly utilize a density bottle, hydrometer or density balance. The last mentioned instrument is probably closest in principle to the Sangamo specific-gravity meter, since it indicates the apparent weight of a totally-immersed plummet. In the Sangamo instrument, however, support of the plummet is effected not by a fine wire, but by a controlled magnetic field. The advantage of this is that the measuring system can be isolated physically from the fluid, and so all the effects of surface tension are eliminated; the output is also obtained as an electrical signal, thus lending itself easily to the control of other equipment.

Electrical Construction and Operation

The main features of the meter are shown in Fig. 1. As mentioned previously, the plummet, which is more dense than the liquid being measured, is supported by a magnetic field which is generated by an electromagnet immediately above it; both the electromagnet and the plummet are constructed from a low-hysteresis alloy, which thus reduces any ambiguity of reading introduced by hysteresis. Located at a fixed distance from the electromagnet are two coils, of equal inductance, which surround the plummet; the coils are fed with an a.c. signal, and the output is obtained from the junction of the two.

Since the coils are balanced inductively, any movement of the plummet away from a position located centrally between them will produce an error signal at the junction; the amplitude of this signal will be approximately proportional to the displacement and will be in phase or out of phase with the supply, depending upon its direction. This error signal is then amplified and, after rectification by a phase-sensitive detector, the resulting d.c. signal is used to control the current in the electromagnet via a power amplifier. A control loop is thus closed, and the plummet is stabilized at the point where the inductance of both sense coils is equal.

System Stability

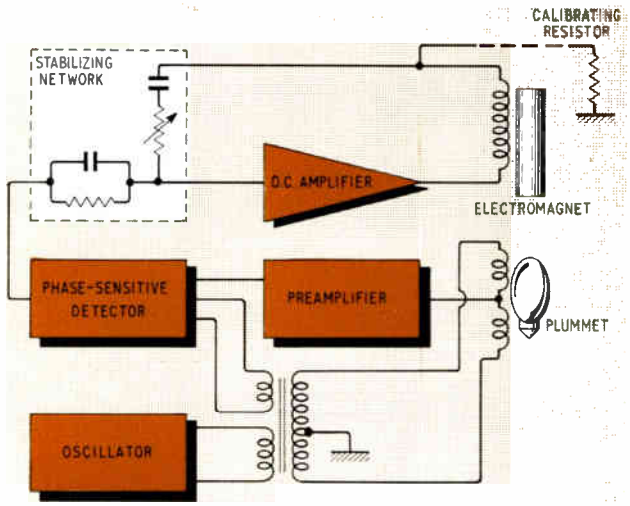
This description of the simple servo action of the amplifier and electromagnet has not taken into account any stability considerations. There is a square-law relationship between the current in the electromagnet and the force it exerts on the plummet, but the effect of this is to produce only a small increase in the average force exerted if the current fluctuates. The equivalent electrical circuit is thus as shown in Fig. 2, and is derived as follows.

The balanced sense coils surrounding the plummet can only sense the plummet position and not the force exerted on it; the output signal is therefore the integral of plummet velocity. Further integrating action is caused by the inertia of the plummet, and complete phase opposition of control and output signals is only prevented by the power loss in the system due to the viscosity of the fluid surrounding the plummet. Despite the integration in the system, which cannot be compensated for, very good damping of plummet movement can be achieved by means of a simple RC network in the amplifier, the response of which can be varied to suit different liquid viscosities.

* Sangamo Controls Ltd.

(a)

Fig. 1. (a) The Sangamo specific gravity meter showing the plummet and baffle at the bottom



(b)

(b) the instrument's control amplifier, given in block-diagrammatic form

Output Signal

To measure the density of a liquid therefore, all that is required is to measure the current flowing in the electromagnet of a previously-calibrated instrument.

Due to the fact that the force required to support the plummet is proportional to the density difference between the plummet and the liquid, the actual density of the liquid will be this density difference plus the density of the plummet. Also, as has been previously mentioned, since neither the plummet nor electromagnet possesses any permanent magnetism, the force between them is proportional to the square of the current flowing in the electromagnet.

The main disadvantage of making a direct measurement of the magnet current is that accuracy of measurement is best obtained if most of the signal is 'backed off' by a known amount. This is done in the Sangamo instrument by measuring the difference between the voltage developed by the magnet current flowing in a calibrating resistor and that supplied by a 'zero-suppression' unit.

This unit [see Fig. 3(a)] consists essentially of a very stable reference voltage and a potential divider chain, which forms the 'range' control that corresponds (after calibration) to fixed values of density. The output voltage of the unit can be set to zero the input to a voltage indicator, which is connected between it and the calibrating resistor. Although any variation of density will produce an output voltage that is part of a square-law curve, the actual non-linearity is so small for small changes that it can be ignored in most applications; correction data is supplied, however, for the full accuracy of the instrument to be realized.

Another potentiometer is also provided in the zero-suppression unit, and this is used to attenuate the output signal so as to enable the full-scale deflection of the voltmeter or chart recorder to indicate a sensible increment of density; this is known as the 'span' control. Fig. 3(b) shows a simplified circuit of the unit, together with the extra input used for temperature compensation. The maximum signal level obtained from the specific-gravity meter is 60 mV for a change in liquid density of 0·01 gm per cc.

Liquid-Temperature Compensation

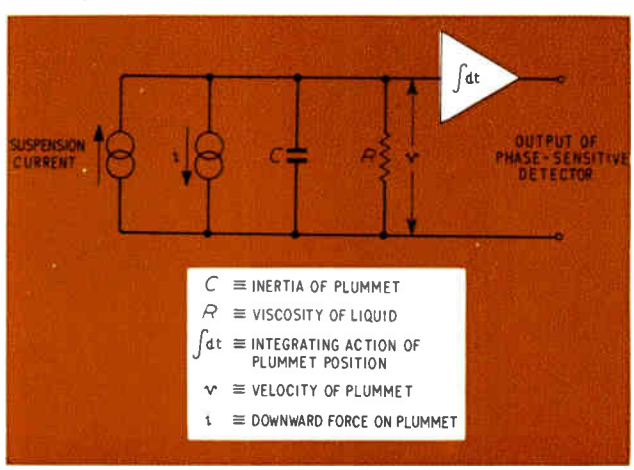
Although the Sangamo specific-gravity meter will measure the density of the liquid surrounding the plummet irrespective of the liquid temperature, it is often necessary to know the density referred to one particular temperature. For this reason, a separate signal is generated by a 'temperature-compensation' unit (see Fig. 4).

This unit is basically an accurate temperature-measuring circuit which utilizes a platinum-resistance thermometer probe in a bridge configuration. The output of this bridge, which can be zeroed for the particular reference temperature of the liquid, is amplified and added to the density-meter signal.

Further control over the gain of the amplifier is provided, so that a large range of liquid-density/temperature coefficients can be accommodated. The maximum rate of compensation is, in fact, 0·001 gm per cc per °C, with even higher rates in the less sensitive ranges of the instrument; the temperature range of compensation is ±10 °C about the datum.

A useful feature of the unit is the provision of a relay output that makes on/off control of the temperature of

Fig. 2. The equivalent electrical circuit between the electromagnet and the phase-sensitive detector of the specific-gravity meter's control system



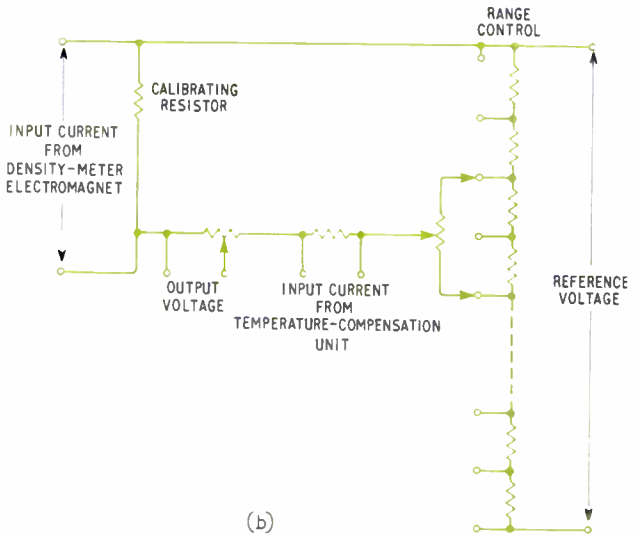


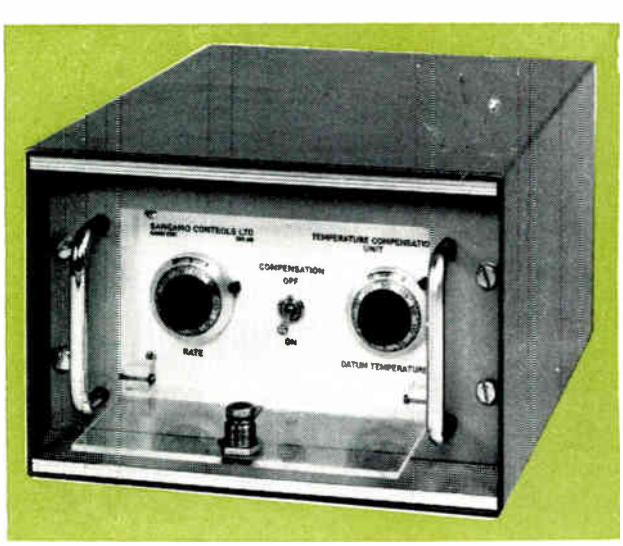
Fig. 3. (a) The zero-suppression unit for the Sangamo specific-gravity meter; (b) a simplified circuit diagram of the zero-supression unit

the process liquid possible at the datum temperature. By this means, the range over which compensation is required can be reduced, hence reducing errors due to liquids with very non-linear coefficients; alternatively, a fluid-temperature range outside that of the compensation unit can be dealt with.

Mechanical Construction

It will be appreciated that the distance beween the electromagnet and plummet must be accurately held, since the force between the two is a direct function of this. The location of the plummet is fixed by the sense coils as previously explained. By embedding the sense coils and electromagnet in an epoxy resin casting, this requirement can be met, with the added advantage that a chemically-inert material is in contact with the process liquid. The plummet density is adjusted by attaching to its surface a weight, which is normally made of stainless steel and is sealed to the surface with epoxy resin.

Fig. 4. The temperature-compensation unit, which permits a maximum rate of compensation of 0·001 gm per cc per °C



The electronics pack is housed in a cast-aluminium box, which is arranged to be sufficiently sealed to allow gas or air pressurizing and thus enables the unit to meet requirements for hazardous atmospheres. Both the zero-suppression and temperature-compensation units also have provision for pressurizing.

The maximum ambient temperature that the electronics housing can tolerate is 50 °C, while the epoxy probe will operate in liquids up to 170 °C. In use, the instrument can be mounted directly in a tank or in a pipe-line, but it is more usual to make use of a sampling tank; this in turn is fed from a bypass on the pipe-line carrying the liquid which is being monitored.

Performance

When due attention has been paid to the temperature of the measured liquid, and gas has been eliminated as far as possible, the repeatability of the instrument has been found to be within ±0·0001 gm per cc. This is obtained with the minimum difference (0·05 gm per cc) between the plummet and liquid density, and thereafter, the repeatability becomes approximately ±0·1% of this difference in density. The limitation on the difference between the plummet and liquid density is mainly due to the increasing degree of non-linearity that occurs as it gets smaller.

Despite this limitation, advantage can be taken of the improved performance obtained by reducing this difference; for measurement over small spans (say 0·005 gm per cc), it is possible to operate with a difference between the plummet and liquid density of 0·03 gm per cc.

Calibration

Instruments are normally delivered calibrated over the customer's required range, with the calibration correct at about 20 °C. The calibrating standard is accurate to ±0·0001 gm per cc, and spot checks have shown that, after calibration, the instrument can be used to make absolute measurements of density with an accuracy of typically ±0·0003 gm per cc, with a difference between plummet and liquid density of 0·2 gm per cc. This is about the working point of instruments so far delivered. Calibrations can be corrected, with a small reduction in accuracy, for any temperature within the working range.

Applications

The applications of the Sangamo specific-gravity meter spread over a wide range of industries. In brewing, for instance, there are many points in the processes (at the run off of the mash tuns, during the fermentation process, and in the blending or filtering of various beers) where it is important to know the density of the beer or beer wort. The instrument is already in service in breweries (see Fig. 5) to provide continuous monitoring of density at such points.

In many sections of the sugar and confectionery industries, density measurement is important; the instrument has been used to monitor the concentration of various sucrose solutions, and has been demonstrated measuring the density of molasses with a viscosity up to 3,000 centipoise. Other applications in the food industry include measuring the density of tea, coffee and meat extracts, milk processing, yeast suspensions etc.

Various applications also arise in the refining, blending and transit of many different oils and petroleum products; evaluation programmes have been carried out to demonstrate the suitability of the instrument for many of these products.

In the chemicals industries, a vast range of materials and processes exists where density measurement is important. Control of polymerization processes, resin manufacture, plastic film, paper coatings, electrolytic solutions, crystallization processes, distillation columns and production processes for various acids and alkalis etc. are typical applications. Applications also arise in rubber processing, atomic energy and in various research projects, where the monitoring and control of a particular solution can be achieved by measuring its density.

The high accuracy of measurement which the instrument offers, together with its robust construction and versatility of range and working spans, permits its application in an increasing number of industries. Its d.c. millivolt output can be adjusted over a very wide range and may be fed into a suitable indicator, recorder or process controller. Density measurements of any volume of solution above approximately 50 cc may be made in beakers, storage tanks etc., though they can readily be made of a flowing liquid by using the sampling tank that is available.

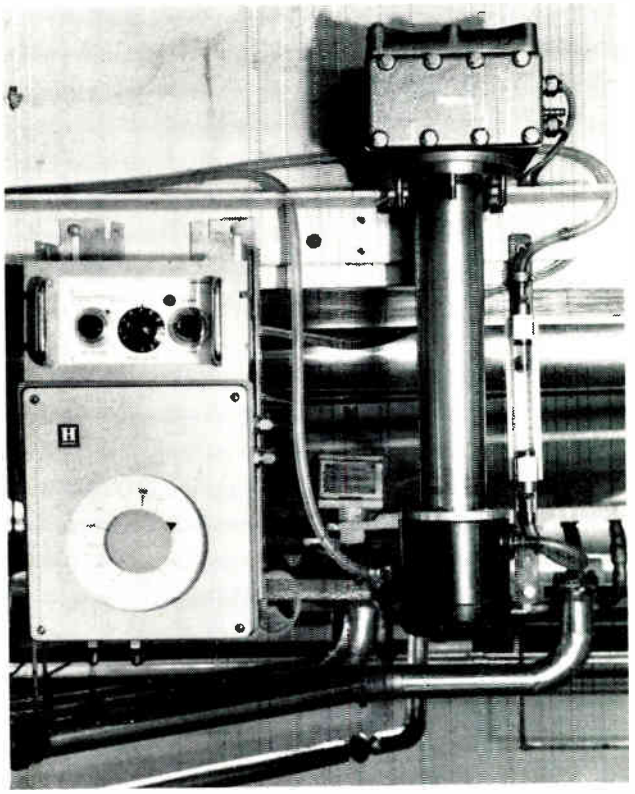


Fig. 5. Here, the Sangamo specific-gravity meter can be seen installed in an Ind-Coope pilot plant at Burton-on-Trent

Yarn Tension Control

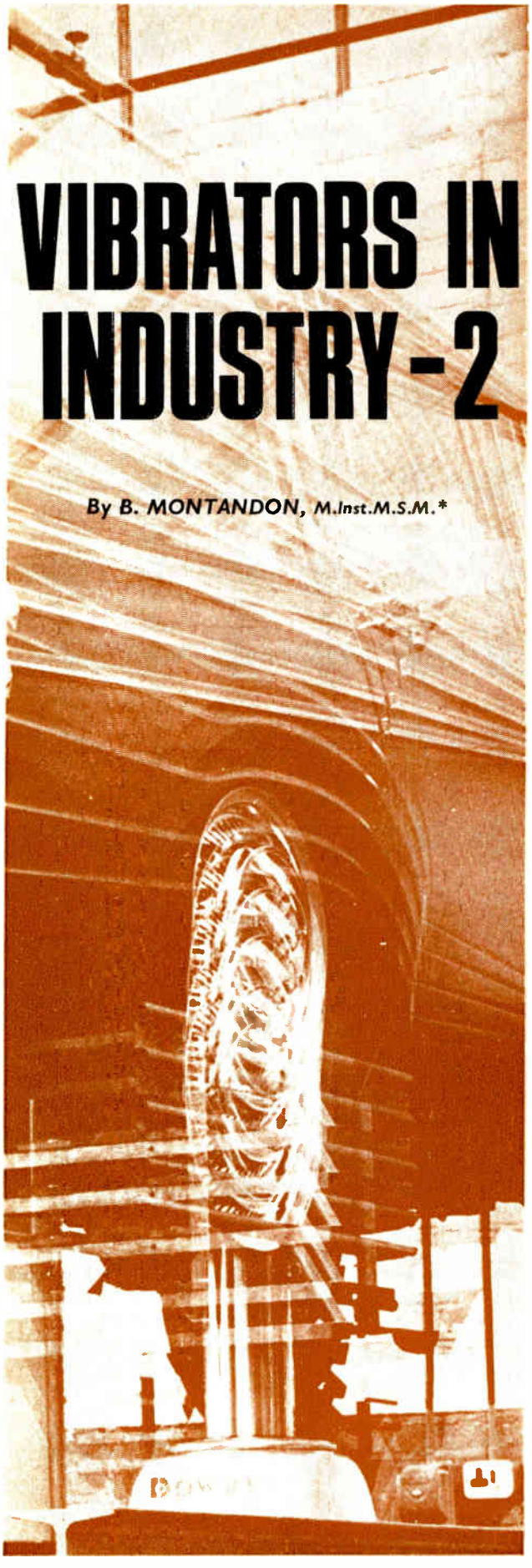
A side-unwinding process, developed jointly by Westool Ltd. of Bishop Auckland and I.C.I. Fibres Ltd., has overcome many of the problems previously associated with the tension control of a running yarn. It is claimed that the new process allows all the yarn from the supply package to be used, resulting in a saving of approximately 2½%, and experiments have shown that it is possible to hold yarn tension as low as 5 gm (with an accuracy of better than ± 1 gm) at yarn speeds of 500 ft per min.

Previously, friction-type tensioning devices gave only a coarse control and had a tendency to 'polish' or 'burn' the yarn when it was travelling at high speeds. In the new method of tension control, yarn from the supply package is taken from the side of the package and threaded through a fixed guide, around a movable guide suspended on a dancer arm, through another fixed guide, and then via some form of capstan haul-off device into the draw frame. The supply package is driven from a constant-speed motor (or from some suitable point on the machine), either direct or by means of a belt, to a specially-designed Warner electromagnetic clutch and brake unit, which carries the supply package on its outer diameter; the excitation of this unit is supplied by a transistorized servo amplifier that is controlled by a potentiometer mounted on the dancer arm.

With the device running and the dancer arm in its mid-position, neither clutch nor brake is energized and the stock reel is free to rotate. Should the tension tend to increase, however, then the dancer arm is raised, thus energizing the clutch ; the degree of energization (and hence rate of acceleration) is governed by the displacement of the dancer arm from its mid-position, and this causes the supply package to speed up ; the rate of yarn delivery is thus increased, reducing the tension until the dancer arm is once more in its mid-position. Should the reel overfeed, there will be a tendency for tension to fall and the dancer arm will be lowered ; this will energize the brake, the degree of energization again being governed by the displacement of the dancer arm from its mid-position.

It should be noted that this is really a tendency and not an actual change, since the dancer arm is purely gravity loaded ; no change in tension will take place, therefore, as long as the arm does not come into contact with its end stops. The response of the unit and the acceleration torque available allow the draw frame to be started up under normal conditions without any yarn breakage.

For further information circle No. 52



VIBRATORS IN INDUSTRY-2

By B. MONTANDON, M.Inst.M.S.M.*

This is the second article in a series on vibrators for environmental testing. It deals with vibrator systems and discusses various characteristics which have to be taken into account when a system is in use or when it is being purchased.

THE previous article in this series dealt with some of the design details of electromagnetic vibrators. However, important as this is it must be considered in relation to the drive amplifier and instrumentation which constitute an electromagnetic vibration system. All the major parts of a system must be designed to work entirely satisfactorily one with the other. Fig. 1 illustrates diagrammatically an electromagnetic vibration system for sinewave operation utilizing a water-cooled vibration exciter and a water-cooled amplifier.

A vibration system consists of a signal source (sine oscillator), a power amplifier and a vibrator. Additional components are a power supply with a d.c. output to feed the field of the vibration exciter, cooling systems for vibrator and amplifier and some form of device to control and measure the vibration level.

The Vibrator

The electromagnetic vibrator is a versatile machine capable of supplying force over a very wide frequency range (even at d.c.). The force output is directly proportional to the current passing through the moving coil (over most of its frequency range) and this current is easily controlled by the operation of the gain control on the amplifier. This machine will therefore be expected to fulfil a number of test functions, including:

(a) subjecting light specimens to high acceleration levels
(b) subjecting heavy specimens to low acceleration levels
(c) subjecting light specimens to low acceleration levels and
(d) operating at high and low temperatures and high altitudes for combined climatic and vibration testing.

(The above tests will probably be executed with both sinusoidal and random drive signals.)

Because of the variety of specimens which must be accommodated, the vibrator should have a large diameter table with numerous fixing points to facilitate easy attachment of the store.

The table should be light in weight in order to satisfy condition (a) above. The maximum acceleration a machine will achieve is given by the ratio:

$$\frac{\text{force output of the vibrator in lb}}{\text{weight of moving assembly in lb}}$$

In order to achieve a low table weight the manufacturer must economize on materials and may have to reduce the number of store attachment points.

A very light table may have a low first major resonance due to excessive flexibility in the table structure. These factors are important as frequently specifications call for the testing of a store to high frequencies—for example, up to 5 kc/s. If a vibrator has a first natural table resonance significantly below this, perhaps at 2 kc/s, the store will probably not be correctly tested because the vibrator moving system might become decoupled at resonance. In this case the energy will not be imparted to the store. Fig. 2 is a simplified equivalent mass-spring system of the vibrator moving system and store. The mass M_b is the body of the vibrator and as the mass is very large it can be considered an immovable body for the benefit of this discussion. The mass of the actual drive coil is M_c and is usually quite light

* Pye-Ling Ltd.

as well as being the forcing member. The mass of the table to which the store is bolted is represented by M_t and K_c is the stiffness of the coupling between M_c and M_t, and is in series. The member marked K_s is a low spring-rate suspension which is designed to maintain the moving coil in its correct position in the vibrator. This is in parallel with masses M_e, M_t and M_c and at high frequencies has little effect on them. The mass M_e is the store and K_e the stiffness of the attachment bolts, etc.

From this diagram it will be seen that if K_c is not stiff enough the forcing member (coil) M_c cannot impart energy to M_t and therefore the store M_e will not be vibrated.

It will be appreciated therefore that before purchasing equipment careful consideration should be given to the test specification in relation to the vibrator specifications.

Most electromagnetic vibration exciters are available with trunnion supports. With a trunnion support the vibrator can be operated with the thrust axis vertical or horizontal. This is particularly useful with the larger vibrators which will be used for testing heavy stores. Most specifications call for the vibration testing of stores in three mutually perpendicular planes. With the arrangement shown in Fig. 3, it will be realized that the weight of the store in relation to the capability of the vibrator (in the foreground) is such that the store can be turned through 90° and still be readily mounted on the vibrator table. However, if the store were very much bigger and heavier, the static load of the store would have to be removed from the vibrator table in order to maintain the vibrator drive coil in the correct position in the magnetic field (as shown on the vibrator in the background and also illustrated in Fig. 4(a)). This will ensure that the vibrator will not be displacement limited in the downwards direction. When vibrating the store at 90° to the first direction, the weight must again be removed from the vibrator to prevent the overloading of the vibrator suspension system. Fig. 4(b) illustrates the correct arrangement.

In order to decide the maximum load which may be

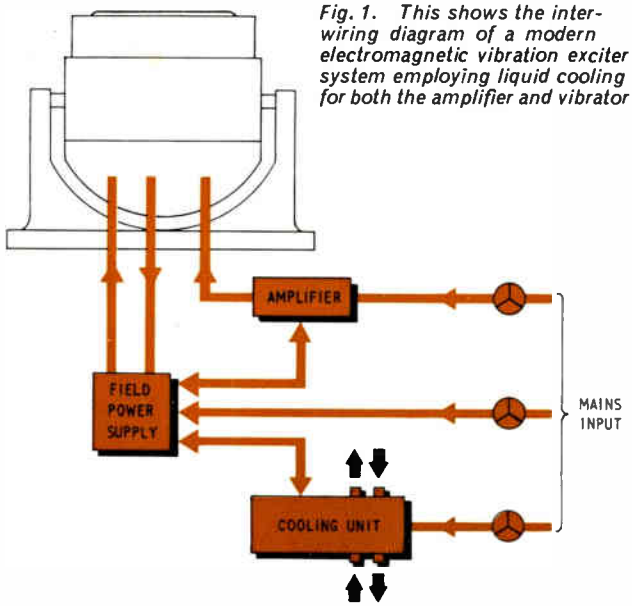


Fig. 1. This shows the inter-wiring diagram of a modern electromagnetic vibration exciter system employing liquid cooling for both the amplifier and vibrator

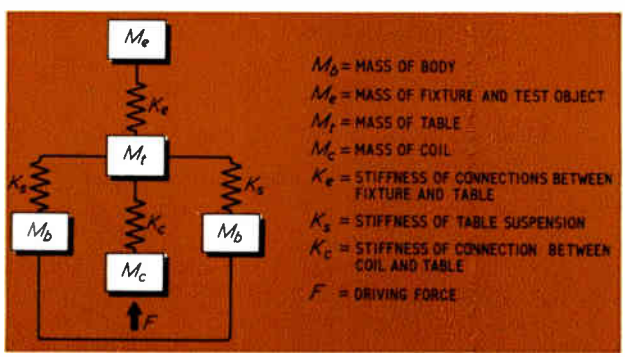


Fig. 2. This simplified equivalent mass spring system represents the vibrator moving system and store

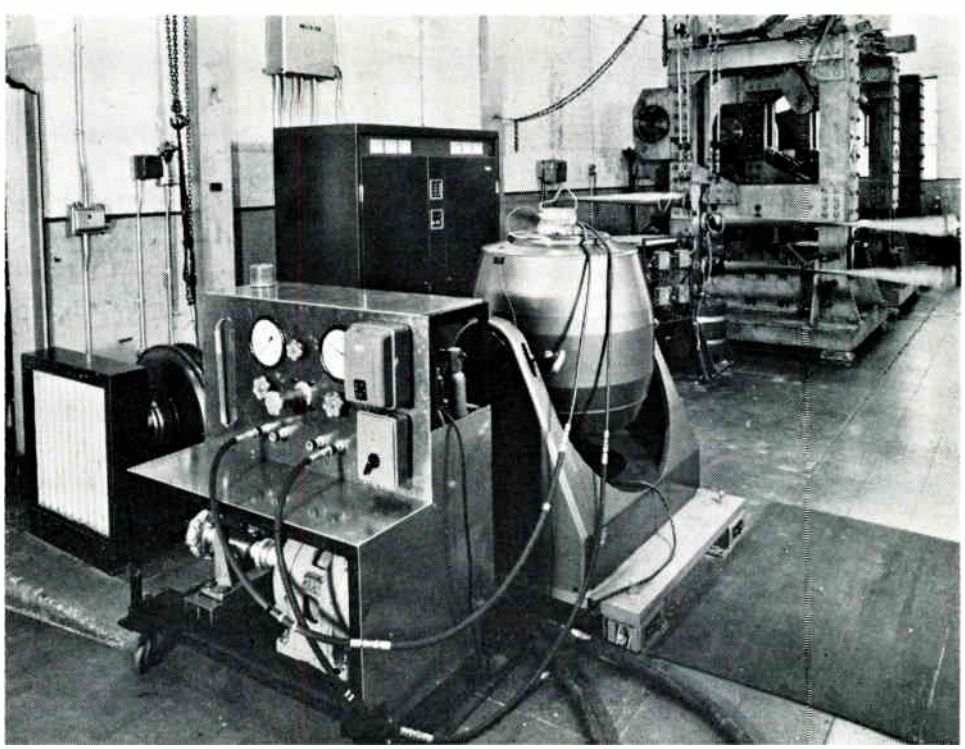


Fig. 3. In this picture a medium thrust vibrator is shown testing an aircraft dual control valve under simulated conditions

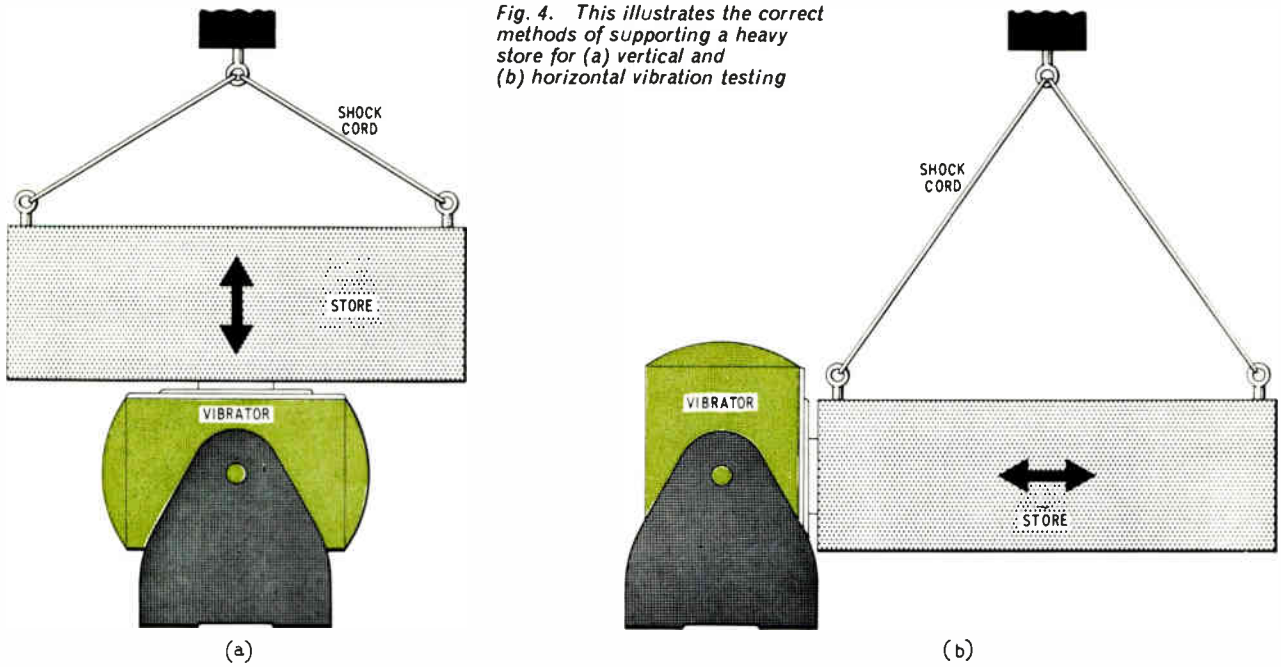


Fig. 4. This illustrates the correct methods of supporting a heavy store for (a) vertical and (b) horizontal vibration testing

vibrated without additional support in the vertical direction, the manufacturer should be consulted. He will advise either the spring rate of the machine or the maximum permissible load.

Obviously a vibrator having a low suspension stiffness could be displacement limited in the downwards direction with relatively light loads and to overcome this problem one must resort to the inconvenience of additional external suspension. One manufacturer overcomes this problem by incorporating automatic load compensation within the shaker by pneumatic methods. A vibrator of 15,000-lb thrust can freely support a load of 1,000 lb when constructed in this manner.

When operating with the thrust axis of the vibrator horizontal the same considerations apply except that now the lateral strength of the table lateral supports is the deciding factor. Again the manufacturer will supply the information required. Fig. 5 illustrates a vibrator mounted in a trunnion support.

Other factors to be considered by the user of electromagnetic vibration systems are:—

1. System distortion
2. Minimum noise
3. Lateral motion
4. Displacement capability
5. Velocity capability
6. The behaviour of the table over its diameter at high frequencies—often called 'table break-up'.

(All the above parameters are as measured at the table surface.)

7. The effect of a load on the table characteristics.

Items 6 and 7 are most important but frequently are not considered by would-be users.

The Effect of a Load on an Electromagnetic Vibrator Table

Axial Resonance

Performance characteristics of vibrator systems are usually quoted by the manufacturer for 'unloaded-table' conditions. While this is an unrealistic condition it does give the purchaser an excellent idea of the system performance and is in fact the only truly repeatable condition. No two stores are likely to be identical and the manufacturer cannot therefore be expected to anticipate the load configuration. However, he must allow for loads in his design and will ensure that the addition of a load changes the performance of his vibrator as little as possible. A change in performance is unavoidable when the weight of the store is high, see Fig. 2. This condition is catered for by the manufacturer who will usually be able to supply curves showing the change in vibrator characteristics when a 'dead mass' load (one having no intrinsic or mounting resonances) of a certain weight is vibrated. Fig. 6 is a graph showing vibrator characteristics with and without load.

Table Break-up

Fig. 2 is a simplified equivalent spring-mass diagram and does not allow for flexural modes of the masses. It is important to know which form the first resonance of the vibrator takes, whether it is the flexural, or bending mode (sometimes called diaphragming) or whether it is the axial resonance caused by M_t, M_c and K_c (Fig. 2) resonating. If the bending mode is the first resonance it means that energy is still imparted by the coil to the table and over some of its diameter a useful thrust may be realized at this frequency. An accelerometer at one position on the table may indicate a satisfactory level but other parts of the table will be operating at radically different levels. If a store is mounted on the table it will not be satisfactorily tested if the accelerometer is on a different part of the table from the store, or if the store covers the whole diameter of the table.

The addition of a mass to the table will change the characteristics of this resonance—just as it changes the axial resonance. The geometry of this mass is a critical factor. Because of this it is difficult for a manufacturer to advise on the effect of the load or table break-up.

Displacement and Velocity Capability

Among the performance limitations of a vibrator system are the maximum table movement in the direction parallel to the thrust axis (the displacement limit), and the maxi-

mum velocity at which the table is capable of moving in this direction. The values of these limits will be governed either by mechanical considerations of the vibrator or electrical characteristics of the amplifier.

The displacement limit is usually a mechanical limit which is a function of the design of the vibrator. Frequently mechanical stops and electrical switches are provided to ensure the design limits are not exceeded. Occasionally a limit will be applied which is below the mechanical limits. This reduced movement is caused by the drive amplifier limitations.

A velocity limit beyond which the table should not be driven will be recommended by the manufacturer. This again is a function of design and is generally applied to ensure long life of the table suspension elements as internal damping within these components might cause the generation of excessive heat.

This mechanical limit is usually very high, 70 in. sec or more, and will not usually prove of embarrassment. Frequently, however, a complete system will have a velocity rating quoted by the manufacturer which is below the mechanical limit. This is a drive amplifier limitation and brought about by optimization of amplifier output voltage (and hence power) in order to achieve an economic system cost.

For a given amplifier a vibrator system may have its full thrust capability, but only a limited velocity capability. In order to achieve the full velocity capability, a drive amplifier having a much greater output voltage and therefore considerably greater power would be required. This is largely due to the back e.m.f. generated at high velocities which necessitates a high voltage from the amplifier in order to pass the required current through the vibrator drive coil. Alternatively, the same system might be capable of providing its maximum velocity capability but with a reduced thrust at the higher frequencies. This is achieved by matching the amplifier to the vibrator at a lower frequency than usual. The price difference between these two systems will be appreciated as being very significant.

Lateral Motion

Lateral motion is the term given to motion of the table in any direction other than the direction parallel to the thrust axis. This motion should, ideally, be non-existent, but unfortunately because of the very wide operating parameters of a vibration exciter, some motion is inevitable. This lateral motion, or 'cross-talk' as it is often called, should be low for an unloaded table over much of the frequency range of the vibrator. At very low frequencies the table (armature) lateral supports will offer a significant constraining effect and the very small movements which might occur normal to the thrust axis will be of virtually insignificant acceleration levels at these low frequencies. Cross-talk will become more noticeable at high frequencies for two main reasons:—(1) the suspension, or lateral support, system will have decoupled from the table which means that no constraint will be offered to the table for small lateral movements of the table, and (2) small displacements at high frequencies correspond to high acceleration levels, e.g. a peak-to-peak sinusoidal motion of 0·001 in. at 2 kc/s corresponds to an acceleration in excess of 200 *g*.

From the foregoing it will be realized that cross-talk is a mass dependent function over much of the frequency range of a vibrator and is therefore controlled by the effective dynamic centre of gravity of the vibrator table and store and jig. Only at very low frequencies is it a function of the table lateral supports.

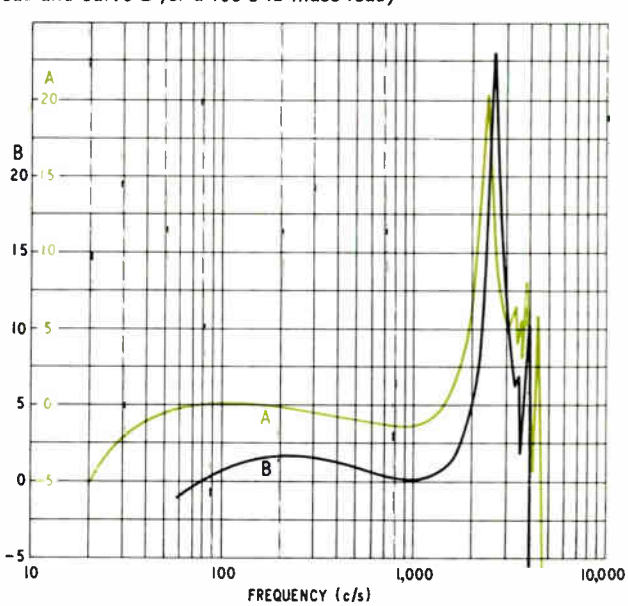
Care should be taken when fixing the store to the vibrator table to ensure that the centre of gravity is coincident with the central axis of the table. If the centre of gravity is too displaced from this position, increased lateral motion will probably result, and in very severe cases some damage might result to the vibrator.

Fig. 5. The vibrator shown, a Pye-Ling shaker model V1007, is air cooled and has a force rating of 1,800 lb thrust and a bare-table acceleration of 90 g

System Noise Level

Most component parts of an electromagnetic system are potential sources of noise and hum. Manufacturers quote noise and hum levels for each item with reference to the maximum output voltage of the unit. It is most important to keep these unwanted signal components to a minimum as otherwise distortion of the vibration signal as monitored at the vibrator table will be significant. This noise level will also define the lowest level to which one can test.

Fig. 6. The effect of a load on a vibrator table is indicated by this graph of acceleration vs frequency (curve A is for a 250-lb mass load and curve B for a 106-5-lb mass load)



Some specifications call for a wide range of test levels over a wide frequency band; i.e. a few thousandths of an inch at 5 c/s to several *g* at 5 kc/s.

A small displacement at 5 c/s is a very small value of *g* and is therefore very near the noise level of even a very good system. Typical noise levels for electromagnetic vibration systems will be 0·1 *g* or less.

Distortion, while inevitable, must be kept low. The purity of the applied signal is important as the frequency range of operation is wide and will include, at most frequencies, the lower order harmonics. In addition, the '*Q*' of the moving assembly (or table) resonance will be quite high and this resonance will be excited by harmonics of the applied signal. This gives rise to significant distortion unless the harmonic distortion of the applied waveform is very low.

Conclusion

It will be appreciated that the quality of the electronics in the vibrator system must be very high. The vibrator itself must be constructed of carefully selected materials and manufactured to an extremely high specification in order to satisfy all the requirements placed upon it. A vibration test system is designed to test a very large number of specimens during its anticipated life, and many of these specimens will have to be tested to destruction. Reliability is therefore of high importance.

Acknowledgements

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Reference

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Second Intelsat Communications Satellite Launched

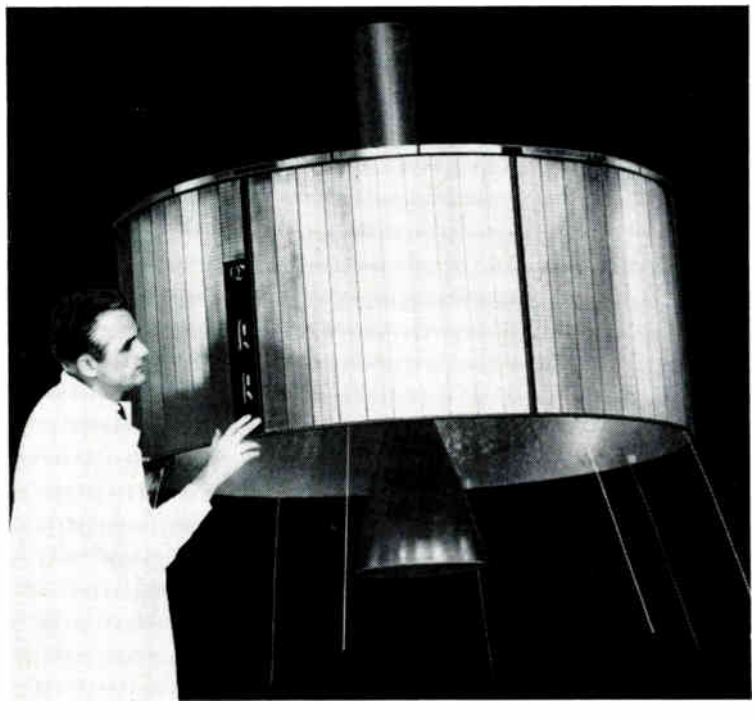
The second in the INTELSAT series of communications satellites was recently launched from Cape Kennedy. It reached a highly-elliptical transfer orbit and while it was in this orbit detailed computations were carried out on the ground. The results of these computations determined the time at which the satellite's motor should be fired to thrust it into an equatorial synchronous orbit over the Pacific so that it would appear to remain stationary near the international date line.

The satellite acts as a microwave relay station for transmission of telephone, teleprinter, television, data and facsimile communication. It links earth stations in the state of Washington, U.S.A., in Hawaii, Japan and Carnarvon, Australia, and will provide communications support for the Apollo manned moon-flight mission. A further satellite is planned for an orbit over the Atlantic to link American and European stations.

Owned by the International Telecommunications Satellite Consortium (INTELSAT), the satellite is operated by COMSAT, the Communication Satellite Corporation. Launched by the National Aeronautics and Space Administration, it was built by the Hughes Aircraft Co.

The satellite is powered by 12,756 silicon solar cells which provide an output of 85 W. Four travelling-wave-tube amplifiers are used and any three of these can be operated at one time to provide a transmitted power of 18 W. Compared to the Early Bird satellite, which transmits a power of 6 W and accommodates 240 two-way voice channels, the new Pacific and Atlantic satellites offer a greater geographical coverage and a greater capacity for communications traffic.

The first satellite of the series, launched in October 1966, was unable to achieve the desired synchronous orbit and is travelling in an elliptical path. It is, however, in use and provides limited communications facilities. The results of tests and investigations into the cause of the failure have been used in the design of the second and third satellites.



This picture of the INTELSAT satellite shows the solar cells around the outer shell, the motor at the bottom of the structure, and the microwave aerial at the top

Electronic Photo-typesetting System

AFTER a six-year development project, the latter part of which was supported by the National Research Development Corporation, K. S. Paul & Associates have produced an electronics-based photo-typesetting system that operates at speeds approaching ten times those attainable on present-day photosetters, and yet which is of the same order of cost.

The Paul-PM filmsetter equipment consists of a number of 'building blocks' (photo-setter, keyboard, justifying calculator, tape merger and monitor), which can be combined in various ways according to the mode of operation required.

Three principal modes of operation are envisaged, the first involving production at the keyboard stage of 'justified' tape—that is, punched-paper or magnetic tape which has been coded so that each line of type is automatically adjusted to a regular column width. In this mode, each keyboard is connected to a justifying calculator and the tape produced is suitable for direct operation of the photo-typesetter; in addition, a tape-merging unit is required for corrections. In the second mode, unjustified tape is produced at the keyboard stage, and a monitor unit is required to convert the unjustified tape into a form suitable for the photo-typesetter; the same unit is used for corrections. The third mode is that in which the photo-typesetter alone is used, being directly operated on-line from a computer.

The photo-typesetter unit uses the principle of flying-spot scanning to generate video signals for each character to be reproduced.

On the face of a cathode-ray tube, known as the index tube (see Fig. 1), the light spot is made to produce a 5-cm sq. raster containing many fine vertical lines. This raster can be formed in any one of 16 positions on the tube face, and at some distance from the tube a group of 16 lenses forms an image of the whole face of the tube on each of 16 areas of a glass matrix plate. Each area of the matrix plate contains negative photographic images in groups of 16 characters, and according to the position of the raster on the tube face, one character in each of the 16 groups will be illuminated by each raster.

Finally, there are 16 photo-cells positioned behind the matrix-plate (one for each group of characters), and at any one time the output from only one of these cells is selected and fed to the subsequent reproducing system; thus, by selecting one out of 16 raster positions and one out of 16 photo-cell outputs, access is obtained to 256 character locations. The matrix plates are prepared photographically, being approximately 15 cm square, and an electro-magnetic matrix-change mechanism is provided, which is automatically controlled by the input signals to the machine; this mechanism can be loaded with any combination of four different plates to give a total of over 1,000 different locations.

The reproducing system consists of a print-out cathode-ray tube, a moving lens and a film magazine (see Fig. 2).

On the face of the print-out tube, the light spot is made to generate straight lines in synchronism with the successive raster lines; however, these lines are all described in the same positions on the face of the tube, and so there is no electronic 'Y deflection'. Light from the tube is collimated and passed via a mirror to a lens, which forms a reduced (1 : 20) image of the c.r.t. face in the plane of a piece of film. The lens is fixed to a reciprocating carriage, which makes horizontal movements corresponding to the length of the line of characters being set, and as the lens moves the successive lines displayed on the face of the print-out tube are exposed side by side on the film. The brightness of the print-out spot is controlled by a video signal from the flying-spot scanner, so that in practice only parts of lines are exposed to build up character images.

Also attached to the moving carriage is a fine-line grating approximately 12 in. long; as this moves, it interrupts the path of a beam of light between a static light source and photo-cell, thereby generating 1,300 pulses per in. of carriage movement. To these pulses are synchronized the line frequency of the raster on the flying-spot scanner and the successive lines on the face of the print-out tube; in other words, the 'grating pulse generator' forms a master clock for the photo-setter. In addition, the pulses are counted to give accurate positioning control of the print-out.

Between each sweep of the lens carriage, the film magazine (which is accurately reversible) advances the film ready for the next line; this movement is controlled from the input signals and is made in ½-pt. increments. A cassette system is used, having a roll capacity of 100 ft, but there is also a facility for exposing on single sheets; either film or paper may be used, and the image may be selected for right reading or wrong reading.

This print-out system has many advantages over other systems in which whole characters appear on the face of a cathode-ray tube. First, there is no restriction on the length of the printed line—in the present machine the maximum line length has been limited to 11 in., which is sufficient for most purposes, but in principle there is no

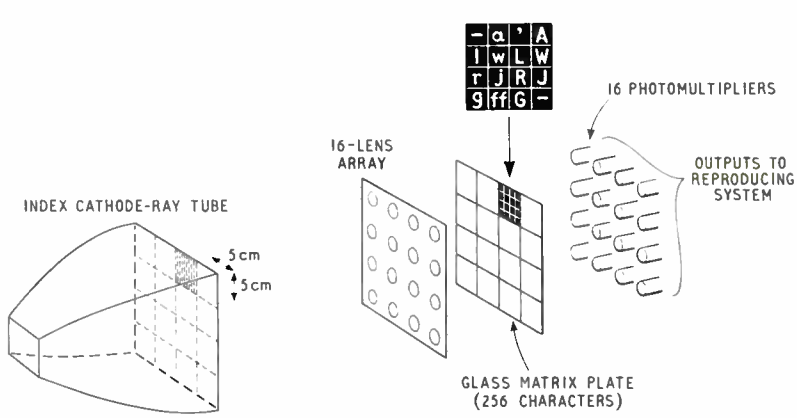


Fig. 1. The whole of the c.r.t. face is focused on to each of the 16 areas of the glass matrix plate. Sixteen characters are 'illuminated' by each raster and the required character is selected by one photomultiplier

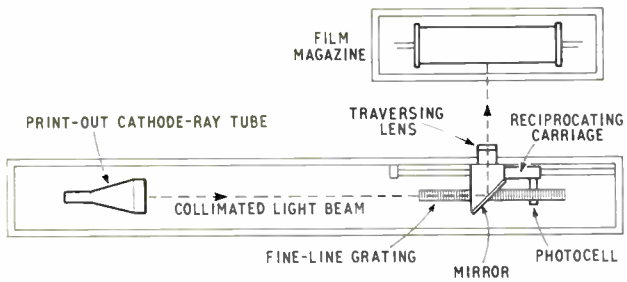


Fig. 2. The reproducing system, showing the c.r.t. print-out assembly. Each selected character is focused on the photographic film, lines of copy being built up by means of a synchronized reciprocating carriage

reason why the whole width of, say, a newspaper page could not be exposed. Secondly, because of the large optical reduction involved, the quality of the exposed image is not critically dependent on the properties of the print-out cathode-ray tube; to achieve equivalent quality using a wide c.r.t. and fixed lens, the tube would have to be 6 m in diameter. Thirdly, the positional accuracy of the exposed matter is independent of the electron optics of the print-out tube, being controlled from the grating pulse generator.

This third point is particularly important, because the final quality of photo-set texts is as dependent on positional accuracy as it is on the quality of the individual character images. For this reason, the positioning accuracy of the system has been rendered independent of the electron optics of the flying-spot scanner and the accuracy of the character locations on the photographic matrix plate. This is achieved by photographing each character together with two fine reference lines, one on the left and one underneath; the horizontal and vertical positioning of the scanning raster is then locked on to these reference lines by a feedback system.

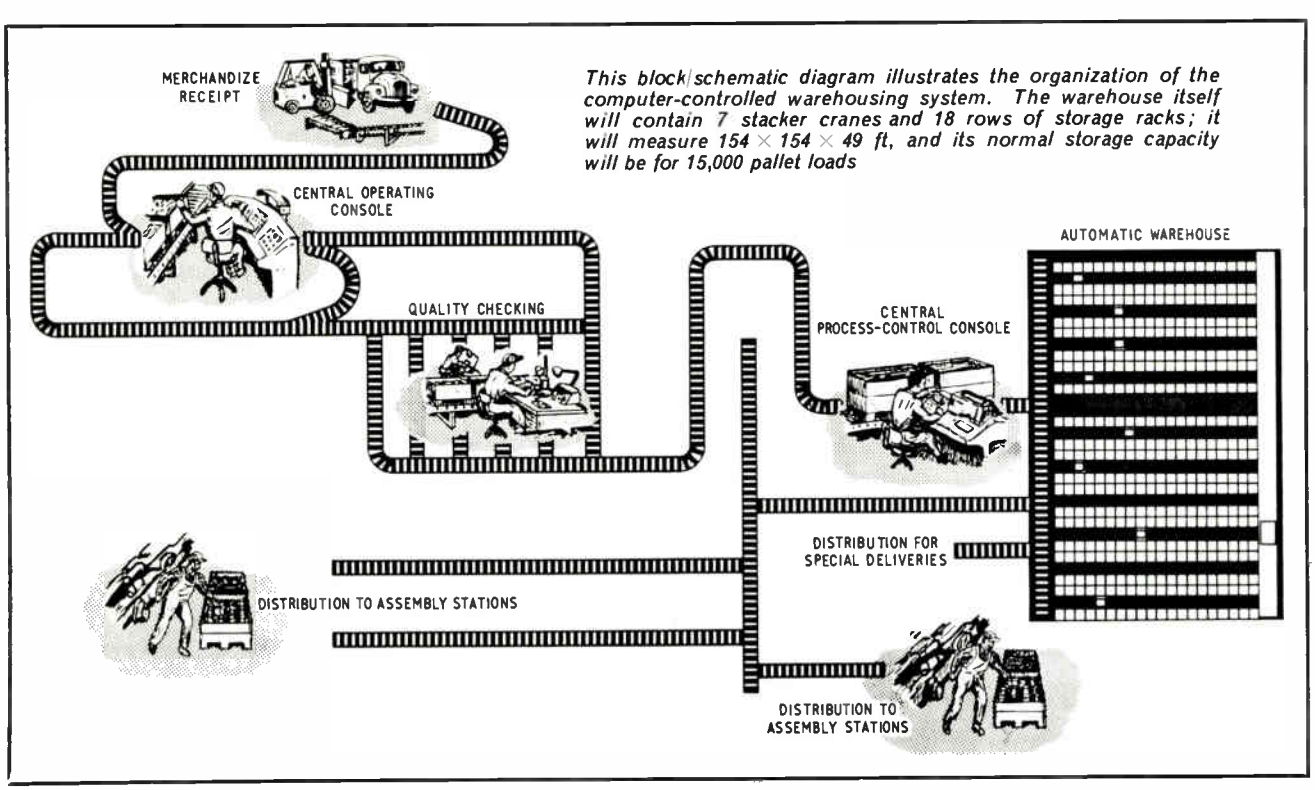
Computer-Controlled Warehousing

Europe's first computer-controlled high-stacking warehouse is to be installed by the Westinghouse Electric Corp. at the new diesel-truck assembly plant of AB Scania-Vabis in Södertälje, Sweden. The basis of the system (see schematic diagram) will be a 'Prodac' 50 computer, which will select storage locations for pallets containing components and then direct the cranes that handle them. The computer will also order the retrieval of the pallet loads according to the type and quantity of their contents, distribute them to the appropriate conveyors, and monitor all the different operations.

All operations will be directed by one operator from a central console. Items coming in on the conveyor belt will be counted automatically, and a c.c.t.v. monitor will indicate which checking stations are free to receive the goods; orders can then be given for the checking tools to be set up, and the pallets will be sent to their stations. Once checked, the parts will be conveyed to the warehouse, where cranes will be directed to store them.

The computer will also direct the handling of components from storage to assembly lines, being capable of interrupting and changing its orders to the cranes and conveyors during any of the operational phases. If a fault occurs, the system will automatically redirect loads on a priority/suitability basis, at the same time printing out a message to maintenance staff suggesting what action it is necessary to take.

For further information circle No. 53



This block schematic diagram illustrates the organization of the computer-controlled warehousing system. The warehouse itself will contain 7 stacker cranes and 18 rows of storage racks; it will measure 154 × 154 × 49 ft, and its normal storage capacity will be for 15,000 pallet loads

APPLICATIONS & TECHNIQUES

Hoist Control by Proximity Detector

In the British Sugar Corporation's factory at Colwick a G.E.C. proximity detector is being used for remote control of a vertical hoist. It enables a dumper-truck driver to start the hoist from the driving seat of the truck once he has emptied his load into the hopper of the hoist.

A pair of electromagnets is attached to the bottom of the front bumper on the truck. These actuate the proximity detector head which consists of a saturable-iron core inductor buried in the concrete at the point where the truck is unloaded. Power to energize the electromagnets is supplied by the truck's battery and is controlled by a push-button on the dashboard.

Having discharged his load, the driver presses the button to energize the electromagnets. The magnetic field set up causes the core of the inductor to become saturated so that the impedance of the inductor falls from a high value to a low value. A signal is produced by the detector and this is passed to a thyristor controlling a relay in the starter circuit of the hoist motor. The relay closes and the hoist is raised.

For further information circle No. 54

Airport Information Equipment

A number of interesting technical features have been incorporated into an airport passenger-information system that has been ordered by the Soviet Union from the Hungarian electronics industry. On the illuminated announcement boards, for example, the luminous points forming the letters and digits consist of neon-filled triple-electrode relay tubes which (in contrast to normal light sources) not only emit light but also, when receiving an appropriate pulse, turn on and off without any special equipment. This enables considerable miniaturization to be achieved, allowing the 35 lights for each letter or digit to be set in an 8 × 12-cm area instead of the previous 42 × 58 cm.

The panel of the arrival/departure indicator has a capacity of 400 letters or digits (in either Roman or Cyrillic script) and, when changing the information, only those words or digits that require correction need be cancelled. Text can be written on the board with a standard automatic telegraph, thus eliminating the need for separate control facilities, and the equipment may be connected into the international telex system to permit very remote control if necessary.

Thyristor Control of Cranes

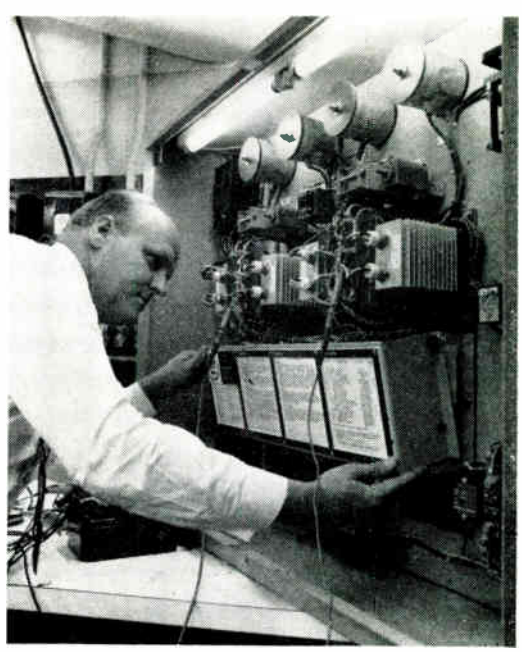
For what is believed to be the first time thyristors are being used in control equipment for cranes. The equipment, known as the '500-LINE' produced by Westinghouse Electric, includes a unit for control of the hoist drive and a unit for control of the travel drive of overhead bridge and trolley cranes.

The solid-state a.c. units replace existing d.c. constant-voltage drives which are commonly used and they eliminate the equipment required for the conversion of a.c. to d.c. Also, they eliminate the need for the saturable reactors used in previous a.c. drives. Their weight is substantially less than that of earlier systems.

The equipment is available for use with 125-h.p. motors. The crane hoist unit is used to control and reverse the a.c. power fed to the polyphase motor which raises the crane hook. It provides a fast, smooth-response drive, the speed control of which is unaffected by the load. Precise speed regulation and stepless speed control allow the load to be suspended at a required height for critical positioning operations.

The crane travel control provides accurate positioning without jogging. Stepless control down to zero torque is possible.

For further information circle No. 55



This shows a thyristor crane-hoist control unit being tested. It is more compact than earlier types of crane control units and offers improved reliability, is easier to instal and requires less maintenance

A&T

Automatic Tank-Filling Control

Potentiometers made by the resistor division of the Plessey Components Group are helping to provide simple, accurate and reliable control in an automatic tank-filling system recently introduced by Fielden Electronics. The system facilitates the safe filling of tankers with such inflammable liquids as paraffin, petroleum spirit and naphtha.

The Fielden type TTR 1 controller consists basically of a capacitance level switch connected to a control unit, with adjustable feedback channels to give the required characteristic. In all, eighteen pre-set type-MP potentiometers are used—for setting the top, middle and bottom scale calibrations on each of two sensing ranges for the three types of liquid.

The sensing electrodes are lowered into the tanker with a loading arm, and the required liquid and level are selected; the electrical output signal from the electrode is then converted into an air signal, which is proportional to the level sensed by the electrode and controls the appropriate valves.

For further information circle No. 56

Testing Paint Fading

Equipment installed at Drynamels Ltd., a Tube Investment Company in Birmingham, is evaluating the fading effect of sunlight on paint much more realistically than conventional ultra-violet radiation techniques. 'Xenotest' apparatus is being used to subject, simultaneously, up to 100 test panels of paint to the fading effects of several years' of exposure to sunlight, by reproducing the effects in a highly intensified form.

The light fastness of pigments and dyestuffs for building paints, industrial finishes and special coatings is checked by means of continuous rotation about Xenon-discharge lamps (see picture), which produce an intense source of ultra-violet light in an atmosphere of controlled humidity.

For further information circle No. 57

Here the equipment is being set up for a test period lasting 1,600 hrs —equivalent to about two years' exposure to sunlight

Ultrasonic Transducer for Liquid Processing

A high-intensity ultrasonic transducer, for use in the processing of liquids in chemical, pharmaceutical and other research and development applications, has been developed by the Westinghouse industrial equipment division. Due to the focusing action of its cylindrical transducer element and the short transmisison distances, relatively high viscosity chemicals can be treated effectively; the treatment time can be varied by controlling the flow rate through series or parallel arrangements of the basic transducer elements, and batch treatment is also possible by using one or more transducer elements as the batch container.

The power intensity level of the device can be about an order of magnitude higher than that provided in conventional high-power ultrasonic cleaning units (which have an intensity level up to about 10 W per sq. in.), and it is particularly effective for breaking up suspended particles or causing adjacent molecules to interact or separate when they normally would not do so. The transducer element consists of magnetostrictive ring laminations, bonded to a hollow stainless-steel cylinder which serves as the process chamber; direct and alternating currents in a toroidal winding then establish the magnetic fields required for radial vibration of the cylinder. The unit is water cooled, flange-mounted caps being available to seal either end for batch testing at pressures from atmospheric up to 250 p.s.i.

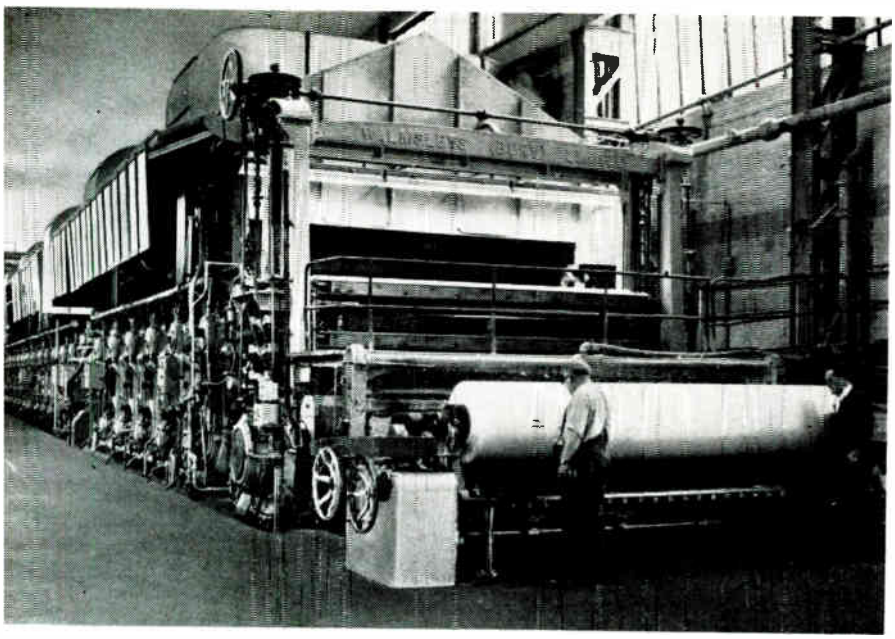
For further information circle No. 58

Thyristor-Controlled Drive Motors

A complex control scheme, using thyristors to provide accurate speed-control and speed-matching facilities for the drives of a paper-making machine, has been supplied to the Reed Paper Group at Imperial Paper Mills, Gravesend, by the General Electric Company.

The paper-making machine includes ten mechanically-separate units (two of which incorporate multi-motor drives) and these rely on the control system for the matching of their speeds. For paper-making, a wide range of overall speed control with precise speed-matching between the various drives is required, and the control scheme must also enable slight adjustments to be made to the speed of each motor, in order to provide 'draw' facilities as the paper passes through the machine.

In both the wet and dry sections of the paper-making machine, two speed-control loops are provided. The first controls the armature voltage (and hence the speed) of a 'master' motor, whose shunt field is fed from a constant-voltage supply; the armatures of the other driven motors on the same section are fed in parallel with the armature of the master



The No. 6 paper-making machine, for which G.E.C. supplied the electrical drives and control equipment

motor, and thus run at an approximate speed match. The second loop functions as an automatic shunt-field current regulator to provide accurate control of the speed of the individual drive relative to that of its master motor.

For further information circle No. 59

Quicker Vibration Analysis

Equipment developed by Marconi Instruments in collaboration with the steam turbine department of English Electric has reduced the time taken for vibration analysis of steam turbine rotors from weeks to hours.

Previous methods of vibration analysis consist of displaying signals from strain gauges on oscilloscopes and the manual tuning of wave analysers to test particular frequencies of vibration. The Marconi units, known as selective level meters or synchronous wave analysers, replace the oscilloscopes and the manual tuning.

The signals from the strain gauges are recorded on multi-track magnetic tape and the recorded signals provide the inputs for a bank of selective level meters. A digital method is used to produce tuning signals so that each level meter is tuned to a different frequency corresponding to a harmonic of the rotor speed. Outputs are taken from the meters to an ultra-violet recorder to provide a permanent record of vibration at different speeds.

For further information circle No. 60

Transparent Ceramic

General Electric Company of U.S.A. has developed a polycrystalline ceramic material that, when polished, is as transparent as glass and yet can withstand much higher temperatures; named 'Yttralox', it has a melting point above 4,000 °F, whereas glass softens at temperatures ranging from about 2,000 to 2,600 °F.

The ceramic is made by pressing into the desired shape a powder of yttrium oxide mixed with a small amount of thoria, and then firing it at about 4,000 °F; this process removes the microscopically-small pores from between the powder particles, which account for the opacity of conventional ceramics by scattering light.

One of the many applications foreseen for this material is in improving high-intensity incandescent and discharge lamps, and it may also find uses as a 'window' for high-temperature furnaces.

For further information circle No. 61

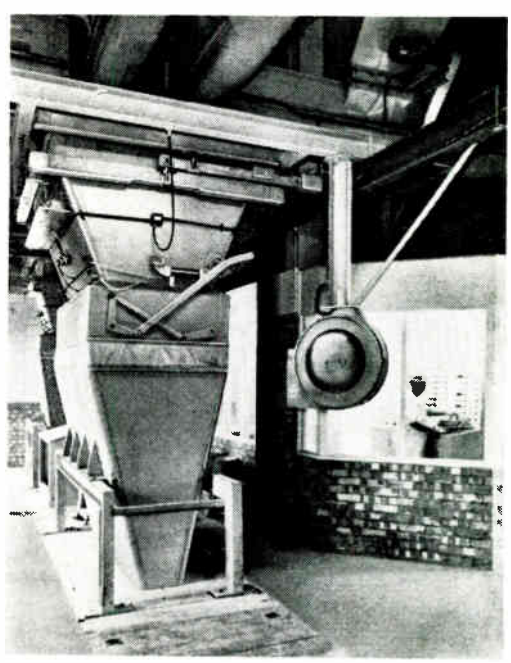
Automatic Batching System

A comprehensive yet compact automatic batching scheme has recently been installed, with a new provender mill, at the Bugbrooke (Northants) mill of Heygate and Sons. Weighing machines and control gear have been supplied by W. & T. Avery, and the new mill is expected to improve output by up to 50%.

Designed around bulk-handling techniques, the mill produces blends by punched-card selection from up to 28 storage bins. Automatic hopper scales (see picture) weigh off the ingredients, which are fed from the bins by augers controlled by electrical sequencing equipment; individual weighments are made to give greater overall accuracy, and batches are then transferred by conveyors for mixing.

An operator at the control desk can control all the operations for selecting and weighing off batches, as well as operating the conveyors and mixer. A display panel gives information regarding the ingredients stored in each bin, and the punched-card reader is also mounted on the console. The indicator dials of the scales are fitted with an analogue generator, the signals from which are used to select and control the materials at pre-determined weights.

For further information circle No. 62



Two automatic scales (of 1,000 and 150-lb capacities) weigh ff the ingredients from the hoppers. The contro desk can be seen in the background

This shows one of the pilot control consoles. The cathode-ray screen can display information on up to 15 aircraft and at any time the operator can interrogate the computer for full information (such as height, speed, destination, estimated time of arrival, etc.) using a keyboard. Each pilot-operator is in communication with the air-traffic controllers over the telephone system so that the controllers can instruct on required changes of course. The pilot-operator then causes the simulated aircraft to alter course by entering data into the computer via push-buttons. Also the operator can advise the controllers when the computer program dictates an alteration of flight path

EUROCONTROL EXPERIMENTAL CENTRE INAUGURATED

Eurocontrol's Experimental Centre at Bretigny-sur-Orge, near Paris, was recently officially inaugurated by Roy Mason, M.P., Minister of Defence (Equipment), President of Eurocontrol. The Centre's task is to investigate and study techniques and methods of air-traffic control with a view to increasing the safety and efficiency of air navigation.

Eurocontrol is the international agency formed to be responsible for control of air traffic in the upper airspace regions (20,000 feet and above) over the territories of the seven member nations. These nations are the U.K., France, West Germany, Belgium, Luxembourg and the Netherlands, who were the signatories of the Eurocontrol international convention drawn up in 1960, and the Republic of Ireland which joined in 1965.

With the increase in the speed of aircraft and the expanding volume of air traffic, an organization such as Eurocontrol was seen to be necessary in the late fifties and early sixties. In the future, existing equipment and techniques will become inadequate to deal with the amount of traffic and the Brussels area is already experiencing difficulties.

In order to study future conditions, the Experimental Centre has been equipped with an air-traffic simulator. This is the only one of its kind in Europe and was built by an international consortium of three companies: Plessey Radar of the U.K., A.E.G.-Telefunken of Germany, and CSF of France.

The computerized system can simulate up to 300 aircraft flying within an area of a radius of 600 nautical miles and being monitored by six primary and secondary radars. Linked to the computer are a number of consoles representing groups of aircraft and operators take the part of pilots to control the aircraft. Radar control desks representing ground-based air-traffic control centres are in communication with the pilot consoles and monitor the

Here can be seen an air-traffic controller's console. The radar screen depicts the positions of each of the simulated aircraft, any one of which can be marked using a rolling-ball controlled marker, and can also display a video map. Each time the controller requires information on an aircraft or requires an aircraft to alter course, he will contact the pilot-operator controlling that aircraft and pass the message over the telephone system

Three horizontal radar displays are installed at the Centre as well as the vertical displays. The horizontal control desks have positions for four operators. The radar shown here can be seen displaying a video map so that the positions of the simulated aircraft can be seen in relation to air traffic lanes and any other important geographical details. Each operator has a rolling-ball marker for identification of any of the aircraft on the display

position of each aircraft. The pilots then alter the flight paths of the aircraft in response to instructions from the controllers. A supervisory position enables any of the pilots' or the controllers' displays to be inspected and permits the entry of further data in addition to that already programmed. The pilots, controllers and supervisors are in voice communication over a telecommunications system supplied by S.A.I.T. Electronics of Belgium. It reproduces as accurately as possible actual ground-to-air communications conditions.

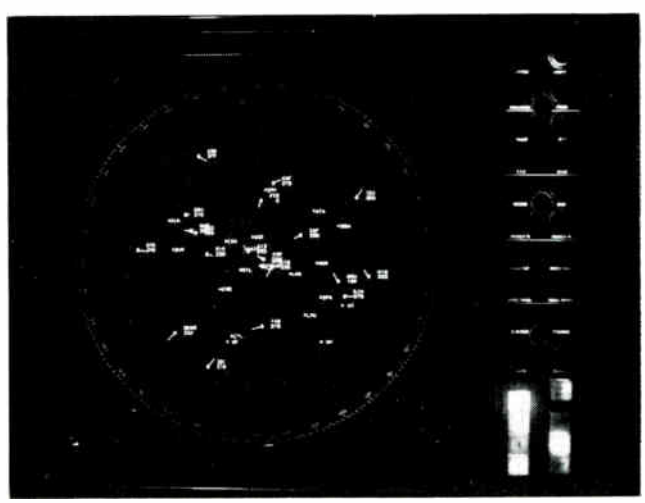
In operation, a program is prepared which will enable the computer to simulate realistic air-traffic conditions. This program is executed and data is recorded during the exercise for later analysis. The record of the exercise can be replayed at any time so that various aspects of it can be studied.

In addition to the simulator, a radar link between the Centre and Orly Airport is being installed so that existing air-traffic conditions can be studied.

The simulator is operated by the simulation division of the Centre. A further division is the trials division. This carries out technical evaluations of both airborne and ground-based air navigation equipment. These two divisions can operate in conjunction with each other to provide national air-traffic control bodies with such services as the calibration of navigational aids and the performance of simulated exercises. An additional task to be undertaken is the training of operators and controllers and instruction on new equipments and methods. Proposed air-traffic control complexes can also be simulated, the results enabling the best possible configuration to be evolved.

The entire installation is constructed on a flexible basis. This enables it to be modified to represent different areas of air-traffic control in the upper airspace.

The Experimental Centre is only part of the Eurocontrol organization and it works in close conjunction with the headquarters staff on several projects. These projects include flight trials in Germany and France and at Boscombe Down in England, operational and technical trials of new equipment, and other tests and investigations all directed towards rendering air travel safer.



In addition to the 'blips' which indicate an aircraft, the simulated display can include other information as shown in this picture of a vertical display. The lines associated with each aircraft indicate the direction of flight while the length of the line represents the speed. Other coded information, such as aircraft height and identification, can also be displayed as lines of alphanumerical characters. One of the experiments being undertaken by the Centre is an investigation into the use of such additionally-displayed information in actual air-traffic control centres

The supervisor's console contains, as shown here, two vertical radar displays and one pilot console. From this the supervisor can inspect any of the radar pictures or any of the pilots' tabular displays. He is in voice communication with the controllers and the pilots and can interrogate the computer or/and enter data into it. In the background can be seen the large-screen radar display produced by a Kelvin Hughes projector

Data Recording for X-Ray Films

A device which eliminates human errors in the identification of medical X-ray films has been developed by Peter Smith Instrumentation in conjunction with The Royal Victoria Infirmary at Newcastle upon Tyne. Known as the 'Datacord', it optically marks each X-ray film with the patient's name and number and the date. In the past the patient's name, number and date were usually copied by hand on to a piece of wax material which acted as a negative to print the required information on the X-ray film. It was often difficult to read and errors could occur.

The illustration shows a radiographer placing an X-ray film on the Datacord. The X-ray request card has already been placed in position. At the touch of a button the required information is printed on to a corner of the film which has been kept 'masked' for this purpose.

The unit is built robustly to stand up to constant use and the prototype has given almost a year's trouble-free service in one of the country's busiest radiological units. It has a convenient push-button control panel and incorporates an electronic timer, which locks to prevent double exposure, and an exposure light which flashes to indicate that the exposure has taken place. The image is printed the right way up on the lower edge of the film so that the data is not obscured when the film is on a viewing box. Maintenance is minimal and spares are readily available.

For further information circle No. 63

Here the Datacord can be seen in use

Manufacturers' Literature

Automation at No. 4 Avonmouth. An 8-page report on the application of automation to the Imperial Smelting Corporation's fourth zinc and lead smelting plant at Avonmouth is now available from Elliott-Automation. It describes the whole case history of the largest automation system ever devised for a non-ferrous metal plant, and is well illustrated with photographs and diagrams.

For further information circle No. 64

Control Instruments. Ether have issued a 16-page catalogue of their process-control instruments and multi-point indicators and recorders for industrial, aeronautical and aerospace applications. Each item is illustrated and accompanied by general notes and specifications, which are also given in German and French.

For further information circle No. 65

Standard A.C. Starters. A list of the standard a.c. starters manufactured by the Watford Electric and Manufacturing Co. is given in this 24-page illustrated catalogue (6700/B). Brief descriptions of direct-on-line, star-delta, stator/rotor and auto-transformer types are given, as well as ratings and dimensions.

For further information circle No. 66

Cold Pressure Welding. G.E.C. (Process Engineering) have produced an illustrated 4-page folder (E193), which describes the applications of cold-pressure welding techniques, together with several single-page leaflets outlining the range of their machines at present available. The process has been developed by G.E.C. for welding non-ferrous metals and their alloys without using heat or electricity.

For further information circle No. 67

Abridged Valve Data. The first part of this fully-illustrated 72-page booklet gives abridged data for the range of power valves and microwave, electron/optical, non-thermionic and other devices manufactured by the English Electric Valve Co. The second part comprises an equivalents index of all EEV types, their applicable CV numbers and other manufacturers' types that they may replace.

For further information circle No. 68

Electronic Components Catalogue. Impectron have issued an illustrated 36-page catalogue of their imported electronic components. It includes specifications and operating characteristics for their range of capacitors, semiconductors, aerials, switches, relays, transformers, potentiometers, panel instruments and ferrites.

For further information circle No. 69

Inventions for Industry. The latest bulletin (No. 29) from the National Research Development Corporation details a number of inventions in mechanical engineering, scientific instruments, chemical engineering and miscellaneous fields that are available under licence for industrial exploitation. Other sections deal with N.R.D.C's role in automation and review its current development projects.

For further information circle No. 70

Philbrick Transconductors. Philbrick Researches Inc. have published a 12-page bulletin (No. 6220) on their range of transconductors. After a preliminary theoretical discussion, their trignometic, logarithmic, quadratic and arbitrary-function transconductors are described, followed by applications notes.

For further information circle No. 71

BSX 19, BSX 20 silicon planar epitaxials with 10 and 13ns maximum switching times

Mulla

The BSX19 and BSX20 are Mullard n-p-n silicon planar epitaxial transistors intended for high speed logic and v.h.f. amplifiers.
In switching circuits optimised for high speed operation, propagation times of 5 to 10ns can be obtained with these transistors. In addition, their voltage ratings enable DTL circuits to be designed to work from a 12V supply with high noise margins (2V) at speeds of 50 to 100ns.
High gain and high cut-off frequency make them also suitable as drivers and amplifiers in mobile and portable h.f. and v.h.f. telecommunication equipment, where output powers of up to 400mW with > 10dB gain are obtained.

Here are brief specifications:

	BSX19	BSX20
V_{CBO}	40V	40V
V_{CEO}	15V	15V
P_{tot} (T_{amb} = 25 C)	360mW	360mW
h_{FE}	20–60	40–120
$f_T$min (10V, 10mA)	400Mc/s	500Mc/s
t_s (I_C = I_B = $-I_{BM}$ = 10mA)	10ns(max)	13ns(max)

Full technical data on these transistors can be obtained from the address below. Also available is a Semiconductor Quick Reference Guide—send for your copy now.
Mullard Limited, Industrial Markets Division, Mullard House, Torrington Place, London, W.C.1. LANgham 6633. Telex 22281

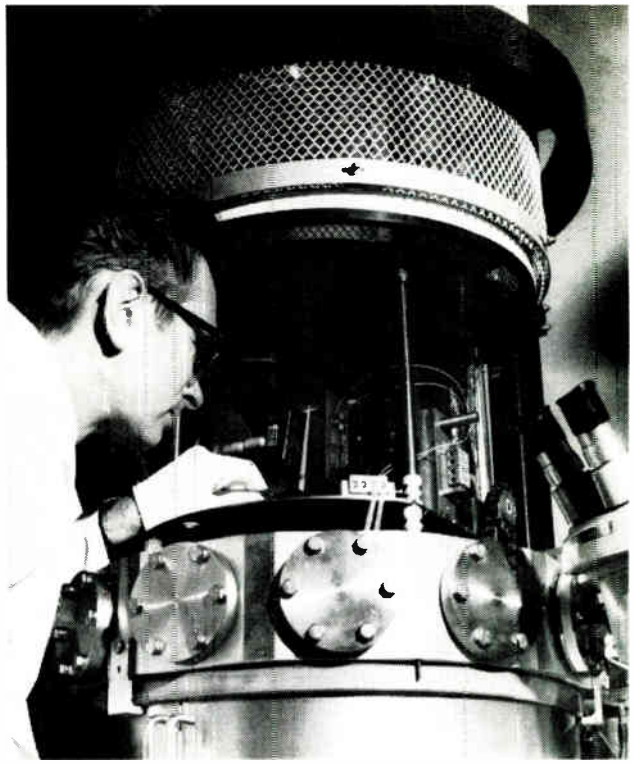
rd Si

planar

IMD57R

For further information circle No. 227

A critical phase in the fabrication of DOFICs is the contact-evaporation process, which has just been performed on a sample inside the apparatus shown here



NEW CONCEPT IN ELECTRONIC CIRCUITRY

Standard Telecommunication Laboratories announced recently that work on a completely new concept in electronic circuit functioning had reached such a development stage that the prospect of replacing complex electronic circuits by a single solid-state device, known as a DOFIC (Domain Originated Functional Integrated Circuit), was near to being realized.

At present, circuit requirements are met by networks of resistors, capacitors, semiconductors and associated interconnections; even when these are reduced to the form of microcircuits, they remain complex and costly, having inherent reliability problems due to the interconnections. Now, STL has produced a method of synthesizing complex electronic functions in a single solid-state bulk-effect device having only a few operational connections; the possibility therefore arises of replacing circuits containing many discrete electronic components by a single piece of semiconductor material only a few hundredths of an inch long. Experimental analogue-to-digital converters that use the new devices have already been devised, and further application possibilities are foreseen in entirely integrated television camera and display systems.

Principles of Operation

The work on domain-originated function generators was initiated at STL when it was realized that very few new design concepts had emerged in solid-state integrated-circuit work which took account of the fact that, although a particular functional requirement was always derived from a single semiconductor crystal, the net result was always highly complex from the constructional point of view; all present integrated circuits, for example, involve expensive drawing and photo-reduction, multiple diffusion, etching, deposition etc.

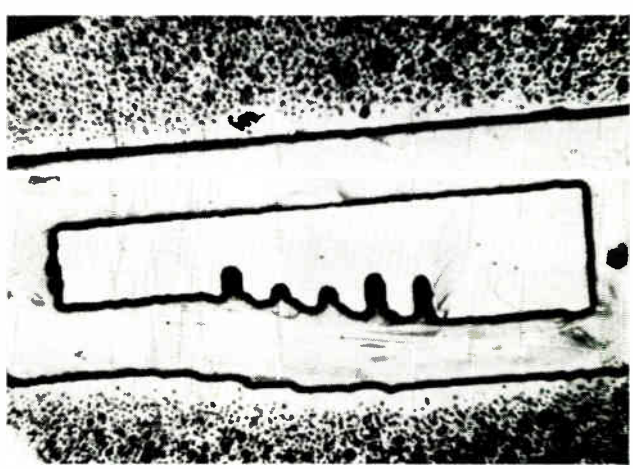
DOFICs make use of basic bulk effects in semiconductor material, in particular the fact that it is possible to produce stable high-electric-field 'domains' moving over a distance that is long compared with the width of the domain; these domains are launched when an applied voltage exceeding a certain threshold value is applied across samples of certain materials. Domains may be formed by such phenomena as field-dependent trapping, electron/phonon coupling, and inter-valley transfer of hot electrons from lower to higher effective-mass states; at STL, most of the work has been confined to the last two categories, in which domains travel at velocities of up to 10^7 cm per sec.

If the domain encounters changes in conductivity (due to doping) or changes in cross-sectional area when it moves through the material, the current through the sample also changes; thus, by specifying the conduction path in these or other ways, an output-current waveform of almost any shape may be produced, and such conductivity-profile shaping constitutes a static characteristic for the device. Of even greater significance, perhaps, is the fact that dynamic control of the device (i.e., while a domain is in motion) is possible by varying the instantaneous bias; a domain can thus be arrested at any point along the drift path. Furthermore, the point along the path at which the domain is removed can be made proportional to the applied bias by introducing an overall slope or taper to the profile.

Applications

Using these features, a simple analogue-to-digital converter that demonstrates the principle has been fabricated; i.e., a device in which the number of output current pulses

Fig. 1. A DOFIC analogue-to-digital converter using epitaxial construction. The digital profile (the five 'humps') and the overall slope combine to give a current-output waveform whose number of pulses is proportional to the applied voltage bias



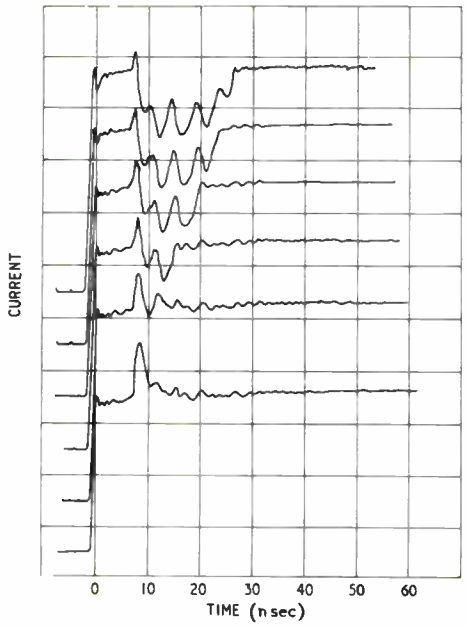


Fig. 2. The output-current curves at various bias levels for the analogue-to-digital converter

is proportional to the applied bias. Fig. 1 shows the epitaxial construction for a four-level device in which the 'digital' profile and the overall slope can be seen, while Fig. 2 shows the output current pulses at various bias levels. Although a 64-level 6-digit coder using a 2-mm-long drift path in GaAs seems quite feasible, this work is still in the research phase and much remains to be done to develop the necessary materials and device-fabricating techniques. A present drawback in devices using inter-valley transfer is that bit rates (determined by the domain velocity of 10^7 cm per sec) are at microwave frequencies; but by using the other types of domain formation (e.g., electron/phonon) these can be reduced by a factor of 100 or more.

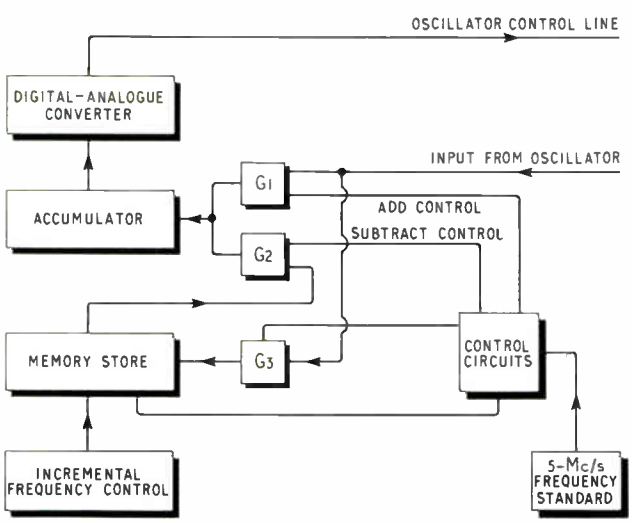
The techniques described above realize the output waveform by monitoring the total current through the device; in addition, however, the high fields due to the domain can readily be picked up by electrodes placed sufficiently near to the surface of the semiconductor. It is therefore possible to have a completely separate electrode system bearing any additional code profile that is electrostatically coupled to the domain; the sweeping domain will then produce output potentials as it moves past the electrode, the latter being shaped to produce any desired time spacing of the output pulses. It is also possible to obtain optical read-out by detecting light excited by the domain as it passes through the crystal, thus giving rise to the prospect of completely different types of display device.

A Frequency-Stabilizer Unit for Communications Receivers

The frequency stability of a communications receiver can be improved with the use of a unit developed by Racal. This unit, the 'Racalator', accepts an input taken from the local oscillator of the receiver being stabilized and produces a voltage output for the receiver frequency-control circuit.

The block diagram indicates the action of the unit. There are two modes of operation, 'tune' and 'hold'. On 'tune' the unit displays, on a six-digit readout, the tuned frequency to an accuracy of ± 100 c/s for rapid tuning and ± 1 c/s for fine tuning.

Once the unit has been switched from 'tune' to 'hold', the gates G_1 and G_3 are opened. The input from the receiver's local oscillator is fed to the accumulator and to the memory store. In both of these the frequency of the input is counted and stored in a digitally-coded form. After a period of precisely 1 sec, determined by a crystal-controlled 5-Mc/s oscillator, both gates close and gate G_2 is opened.



This block diagram shows the essential stages of the frequency-stabilizing network

An output from the memory store corresponding to the frequency count stored is fed via G_2 and is subtracted from the contents of the accumulator. This will leave the accumulator empty as the contents of both the accumulator and the memory are equal. The gate G_2 then closes and G_1 alone opens; G_3 is not opened again until after the unit has been switched to 'tune' and back to 'hold'. The oscillator frequency is once again counted and stored by the accumulator and the permanently-stored value in the memory (corresponding to the initial local-oscillator frequency) is subtracted from the accumulator contents.

If no frequency drift has occurred in the receiver's local oscillator the accumulator will be left empty and will produce no output. If a frequency drift has occurred the value of the difference between the new and the original frequency will be left in the accumulator. This 'difference' signal will be fed to the digital-to-analogue converter which will produce an analogue voltage output corresponding to the magnitude and direction of the drift. This can be fed to a frequency-control circuit, such as that in a normal a.f.c. loop, in the receiver to adjust the tuning of the local oscillator for the correct frequency. In this way the local oscillator frequency can be stabilized to within ± 2 c/s. The digital readout can display either the local oscillator frequency or the tuned frequency of the receiver when the unit is in the 'hold' mode.

An incremental frequency control is included for use when the received frequency is drifting.

Measuring $3\frac{1}{2}$ in. high, the unit fits a 19 in. rack.

For further information circle No. 72

WELDING ELECTRONIC DEVICES BY ULTRASONICS

By G. E. LITTLEFORD*

With the rapid advances in microelectronics technology, a need has arisen to replace conventional (but now impracticable) methods of fusion-welding electronic devices by much higher precision techniques. One solution to this problem has been the development of ultrasonic welding equipment, the operation, advantages and applications of which are described in this article.

IN the last two or three years, microelectronics have passed from the realms of research to the production line. In their process of development, some of the greatest problems have concerned the need for precision welding very fine wires to a variety of components, for joining dissimilar materials, for interconnecting metallized surfaces with film thicknesses as low as 100 Å (Angstrom units) and for encapsulating semiconductors, microcircuits and other electronic devices.

For such requirements, the conventional techniques of fusion welding are impossible on the grounds of temperature rise alone, apart from other considerations, and it has been established that the only satisfactory answer to the problems raised by advanced electronics technology is the employment of ultrasonic welding.

The Ultrasonic-Welding Process

The principles of ultrasonics will be already familiar to many readers. The sound waves which we detect in the human ear are vibrations in the air which oscillate at frequencies of not less than 20 c/s and not more than 15,000 c/s. Waves at frequencies above this range are called ultrasonic.

As is the case with many industrial processes, the mechanism of ultrasonic welding is not completely understood. It is known, however, that it overcomes the conventional barriers to welding by plastically deforming the interface between the workpieces in such a way that the adhered moisture and oxide films are dispersed; the irregular surfaces of the two workpieces are thus made to conform to each other, thereby causing a large area of intimate contact between the nascent metal surfaces. Joining is accomplished without the use of fluxes or filler materials, without excessive mechanical force or concomitant deformation, and without externally-applied heat.

A wide range of metals and alloys, in a variety of configurations, can be effectively joined by this process. Although originally used only for joining thin sheets of relatively-soft material (such as aluminium, copper and brass), subsequent developments have established that it is perfectly feasible to bond high-temperature and refractory metals such as molybdenum, tantalum, beryllium, zirconium and stainless steel. Bi-metallic junctions have, in fact, been achieved with materials of widely different physical properties, such as aluminium and stainless steel, copper and nickel, or titanium and beryllium.

Welding and Encapsulation Equipment

Ultrasonic equipment for welding includes an electric generator to produce electrical oscillations at the required frequency, a transducer, a velocity transformer, a welding

* Kerry's (Ultrasonics) Ltd.

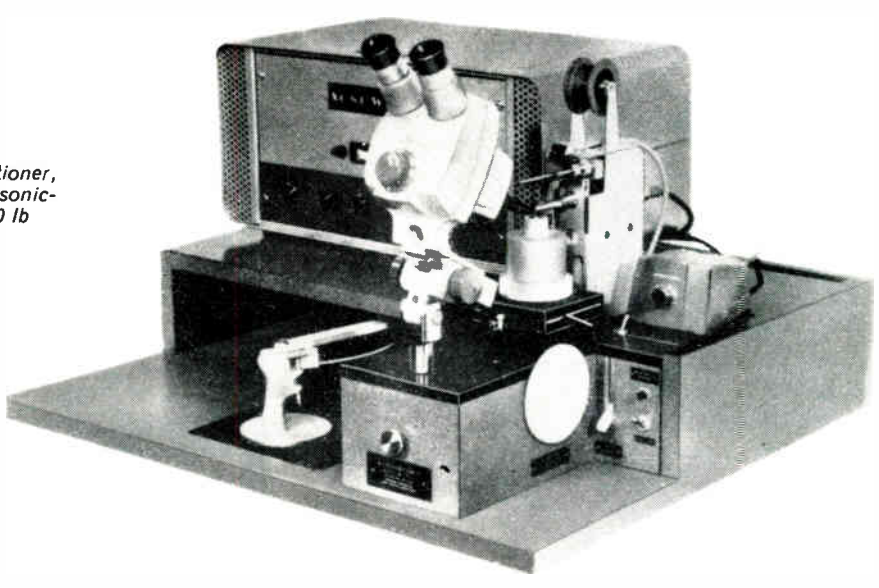


Fig. 1. The Model MP-20-L micropositioner, which is a completely-integrated ultrasonic-welding work station weighing only 190 lb

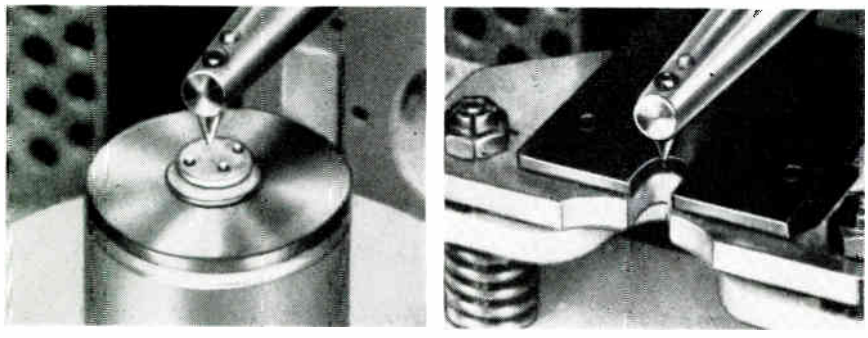


Fig. 2. These two close-ups show the welding tip of the MP-20-L in position over the work-holding chuck. The vacuum chuck on the left is standard equipment, whereas the mechanical chuck (right) is optional

tip, a support for the materials to be welded, and some means of applying a clamping force to the material. For this class of work, a magnetostrictive transducer is generally used.

Ultrasonic welding equipment is compact and clean to use—factors which are of very great importance in all electronic applications; furthermore, a number of equipments may be mounted on a single bench for production runs. Fig. 1 illustrates the micro-positioner model MP-20-L, which is manufactured by Kerry's (Ultrasonics) Ltd. It is specifically designed for lead-wire bonding as required for microcircuitry, and all the components for wire feed, work manipulation under the welding tip, welder-head operation and positioning are included within the cabinet.

Fig. 3. This ring-spot ultrasonic equipment may be used for encapsulating materials where true hermetic sealing is required

The ultrasonic welding head consumes only 20 W, yet is capable of welding fine wires and foils in transistors, microcircuits and solid-state circuits. The unit permits sound and reproducible welding of wire to two different materials without re-setting the power, clamping force or weld-pulse time, and without affecting the precision of such machine settings. Single-hand operation includes X-Y positioning, welder-head lowering, clamping-force application, weld-cycle initiation, head lift and wire feed, without releasing the hand grip. Setting up for a second weld, including Z-position change and weld-control change (power, clamp force and weld force), is accomplished by operating a single-wheel control with the right hand, while maintaining a grip on the X-Y positioning control handle; rotational adjustment through 360° at the base of the work chuck is right-hand operated.

A rapid change of workpieces is possible by automatically releasing the vacuum chuck (see Fig. 2) with specific adaptors for the assembly being welded. A welding head tilt provides additional clearance for part changing, and wire feed is provided through an angled welding pin, which thus ensures that the wire is always positioned and controlled.

Fig. 3 shows an example of ring-spot ultrasonic equipment, which may be used for encapsulating semiconductor materials, explosives, propellants etc. It is particularly suitable for encapsulating materials where true hermetic sealing is required, and in ring geometries will form leak-tight seals at a sensitivity of 10^{10} cu. cm/per sec of helium at S.T.P. conditions.

Advantages

Ultrasonic welding is a means of creating true solid-state metallurgical bonds, and a number of particular advantages arise from this characteristic.

In the field of microelectronics, there is no lower limit to the thinness of materials that can be joined by ultrasonic welding; fine wires of less than 0·003 in. diameter have been satisfactorily welded, and thin foils of 0·00017 in. thickness have been joined without rupture. This ability lies at the heart of the ultrasonic welding process, which does not employ melting to achieve its effects and thus presents no thermal-control problems when handling microcomponents.

There is no theoretical limit to the ratio of thicknesses that can be joined, because ultrasonic welding, not being a thermal process, does not risk damaging the thin section by large amounts of heat.

A wide variety of similar and dissimilar materials can be joined, and Fig. 4 indicates some of the material combinations that can be ultrasonically welded on a production

basis. It will be noted that aluminium may be welded to glass or copper to steel, in spite of the wide differences in physical properties of these materials.

Those materials which have relatively large coefficients of electrical or thermal conductivity are inherently difficult to weld by means of the resistance-welding process, because of the large amount of electrical energy that is required to create and maintain enough thermal energy in the weld area to accomplish fusion; if this magnitude of electrical energy is not properly controlled, 'burn-through', insufficient fusion or other weld faults will result. Ultrasonic welding is not restricted by this phenomena; furthermore, in many other materials, the undesirable results that follow the application of thermal-welding processes (oxidization grain growth, recrystallization and other adverse metallurgical and mechanical effects) are eliminated or minimized by using ultrasonic welding.

Because no fluxes, electrode-shielding coatings or adhesives are used in the ultrasonic-welding process, there is no contamination of the weld or its surroundings; this advantage is particularly valuable in packaging and encapsulating applications.

Ultrasonically-welded continuous seams, whether produced by a series of overlapping spot-type welds or by ring-welding techniques, are capable of producing hermetic seals and pressure-tight joints in many materials and thicknesses. Packages containing volatile materials such as helium have shown no loss of weight after more than two years' storage at both ambient and elevated temperatures.

Surface cleaning is not highly critical when preparing most materials for ultrasonic welding, because the vibratory displacements occurring during the welding process disrupt many normal oxide layers and other films on the surfaces to be joined. Those materials that are readily weldable (such as aluminium-clad alloys, brass and copper) can be welded in mill-finish condition and require little more than the removal of surface lubricants with a detergent reagent. Welding of heat-treated materials is more readily accomplished if they are mechanically abrased or descaled in a chemical etching solution, but once the surface scale has been removed the time that elapses before welding is not important. By employing high-power equipment, it is in fact possible to produce ultrasonic welds through surface deposits or coatings. In experiments, heavily oxidized Iconel X sheet has been successfully welded without prior removal of the heavy oxide coatings, and good welds have been produced in aluminium having anodized coatings up to 0·0001 in. thick.

Ultrasonic welding is a most desirable means of creating low-noise low-resistance junctions, because it produces void-free welds with relatively little, if any, foreign-material inclusions. This factor is particularly valuable when welding dissimilar metals, for the low temperature of ultrasonic welding eliminates or greatly minimizes the formation of brittle, high-resistance, intermetallic compounds.

Finally, the low-temperature nature of ultrasonic welding allows it to be used in the immediate vicinity of temperature sensitive or volatile materials without adverse effects.

Applications

In the fields of both electronics and microelectronics, many techniques making use of ultrasonic welding have been developed to a production stage. In microcircuitry, whether it be thin-film, thick-film, flip-chip or monolith, ultrasonic welding already plays an extremely important part. Microcircuits, already used extensively in the computer field, will undoubtedly be developed in numerous other applications in the years immediately ahead of us; ultrasonic welding is bound to play an important part in all developments of the microcircuit, because it answers the problem of how to provide reliable junctions with the films used and the remainder of the system. Very close dimensional tolerances can be maintained because there is no pre-heating of the part, and thus no thermal distortion can occur; furthermore, ultrasonic welding causes relatively slight modifications in the characteristics of the film or the conductor element. Because no electric arc occurs, and no electric current passes through the joint, there is no contamination of the films and no problem of providing closed circuits for the welding currents.

Its ability to create bonds between a very wide variety of dissimilar materials makes ultrasonic welding an extremely flexible tool when applied to the problem of welding interconnections to microminiature circuit elements.

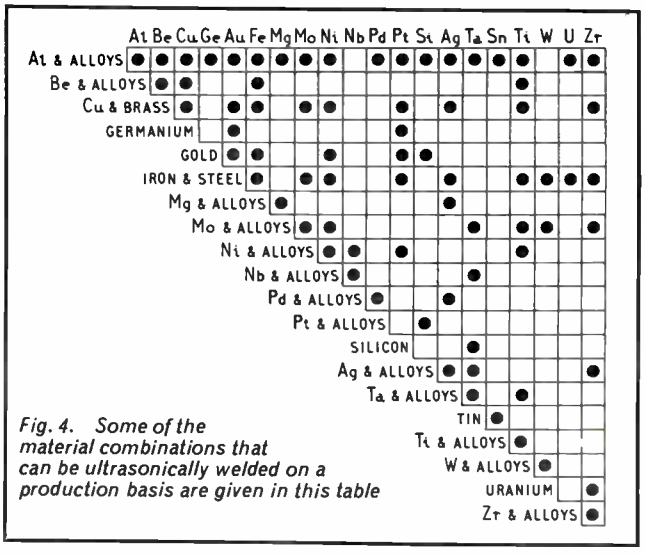


Fig. 4. Some of the material combinations that can be ultrasonically welded on a production basis are given in this table

Fig. 5. Listed here are some of those electrical conductors that have been successfully bonded to metallized surfaces using ultrasonic-welding techniques

Film	Substrate	Conductor	Conductor Thickness (in.)
Aluminium	Glass	Aluminium Wire	0·002
,,	,,	Gold Wire	0·003
Nickel	,,	Aluminium Wire	0·002
,,	,,	Gold Wire	0·002
Copper	,,	Aluminium Wire	0·002
Gold	,,	,, ,,	0·002
,,	,,	Gold Wire	0·003
Tantalum	,,	Aluminium Wire	0·002
Chromel	,,	,, ,,	0·002
,,	,,	Gold Wire	0·003
Nichrome	,,	Aluminium Wire	0·0025
Gold (4 μin.)	,,	,, ,,	0·010
Platinum (1 μin.)	,,	,, ,,	0·010
Gold–Platinum (9 μin.)	,,	,, ,,	0·010
Palladium (8 μin.)	,,	,, ,,	0·010
Silver (8 μin.)	,,	,, ,,	0·010
Copper (electro-plated on silver)	,,	Copper Ribbon	0·028
Molybdenum	Alumina	Aluminium Ribbon	0·003
Gold-Platinum (7 μin.)	,,	Aluminium Wire	0·010
Aluminium	Silicon	,, ,,	0·010
,,	,,	Gold Wire	0·002
Silver	Ceramic	Aluminium Wire	0·010

and Fig. 5 lists some of the combinations of films, wires and ribbons which have been successfully bonded. Not only has the process been applied to aluminium wires—the most versatile conductor elements—but also to gold, copper and nickel conductors.

In the realm of semiconductor bonding, ultrasonics is already playing a significant role. Gold and aluminium wires, ranging in diameter from 0·005 in. to 0·025 in. have been successfully bonded to silicon and germanium semiconductor surfaces; lead-wire bonding to transistor semiconductors is also extremely satisfactory and, like many of the processes described in this article, has a number of technical and economic advantages. As a precision process, ultrasonic welding not only reduces the number of rejects very considerably but speeds up the output of the whole production line.

In semiconductor bonding, the adoption of the ultrasonic welding process has overcome the problems of the so-called 'purple plague'—the presence of a brittle purple compound in the vicinity of gold wires which have been bonded to aluminium-silicon junctions.

Ultrasonic welding has also been successfully adapted to the manufacture of various igniter devices than rely upon high-resistance bridgewire elements to initiate explosions or other chemical reactions. Most such bridgewires are very small in diameter, and the ability of the ultrasonic process to join consistently fine wires to larger terminal posts makes it very valuable. Filament wires of 0·001 in. diameter and made of such materials as nickel-chromium or tungsten-platinum have been successfully joined to terminal posts of copper, iron, phosphor-bronze and other metals.

In a very wide variety of thermocouple junctions, the ability of ultrasonic welding to join dissimilar metal combinations makes its advantages apparent, and it is even possible to weld thermocouple junctions directly to ceramic and other non-metallic workpieces.

Aluminium-foil windings are being applied to coil components these days because of the weight-saving factor and, in this process, ultrasonic welding is especially valuable when the foil is coated with plastic films as a means of insulating the individual coil windings.

Until the advent of ultrasonic welding, one of the commonest problems in the electronics industry was to provide a means of joining contact materials such as silver, gold, palladium and platinum to spring metals in the manufacture of switches and relays. Because of the differences in thermal and electrical conductivity of the contact metal and the spring material, it was usual to prepare the contacts in the form of a composite structure, in which the contactor metal was backed with a metal suitable for welding to the spring material. However, ultrasonic welding mades it possible for contact metals to be welded directly to a wide variety of dissimilar spring metals and, because the ultrasonic weld is created in the solid state, the formation of intermetallic compounds (which could ultimately result in failure or loss of conductivity) is greatly reduced.

The ultrasonic welding process has also been used with considerable success as a means of attaching leads to tantalum electrolytic capacitor plates in the manufacture of tantalum capacitors. Originally, these components were made by resistance welding tantalum-wire leads to tantalum-foil plates and subsequently forming an anodic film on the tantalum-foil plate to provide a dielectric. Because of the high temperatures inherent in the resistance welding process, a thick and irregular oxide film forms on both of the workpieces; this can affect the subsequent electrolytic process so that a uniform anodic film is not obtained. Once again, the low-temperature nature of ultrasonic welding prevents the formation of the oxide film growth, and there are no leakage problems.

Conclusion

Summing up, ultrasonic welding has already made a valuable contribution towards the successful development of microelectronics, and has proved its practicability and economy both in research and actual production. The sophistication of present-day electronics demands lightweight materials and high-strength joints of high temperature; ultrasonic welding has already proved that it can provide these requirements more efficiently, more precisely and with greater speed than any other method. In this article, some uses that have reached the production stage have been briefly discussed, but there is no doubt that the successful application of ultrasonics to electronics is only in its infancy and many further developments will be achieved in the near future.

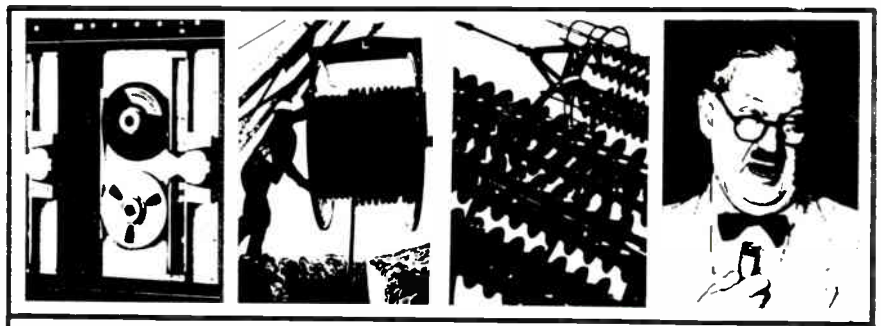
Illustrations by courtesy of The Sono Bond Corp., U.S.A.

Automatic Control of Cold-Strip Rolling

Manual control of cold-strip rolling involves the continuous correction of the strip thickness by means of setting screws according to micrometer readings; this imposes a considerable strain on the operator and leads, inevitably, to a considerable amount of out-of-gauge production. In order to automate the whole process of thickness gauging and control, the metal works of Csepel Iron and Steelworks —Hungary's largest metallurgical centre—have installed in their continuous reversing mills an X-ray system that was supplied by Ekco Electronics Ltd., of Southend-on-Sea, Essex.

The equipment uses the principle that rolled strip absorbs X-rays in proportion to its thickness. The gauging-head assembly consists of an X-ray source, which emits a constant level of radiation into the strip, and an ionization chamber (situated underneath the strip and in line with the source), which continuously monitors the amount of radiation passing through the strip. Having calibrated the ionization chamber, the variations in its current output thus represent accurately-measured changes in strip thickness, and can be amplified and used to adjust the roll-setting screws to maintain the required strip conditions.

The measuring equipment is self-calibrating as each reversing occurs, and during the rolling process the gauge may be checked by pointer instruments on the operating console. A gauging range of 0·25 to 4·0 mm is provided, with an accuracy of $\pm 0{\cdot}02$ mm, and the roll stand may be manually controlled if required.



TALKABOUT

By NEXUS

C. P. Sandbank and his team at Standard Telecommunications Laboratories have edged solid-state electronics across yet another frontier by exploiting the Gunn effect to provide an analogue–digital converter in a single chip of gallium arsenide material.

The new devices, which promise to be a major advance on conventional integrated circuits because of simplification of the construction process, have been christened DOFICS (Domain Originated Functional Integrated Circuits). Reliability, too, should be much better as interconnections are greatly reduced.

The S.T.L. team have controlled the movement of the domain through the material by doping or changing the cross-section of the conducting path. Dynamic control of the current through the device can be achieved by varying the instantaneous bias and, by tapering the conductivity profile, the point at which the domain is arrested along its path can be made proportional to the bias applied.

The analogue–digital converters so far fabricated have merely demonstrated the general principle and already it is quite evident that many other ingenious applications are in the pipeline. Optical read-out is possible from light emission in the crystal and the high fields of the domain can be detected by electrodes in proximity but not physically connected to the device.

Have S.T.L. jumped the Gunn? It is known that similar work is in progress in the United States but as far as I know this is the first positive announcement that practical devices have been constructed. Why should we not blow the British trumpet for a change? It seems an excellent idea provided nobody runs away with the idea that DOFICS will be commercially available this year or next. And S.T.L. have been wise in stressing that all that has happened is that the principle has been demonstrated and that much work remains to be done.

Meanwhile, most of us working in the hard commercial reality of the workaday world have to be content with discrete component circuits or, at best, ordinary integrated circuits. The latter are pouring out of the factories in satisfying numbers as yields go up and prices come down. The computer manufacturers are naturally still the biggest users but, with prices tumbling, the market is getting wider.

This wider market includes lots of new boys looking at integrated circuits for the first time. They are innocent of the fetching ways of the I.C. circus which has been stumping up and down the country banging the big publicity drum at symposia, conventions and technical discussions where competing manufacturers, behind the smoke screen of presenting learned papers, were becoming hopelessly involved in a tricky but jolly game of one-upmanship in claims on specification and performance.

The circus was great fun. Because the number of manufacturers was very few and the number of users not much greater, everyone knew everyone else, private jokes were abundant and gusts of laughter not uncommon from the audience when a speaker was asked if he really meant what he said. Banging the big drum and blowing the biggest trumpet was the order of the day. We all knew the situation and revelled in its comic implications. We accepted that pressure was being applied by company commercial departments and that there was even some commercial justification in giving I.Cs the extra boost that would get them out of the discussion stage and into equipment that little bit sooner.

But the escalation of claims resulted in some misleading published data which could so easily trap the unwary. The numbers game at that stage consisted of unashamed presentation of data in the best possible light. Here are some samples.

A maximum storage temperature figure for one device was quoted as 300 °C, a world-beater in the numbers game. A truthful figure, but part of an incomplete specification which omits to state for how many minutes the device would survive at some 65 °C above the temperature of melting tin! The device has since been 'downgraded'. But, for some time, it was one up (on paper) on the competition.

Manufacturer A was using chips from manufacturer B. Having made his sample batch, A started life tests and noted a high failure rated at 175 °C after 1,000 hours. He tried a batch of B's completed devices on life test and these were as bad. On enquiry, B admitted that he had not life tested at 175 °C although he claimed the device was capable of operation at this temperature. He was honestly confident his devices would keep working but confidence, in this case, wasn't enough. The device now has a limited life rating at 175 °C.

These two are simple examples on temperature. Many others could be cited on different parameters including a little classic where the supply voltage tolerance quoted as ±20% had to be held to within 1% in practice if certain other parameters were taken near their quoted limits.

The poor old system designers were stuck with the problem of interpreting the data and correlating it into practical engineering terms.

Putting the onus of interpretation on the system designer is all very well for the old hand but what of the new boy? Glowing specifications are not necessarily dishonest but they do tend to give a false impression of what can and can't be done. The practical constraints required in system design were by no means obvious from limit figures.

Fortunately, a new concept in presentation of data has already been put into practice by Mullard who, in their Design Data section of their published I.C. information sheets, have taken the guesswork out of the system. Design data is based entirely on worst conditions and accommodates every adverse

operational factor plus manufacturing spread of characteristics of the device and compatibility with other devices in the system being designed. Provided the systems engineer observes the basic rules laid down, then, say Mullard, his system will work and keep on working.

There are encouraging signs that all IC manufacturers will eventually adopt this system. It is sensible and certainly helps the engineer who has little or no direct experience with I.Cs but is longing to have a go. And if I.C. device manufacturers hope to penetrate the mass market which they need, then the little man using small quantities as well as the computer manufacturing giant using millions must be courted.

As we swing once again into the hectic round of the exhibition season we are faced with the problem of selection. Visiting every one is a full time job. To 'do' an exhibition properly can take three or four days. To visit them all, including the nearer Continental shows, involves quite a lot of travel.

A new one this year which should give value is MEDEA '67 which opens at Earls Court, London, on March 13. Its full title is the International Medical Engineering and Automation Exhibition and its sponsors are the Electronic Engineering Association and Scientific Instrument Manufacturers' Association.

There should be plenty to see for the industrial electronics man. Don't be put off by the hocus-pocus of medical terminology. Shyly hidden away behind those impressive sounding phrases are good honest pieces of electronic engineering which are no less valid when applied to industrial measurement and control than to medical science. In fact our old friends Elliott-Automation, Honeywell Controls, Beckman Instruments, Decca Radar, Electronic Associates, Joyce Loebl, George Kent, Vickers and a host of others will be there in strength.

Many of the systems shown will have had their origin in industry and communications. They will be refined in many respects and will have special qualities such as clinical cleanliness. But basically they will embody sound basic engineering and instrument practice adapted for medical use. Some of the newly developed medical electronics systems could have uses in industry. There is plenty of scope for two-way traffic in ideas.

Dr. Dennis Hill of the Research Department of Anæsthetics of the Royal College of Surgeons is one of the leaders in getting engineers and medical men together in the early stages of design and in promoting the use of electronics in a field where the stethoscope, the pill and the bedside manner are still regarded as the main armament in fighting disease. The doctors are slowly becoming convinced that a stethoscope or a sensitive finger on the pulse, although sanctioned by custom, are not the only transducers now available. The problem is that the other transducers cost hard cash and lots of it—and that really hurts. Nevertheless, medical electronics is slowly penetrating both the barriers of conservatism and the bank balance.

Provided you are not too squeamish there will be much to enjoy. Elliott Automation will be showing a new heart therapy machine which displays the cardiographic waveform of the patient's heart so that the operator can pinpoint the optimum moment to apply a stimulating shock.

Another exhibit is billed as a controllable telemetry device which can be implanted in the body. It switches on only when interrogated by radio command. Battery life is thus conserved.

Such a device was described by Clive Weller of the Institute of Psychiatry over twelve months ago but this was implanted in a cat's skull and used to transmit E.E.Gs* to an external receiver A single transistor oscillator was used, frequency modulated by a varactor diode to give a deviation of some 2 c/s per microvolt of E.E.G. signal on a carrier of 20 Mc/s. The control device was a transistor bistable switch implanted in the cat and controlled by a 10 Mc/s external signal.

As transmission of the E.E.G. was only required on special occasions it was most useful to have the remote switch and the cat, it was reported, had worn the transmitter for some months. The 'special occasions', it appeared, were when the cat was mating. All good clean stuff and well up to the standard of the latest TV plays and the lower strata of science fiction. Even the psychiatrists, although still pre-occupied with the same ideas that excited Freud fifty years ago, are slowly deserting the couch and the consulting room and moving in to the labs. And the vogue term, to be 'switched on' is getting uncomfortably literal.

Electronic engineers visiting Medea '67 should not shy away if introduced to doctors. Only a few will be witch-doctors. Many, like Dr. Dennis Hill, M.Sc., Ph.D., F.Inst.P., M.I.E.E., are eminent physicists using quite comprehensible engineering vocabularies and they certainly won't want to inspect your tongue or sound your heart.

* Electroencephalograph.

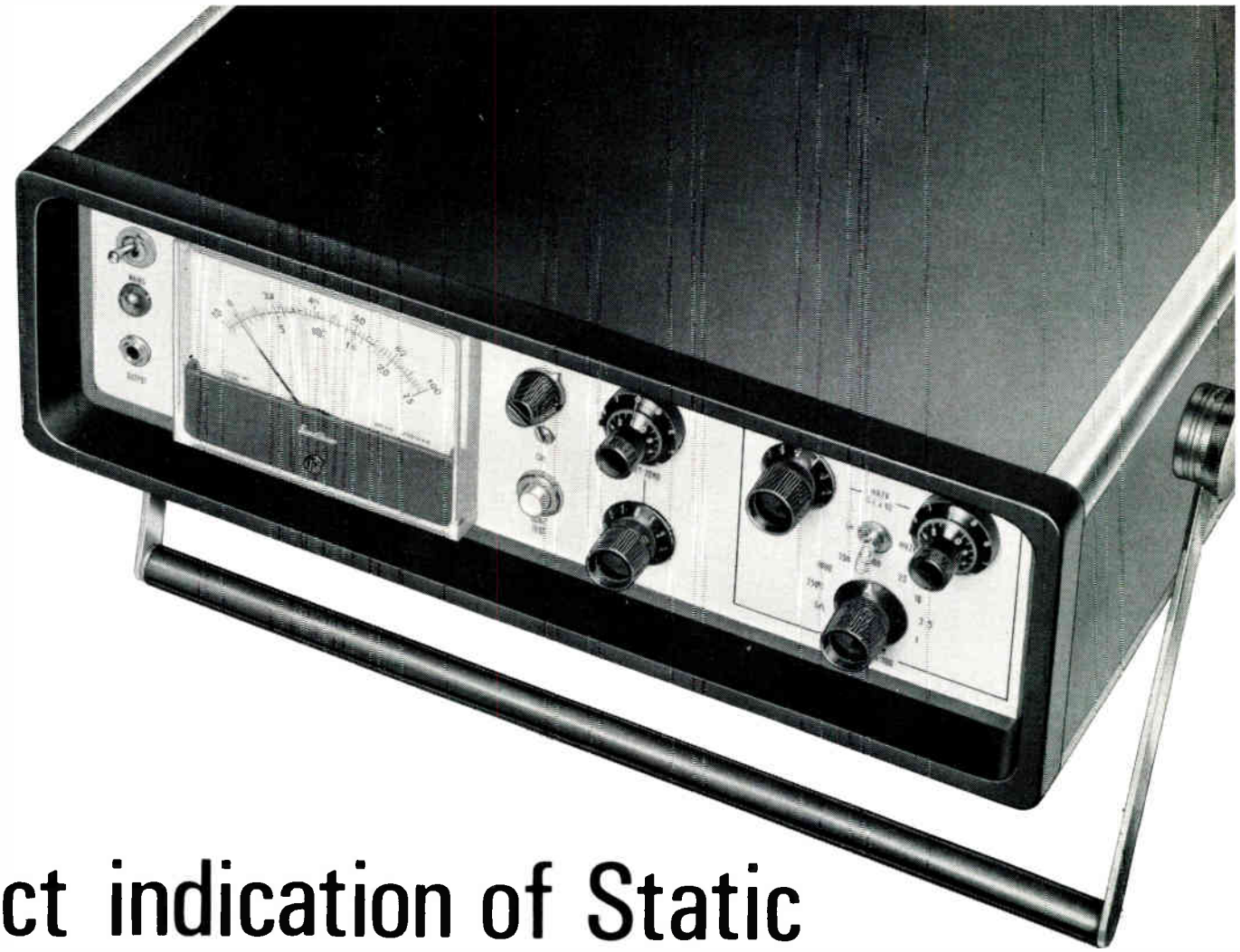
The public wrangles on education are unceasing. Report after report after report is published and most are greeted with thunderous acclaim and then quietly slipped away in the pending file. The cost of producing these documents is astronomical and the findings, after two or three years of marathon committee meetings, are often already out of date when published and commonly trivial or obvious in content.

While the public at large, the upper and lower echelons of our education hierarchy and the interested Government departments mostly talk round the subject I find the electronics industry is quietly doing a great deal. Mind you, industrial education hasn't the high-minded motives that are hopefully attributed to general education. Wicked money-grubbing capitalist companies form the sinister background from which industrial education emerges. And the malevolent objective is to train and encourage people in new skills and technologies so that they are better equipped to compete with their rivals at home and overseas, to make their own companies and the nation more powerful and, by so doing, improve our standard of living.

Marconi Instruments Ltd. have now joined the conspirators. Their sales engineers and overseas agents can now be seen wearing a jaunty look, oozing with self-confidence and eager to discuss the intricacies of binary logic. Marconi Instruments are nothing if not up-to-date. They originated "It's Logic that Counts" a programmed text book on the subject designed to familiarize the sales organization with logic circuitry. It proved such a success that it has now been made generally available at a nominal price of £1.

This is a genuine how-it-works book taking the reader in programmed stages from simple gates to the complexity of a modern digital counter. The scrambling of segments in the book stops the reader moving on until he has mastered each segment and the clever ones can do the whole course and yet read only one third of the text. The rabbits take a little longer, read a lot more, but finish up equally well informed. The value of this type of instruction over a conventional text book is that by the time you have reached the end you find you have not only learnt about logic but actually understand it—which is quite a different thing.

Hardly bed-time reading, but entertaining as well as instructive. We could all do with a lot more brain-washing by subversive literature of this quality.



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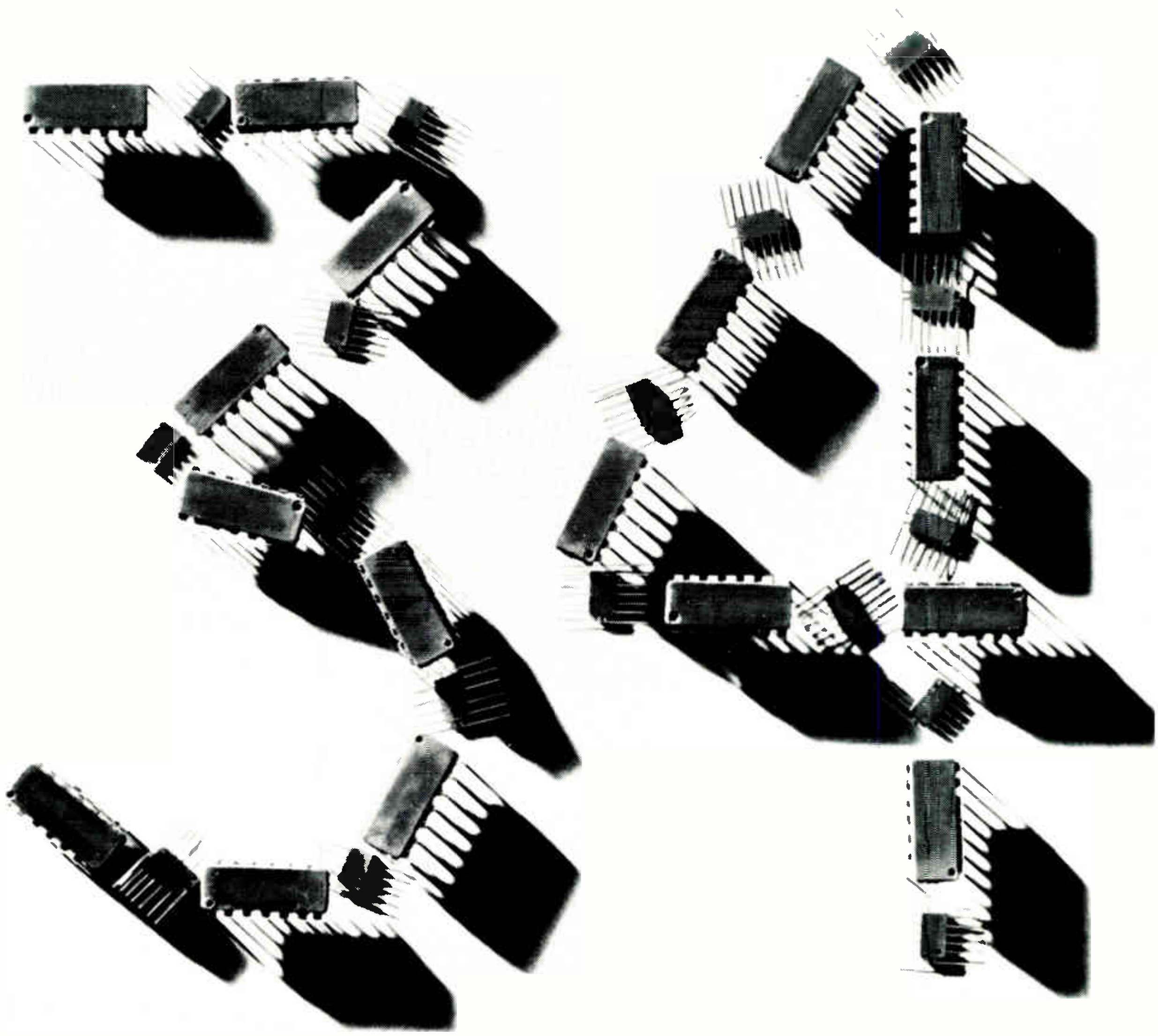

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FCH151	Triple Nand/Nor gate	FCH152
FCH161	Triple Nand/Nor gate	FCH162
FCH171	Triple Nand/Nor gate	FCH172
FCH181	Quadruple Nand/Nor gate	FCH182
FCH191	Quadruple Nand/Nor gate	FCH192
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NEW APPARATUS

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1. Thermoelectric Generators

Maintenance - free thermoelectric generators, manufactured by the General Instrument Corp. (U.S.A.) are now available from Ad. Auriema; they will give outputs of up to approximately 50 W at 8·6 A or, with converters, outputs of 12 or 24 V at up to 40 W. (The basic unit is designed to provide 2½ W and is supplied in multiples of 6 and 12 W). Heat is supplied to the devices by the catalytic burning of propane gas, a series of heat-rejection fins, which will operate in still-air temperatures of up to 120 °F, providing the cooling. The modules are hermetically sealed for long life; with no moving parts lubrication is not needed.

For further information circle No. 1

2. Planar Turbulence Amplifier

A planar turbulence amplifier (a miniature fluidic device consisting of two plastic wafers) forms the basis of a new fluidic system introduced by Maxam Power. Operating on the same principles as standard 'Maxalog' turbulence amplifiers (shown on left of picture), the devices can be mounted in modular units with integral-circuit connections or assembled in banks; cover plates can incorporate etched connecting channels (the pneumatic equivalent of a printed circuit) to give any logic function using the same basic elements.

For further information circle No. 2

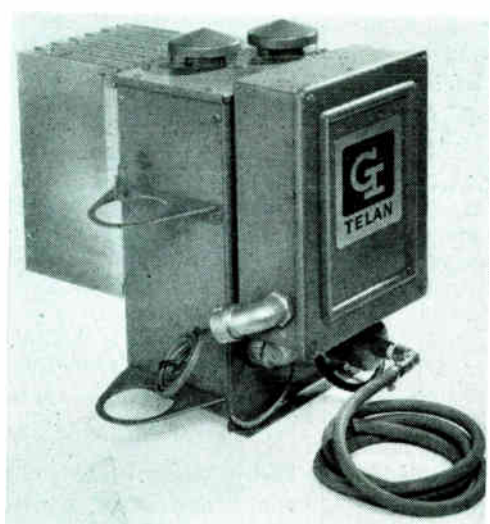
3. Time-Delay Correlator

A fully-transistorized Ad-Yu model 1050 time-delay correlator, which produces accurate time correlation by using a continuously-variable delay line instead of the more conventional point-to-point sampling, has been introduced by Livingston Laboratories; it ensures that valuable data is not missed during the correlation period, and that there is no false output due to random spikes. Outputs are suitable for XY plotting, and include a time-analogue signal directly proportional to delay time, which is derived from the delay-line sweep motor. A series of interchangeable delay lines is available, allowing delay times from 180 msec to 180 μsec; it enables correlation to be carried out from below 5 c/s to 200 kc/s, the upper frequency being limited only by the multiplier circuit.

For further information circle No. 3

4. Paper-Tape Perforator

Data Dynamics are now offering Teletype paper-tape perforator equipment (based on their model 35) that provides low-cost tape preparation with or without hard copy; at remote locations, data can be punched on tape using the keyboard punch and then transmitted by a Teletype tape reader for feeding directly into computers. The equip-



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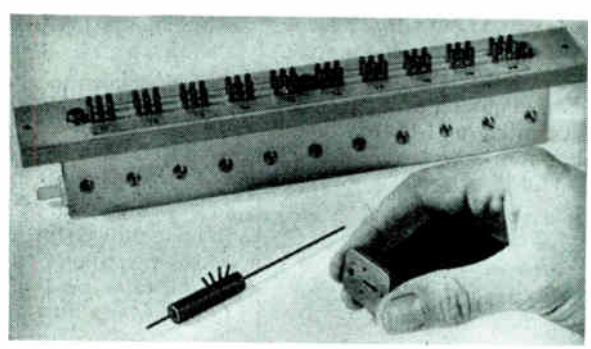

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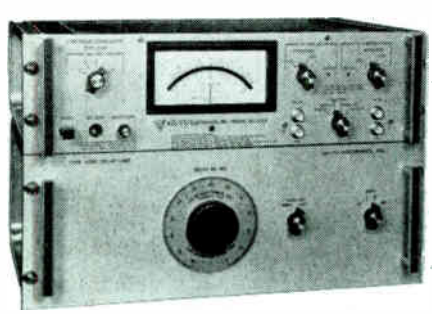

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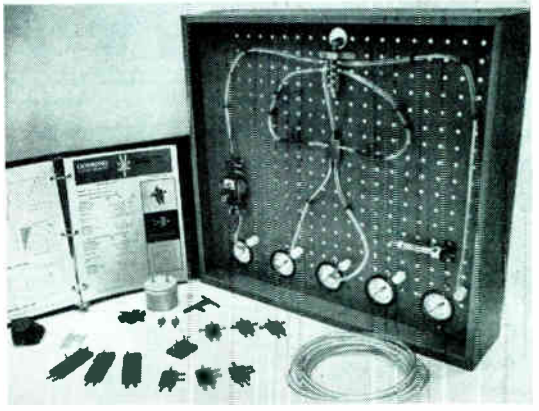

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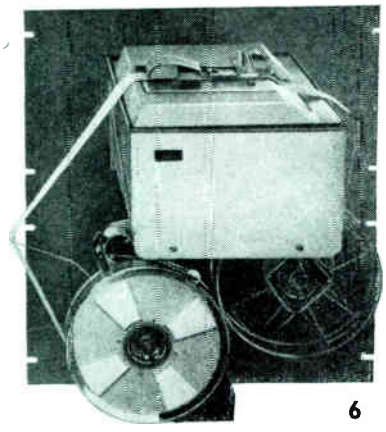

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8

ment provides for typing and non-typing perforation of 1-in. 8-level tape and has a keyboard capacity of 15 characters per sec; it has vacuum chad disposal, a repeat key, character counter, end-of-line indicator and a four-row keyboard for ASC11 or similar codes.

For further information circle No. 4

5. Fluidics Kit

A kit designed to provide engineers with a practical workin[illegible]nowledge of fluidic circ[illegible]ailable from [illegible]partment of [illegible]It contains [illegible]ultivibrator [illegible]ponents— counters, [illegible] gates; [illegible]read-out plastic [illegible] board being [illegible]An in- [illegible]ation of fluidic devices, describes 12 experiments and lists several applications.

For further information circle No. 5

6. Tape Punch

Addo have introduced a panel-mounted version of their tape punch; it is mounted on a standard 19-in. rack panel and is complete with tape spool, tape-low indicator, automatic tape-rewind unit and chad-collection box. It can produce 5, 6, 7 or 8-channel punched paper tape or edge-punched cards at 18 characters per sec, and because of the very small current required by the interposer magnets, it can be operated by transistorized circuitry.

For further information circle No. 6

7. Shaft-Position Indicator

An absolute position-measuring device (the 'Tele-Digitizer'), which gives an indication of the position of its input shaft on demand, has been introduced by Moore Reed; its output is a time gate, the duration of which is proportional to the angular setting of the shaft. This output can be transmitted down a single line (with a common return) or a pair of lines; angular displacement is determined by counting time pulses during the gated interval, and several remote measuring stations can be connected to a single counter or series of counters. The device has a torque of less than 1 gm–cm and a resolution in excess of 1 in 1,000.

For further information circle No. 7

8. Light Projector

Hird-Brown have announced the availability of a long-range light projector for use primarily in photoelectric applications. Called the WP, the unit incorporates its own mains transformer to supply the 12-V, 21-W tungsten-filament lamp, and the optical system consists of a

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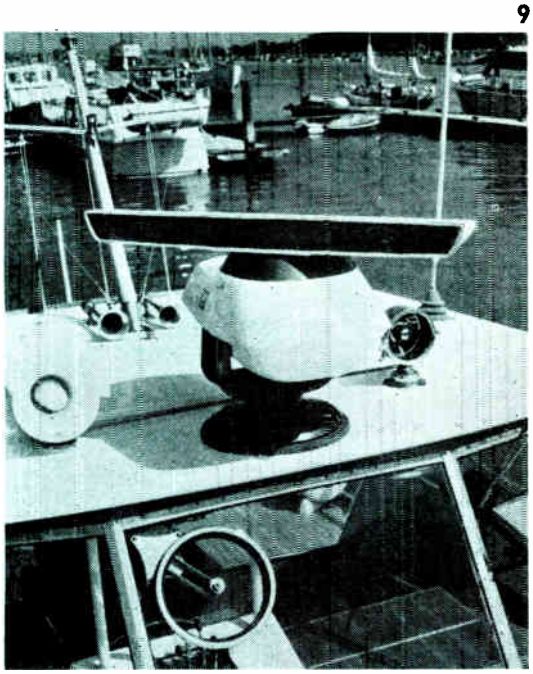

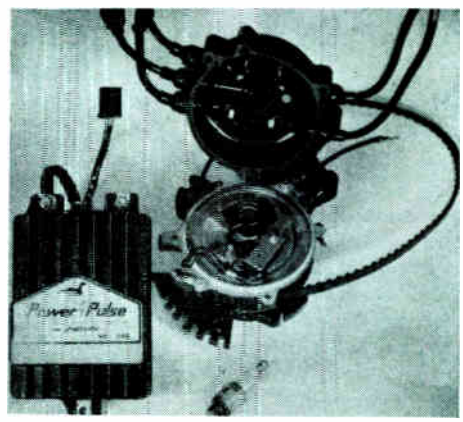

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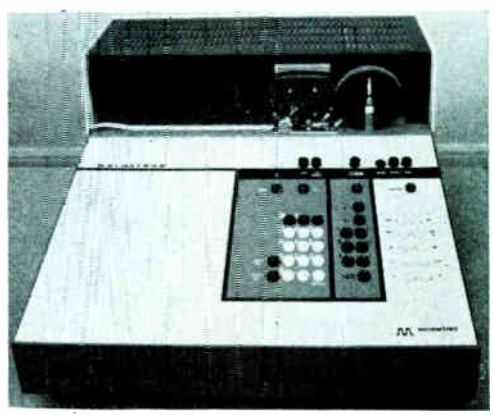

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$3\frac{1}{4}$-in. high-accuracy parabolic mirror complete with adjustment mechanism. The projector is designed to give ample light for photo-electric purposes at ranges up to 75 ft, and an infrared filter may be fitted if required.

For further information circle No. 8

ELECTRONICS

9. Marine Radar

The Decca 101, a low-cost marine radar designed for small vessels, has been developed by Decca Radar. Easy to install and operate, it has ranges of $\frac{1}{2}$, $1\frac{1}{2}$, 5 and 15 nautical miles. The 7-in. cathode-ray tube display incorporates range rings and the complete display unit, which contains all necessary controls, is compact for mounting on a bulkhead, deckhead or table top. A scanner unit contains both the 3-ft rotating aerial and the transceiver, which employs microcircuits and silicon transistors. The power unit operates from supplies of 12, 24, 32, 110 or 220 V d.c. or 115 or 230 V a.c.

For further information circle No. 9

10. Electronic Ignition

An electronic ignition system, the 'Power-Pulse' produced in the U.S.A. by Johnson Motors, is available in the U.K. from E.P. Barrus (Concessionaires) Ltd. This is a capacitor-discharge system which is powered by a 12-V battery to deliver a 20-kV pulse to spark-plug electrodes. A four-prong rotor in the distributor replaces the conventional breaker points and capacitor. As each prong passes a sensor coil, a spark is produced. With a voltage rise at the plug of 5 μsec, surface-gap plugs can be used, an increase in plug life of five to 10 times that of ordinary plugs being achieved. Smoother running and improved combustion efficiency are other advantages.

For further information circle No. 10

11. Desk-Top Computer

The 'Mathatron' desk-top digital computer manufactured in the U.S.A. by the Barry Wright Corp. is now available in an improved version. This is a push-button programmable unit which can store formulae and data. Among the added features are a facility which enables an operator to insert a square root into a mathematical operation using normal algebraic notation, and a memory lock which enables programs to be retained when the power is switched off. Special versions with prewired programs pertaining to particular requirements are available. It can be obtained in the U.K. from Scientific and Computing Instruments Ltd.

For further information circle No. 11

NEW

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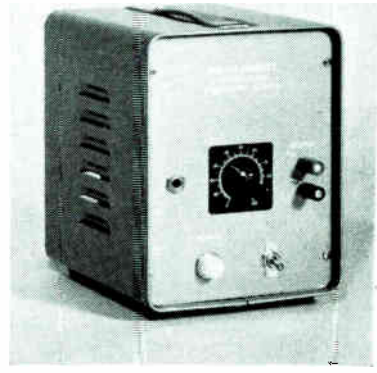
12. Telemetry Amplifier

The IM-60, a recent addition to Industrial Electronetics' telemetry accessories line, is a linear solid-state amplifier designed to couple the high output impedance of telemetry receivers to low-impedance loads such as recording galvanometers. Output limiting protects the recording device from excessive output signals and the gain is continuously variable. It is available with either a self-contained power supply or battery.

For further information circle No. 12

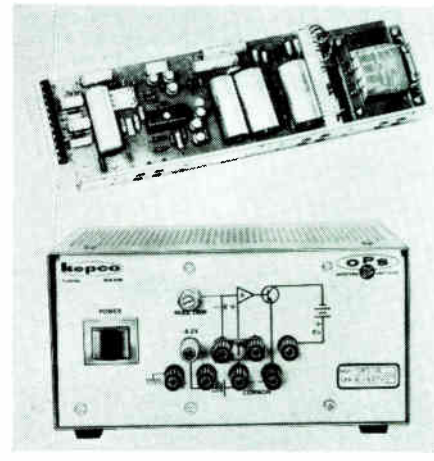


12

13. D.C. Amplifier and Power Supply

Ad Auriema have made available an operational power supply (OPS) produced by Kepco of the U.S.A. This combines a high-gain d.c. amplifier with adjustable offset voltage and offset current, a power amplifier, d.c. sources and two temperature-controlled voltage reference sources of −62 V and +62 V d.c. in one unit. Powered by a 115–230-V a.c. supply, it can be used with feedback resistors or reactances for d.c. amplification, integration, differentiation or other functions.

For further information circle No. 13



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14. Electronic Calculator

An electronic printing desk calculator has been produced by Monroe International of the U.S.A. and can be obtained in the U.K. from Litton Business Systems. Known as the EPIC 2000, it features simple push-button operation and has the ability to store a mathematical routine. Once the machine has been instructed, by the use of the keyboard, to follow a routine, it will do so on any set of figures entered on the keyboard until the routine is cancelled. A routine can consist of complex combinations of addition, subtraction, multiplication, division and square roots.

For further information circle No. 14

15. General-Purpose Computer

The BIT 480 general-purpose desk-top computer produced by Business Information Technology Inc. of the U.S.A. is a versatile machine providing both binary and decimal arithmetic and featuring sequential and priority interrupt facilities. Operating on a variable word length, it has a memory expandable to 65,000 characters. A full range of optional devices and peripheral units is available. It is suitable for use as a data communications terminal, an industrial process controller, a data acquisition link or a scientific processor.

For further information circle No. 15

COMMUNICATIONS

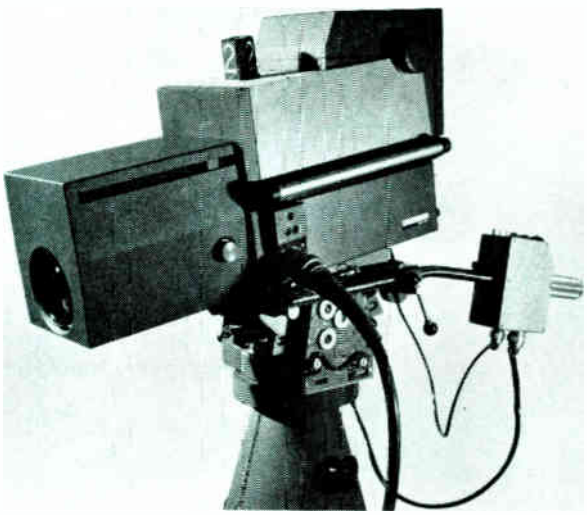
16. Television Camera

The basic form of the Marconi mark 6 monochrome television camera uses a vidicon tube and is intended for telecine use. Additional units, and the incorporation of a plumbicon instead of a vidicon, render the camera suitable for studio and outside broadcast use. The sensitivity enables good pictures to be obtained with lighting levels lower than 50-ft candles. The stability of the circuitry allows the equipment to be set up prior to transmission and little or no re-adjustment will be necessary during transmission. This leaves the cameraman free to concentrate on picture production. The number of controls on the remote control unit has also been minimized. The camera is illustrated fitted with a tilting viewfinder and a zoom-lens unit which can incorporate all the circuitry necessary for full servo control of the zoom lens from a control box located for easy operation by the cameraman.

For further information circle No. 16

17. Radiomicrophone

A radiomicrophone system which enables up to five microphones to be used without mutual interference has been produced by S.N.S. Communications. Known as the Wolec type C mark 2, it uses a miniature



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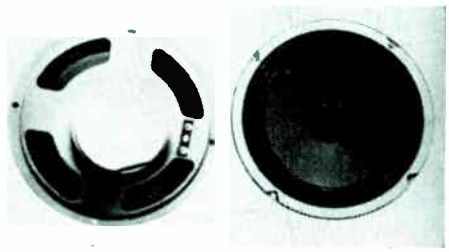

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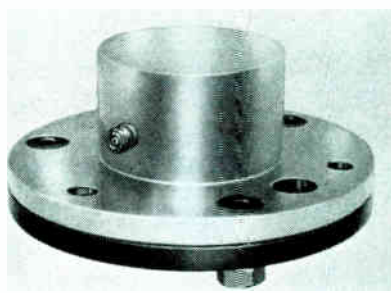

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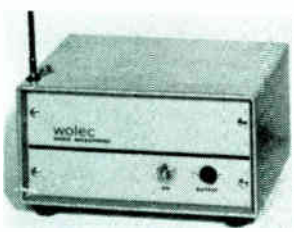

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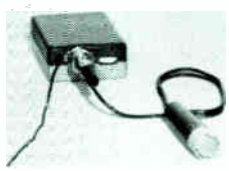

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transmitter connected to a microphone both of which are carried by the user to link him to a public address system while permitting him freedom of movement. A crystal-controlled carrier signal at any one of five frequencies between 174·6 and 175 Mc/s is phase modulated and radiated from a 35·43-in. long free-hanging wire aerial. The signal is picked up by a receiver (situated up to 50 yards away indoors, further out of doors) which produces an audio output for feeding to a public-address amplifier.

For further information circle No. 17

18. Bass Loudspeaker

A low-cost 6½-in. circular cone loudspeaker has been announced by the Plessey Components Group. The speaker, when used with a tweeter in a suitable enclosure, will give a high quality of sound reproduction. The frequency response of the unit is flat from 40 to 1,000 c/s when correctly loaded. The power rating is 12 W and standard coil impedances are 8 and 15 Ω.

For further information circle No. 18

19. High-Intensity Microphones

Piezo-electric high-intensity microphone capsules with diameters from ⅜ to 1⅛ in. have been introduced by D. J. Birchall. They have charge sensitivities of 40–2,000 picocoulombs/p.s.i. and can be used in conditions of high ambient pressure and in ambient temperatures of up to 250 °C. With a stainless-steel case and welded diaphragm, the units are insensitive to vibration.

For further information circle No. 19

20. S.S.B. Transceiver

A single-sideband transmitter-receiver for operation in the 2–10 Mc/s frequency range has been introduced by Raytheon. This, the model CSB-15, operates directly from 12-V d.c. sources and can be supplied with up to four customer-specified channels in any relation to each other within the operating frequency range. Rugged, light-weight and compact, it is suitable for mobile or portable operation and has been designed for use by non-technical personnel. Fully solid-state, it features reliable operation, low current drain, and plug-in modules for easy servicing.

For further information circle No. 20

21. Television Pattern Generator

A television pattern generator, type SG4, has been introduced by Grundig. It provides a video signal of a pattern of vertical or horizontal bars or a crosshatch or dot pattern. Both the video and line frequency are adjustable as well as the synchronizing pulse amplitude and the video amplitude. Channels 2 to 12 are covered by the frequency range of the

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output and a u.h.f. signal output is provided. A 5·5-Mc/s oscillator is frequency modulated with 1 kc/s to provide the intercarrier sound frequency and an i.f. output of 38·9 Mc/s is produced. External modulation can also be used.

For further information circle No. 21

INSTRUMENTATION

22. Peak Data Recorder

A unit which records peak values of strain has been developed by Intercole Systems. It responds to the output of a strain-gauge bridge and displays the strain level on a numerical readout or on a row of lamps (as illustrated) corresponding to increments of strain. The highest peak occurring after the display has been manually reset is registered. The unit is also for use with power presses or similar reciprocating machinery, the display being reset from a contact mounted on the machinery. A built-in relay can be set to close-down a machine should dangerous stress levels occur.

For further information circle No. 22

23. Resistance Measurements

The model 242B resistance measuring system, developed by Electro Scientific Industries of the U.S.A. and available from Livingston Electronics, enables resistance measurements to be made with accuracies of 50 p.p.m. for direct reading and 1 p.p.m. for comparison measurements. The system consists of the model 240 Kelvin ratio bridge, the model 801 d.c. generator detector and the RS 925A decade resistance standard. Separate resistance and deviation dials simplify component checking and temperature coefficient measuring, and low resistance measurements can be made even with the presence of lead and contact resistances. The effects of humidity and other leakage problems have been eliminated for high-resistance measurements.

For further information circle No. 23

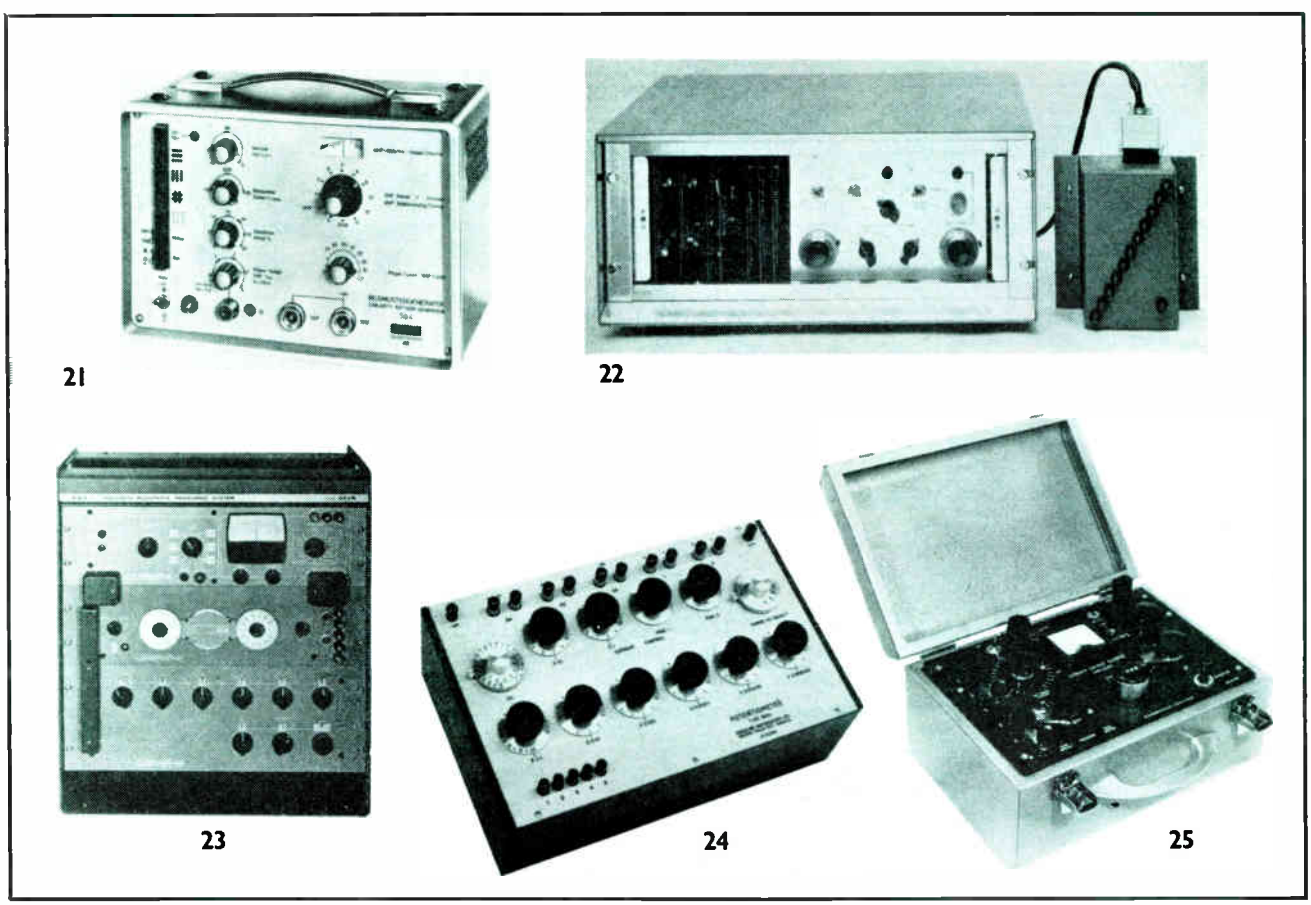
24. Precision Potentiometer

Claude Lyons Ltd. have made available in the U.K. the type 9160G six-figure precision d.c. potentiometer produced by Guildline Instruments of Canada. This has three voltage ranges: up to 2 V in 1-μV steps, up to 0·2 V in 0·1-μV steps and up to 0·02 V in 0·01-μV steps. Contact resistance problems have been eliminated for all switches and thermal e.m.fs are less than 0·1 μV. Accuracy is high and complete self-checking facilities are incorporated. The standard-cell dial covers the range 1·017500–1·019600 V in 100-μV steps plus a continuously-variable dial.

For further information circle No. 24

25. Strain-Gauge Bridge

The battery-operated portable strain-gauge bridge type 5580 designed by H. Tinsley and Co. is for use with Tinsley resistance strain gauges having resistances between 50 Ω and 2 kΩ. It is suitable for single-gauge, two-gauge and four-gauge bridges. Measurements of stress and strain are made by manually adjusting the instrument for bridge balance, indi-



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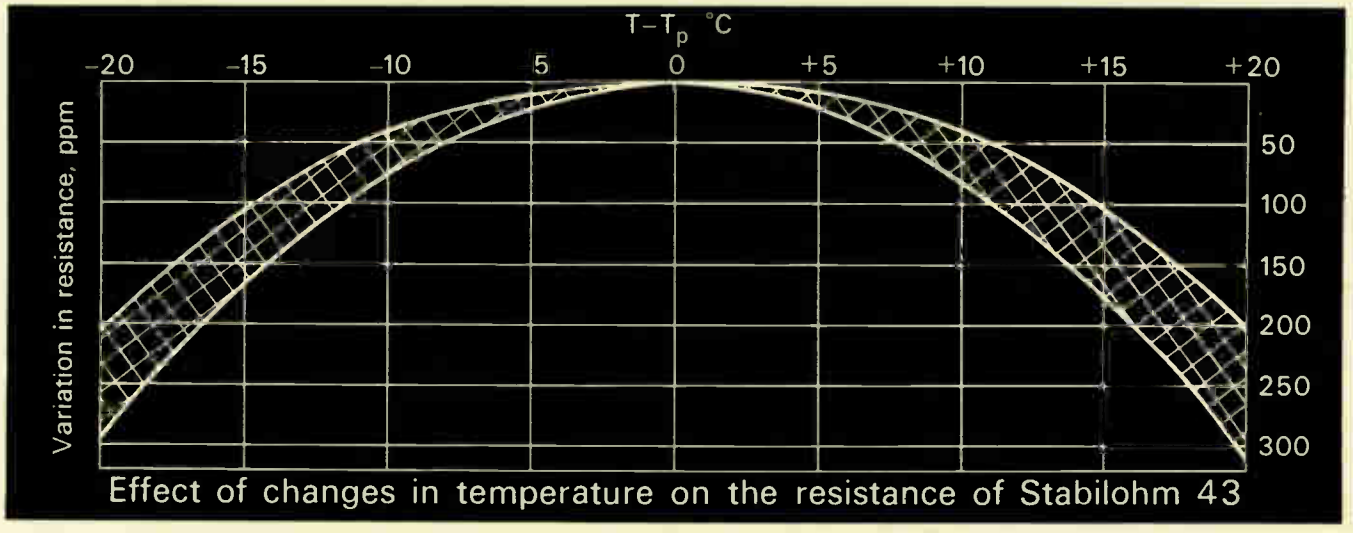

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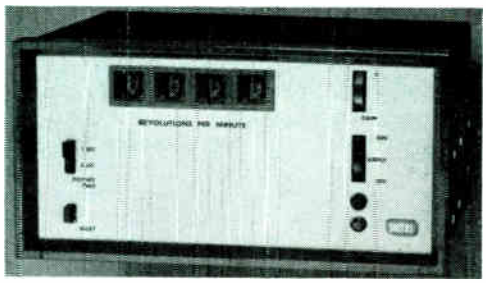

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cated by a centre-zero meter. Two ranges are provided, ±10,000 units of microstrain and ±1,000 units of microstrain. The limit of error of the bridge is ±0·5% of reading or 5 units of microstrain, whichever is the greater.

For further information circle No. 25

26. Digital Tachometer

A rugged four-figure digital tachometer has been produced by Smiths Industries for the measurement of speed directly in r.p.m. It will operate from various transducers, including inductive and photoelectric types, and will accept input signal frequencies up to 100 kc/s, the minimum input pulse height being 200 mV peak. The standard model has a sampling time of 1 sec and display times of 1 and 5 sec are selected by push buttons. Other versions have sampling times between 10 msec and 10 sec. A crystal-controlled oscillator provides a reference signal to give an accuracy of ±0·1% up to 100,000 r.p.m. at operating temperatures between 0 and 50 °C.

For further information circle No. 26

27. Transient-Signal Analyser

An analyser (the French 'Art-1000'), which will extract weak signals from unfilterable background noise, has been introduced by H. G. Stevens. Altogether it has 18 operating modes, stored on plug-in program cards, and these include signal averaging and enhancement, amplitude analysis, amplitude/time histograms and pulse/spike counts. Up to four analogue or digital inputs can be accepted by the 1024-channel memory, analysis time for the full 1024 channels ranging from 50 msec to 40 sec; analysis-delay times range from 0 to 100 sec, in steps of 1 msec. Readout options include external oscilloscope, X-Y and X-t recorders, fast digital plotters, card or tape punch, magnetic tape recorder, and slow or fast printers; a number of accessories are also available in module form.

For further information circle No. 27

28. Electronic Counter

A recent addition to the Hewlett-Packard range of electronic counters is the model 3735A, a compact six-digit instrument with a frequency range up to 12·5 Mc/s and a sensitivity of 10 mV r.m.s. above 10 c/s. Facilities are provided for totalizing and for the measurement of frequency, period, period average (up to 10^5 periods in decade steps), frequency ratio and time interval. Automatic decimal point indication is included. A binary-coded-decima output to drive a digital recorder or other data processing equipment is available.

For further information circle No. 28

29. Digital Voltmeter

A low-cost integrating digital voltmeter, known as the DV meter type 500, has been introduced by Weir Electronics. With a four-digit readout using neon tubes, this unit measures 1 mV to 1 kV on four push-button selected ranges. The measurements are made to an accuracy of ±0·1% of full scale ±0·2% of reading ± one digit. A good reliability has been achieved with the use of solid-state printed circuitry and a 1-kV overload on all ranges can be tolerated. Push-button polarity reversal with a neon indicator and automatic decimal-point indication are included.

For further information circle No. 29

30. Infrared Pyrometer

The 'Infred 11' pyrometer manufactured in the U.S.A. by the Rockwell Co. and marketed in the U.K. by Wessex Electronics covers temperatures ranging from 70 to 2,500 °F (21 to 1,370 °C). It is suitable for remote temperature measurement and control in many industrial appli-

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cations and environments. A particular use is the measurement of the temperature of glass or materials in quartz infrared ovens. The unit has a spectral response of 4·9–7·5 microns.

For further information circle No. 30

CONTROL

31. A.C. Servo Controls

Vosper Electric have developed a range of a.c. servo units for control and power actuation that make full use of the company's static-switching units. Of the three distinct units for covering the requirements of industrial and marine applications, the a.c. proportional servo unit (with motor output) consists of a synchro-transmitter coupled to the lever or other operating device, with a corresponding synchro-receiver coupled to the final output of a geared a.c. servo-motor; performance characteristics of the unit are such that the minimum increment of the synchro-transformer is 1° over a full range of 120°. The design load is 12·5 lb-ft, and the full range of movement is covered in 5·5 sec when the motor is running at 75% of full speed. The other two units are an a.c. on/off servo, and an a.c. proportional servo for use with servo valves; the picture shows elements of a typical proportional servo system.

For further information circle No. 31

32. Lightweight Actuator

A high-performance ultra-lightweight actuator has been introduced by the electrical equipment division of the Plessey Dynamics Group; known as the Cub-mole, it is designed for operating aircraft fuel cocks and valves, and similar applications. It is a two or three-position rotary actuator, weighing only 13·5 oz with brake, and has a normal working load of 35 lb, a maximum working load of 50 lb and a maximum static load of 90 lb. The actuator is fully tropicalized and operates over a temperature range of −55 °C to +120 °C ambient; the operating time for 180° travel is 4 sec, and 18-in. flying leads are brought out through a rubber grommet.

For further information circle No. 32

33. Plug-board Matrix

Oxley Developments have added further plugs and pins and a recessed bezel frame to their 'CONTROLOX' programming system. This system uses a standard plug board fitted with contact strips on one side and having socket points arranged in a 10 × 10 matrix. The boards are stacked together and shorting pins and diode pins are inserted into the sockets to connect the contact strips of different boards as required. Stacks can be connected side by side to increase the matrix size and the additional pins now allow stacks of up to six boards to be used. The system offers a contact resistance of less than 5 mΩ, a breakdown voltage between the contact strips of 3 kV d.c., and a current rating of 5 A.

For further information circle No. 33

34. Static-Switching Systems

Complete static-switching systems assembled in one integrated installation can be produced with 'Fairstat', a new range of solid logic devices from Fairey Engineering. The range covers two series of logic and control modules (together with a standard mounting panel incorporating a pre-coded termination unit), and the Fairstat system handles the control task from sensing input signals to operational power outputs. The series 200 (illustrated) is a plug-in unit that employs modular connections, whereas the series 500 is a wire-in unit. Both units use printed circuits, and up to 36 modules with indicators and termination units can be accommodated in the series 500 panel; for the series 200, the panels are prewired and will accommodate up to ten modules together with similar indicators and termination units.

For further information circle No. 34

35. Programming System

D.E.B. Electronics have developed an inexpensive programming system that consists of two patterns of parallel copper strips at right angles to each other on opposite faces of a $\frac{1}{16}$-in. thick laminated base material; there are holes at each intersection of the two patterns, and these holes lie on a 0·300-in. matrix. On the plug-in version of the matrix, all the strips are connected to an edge connector, though a flush-mounting version is also available; it is programmed by connecting tracks on opposite sides of the board through the holes with either a shorting pin or a component holder. The latter will accept a wide range of components.

For further information circle No. 35

36. Flameproof Tacho-Generator

The motor and control-gear division of A.E.I. has introduced a flameproof enclosure (holding Buxton certificates for groups I and II gases) for its high-accuracy permanent-magnet d.c. tacho-generator. The tacho, which is used for the control of servo systems, speed matching and recording, has a linearity accuracy which is constant within ±0·15% over a wide speed range down to within 1 to 2 r.p.m., and has a temperature compensation better than 0·003% of output voltage per °C over normal ambient range; its ripple content is 0·5% peak-to-peak low frequency, and 2% peak-to-peak total ripple. Two ratings are available, being 0·1 and 0·2 V per r.p.m., with maximum speeds of 4,000 and 2,000 r.p.m. respectively.

For further information circle No. 36

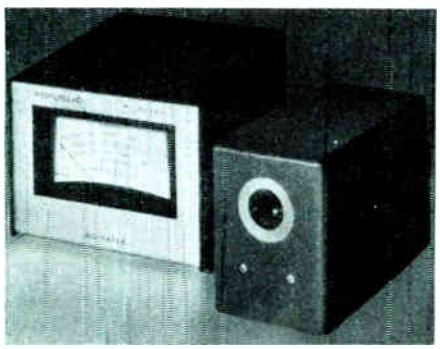
37. Vibration Monitor

Damage due to mechanical malfunction of rotating and reciprocating machinery can, it is claimed, be most effectively avoided by using the Vibraswitch unit now being marketed by Industrial Electronic Controls. The unit is responsive to both amplitude and frequency, and a wide selection of auxiliary accessories (such as time-delay and monitoring devices) is available; control units monitoring up to three sensors can prevent false alarms during start-ups or momentary power surges. In operation, the device actuates an audible warning system and/or shuts down the machine when the vibration level of protected equipment exceeds 'normal' levels; three models are available, for electric-contact actuation or pneumatic actuation.

For further information circle No. 37

38. Laboratory-Furnace Controller

A portable controller (type 15–98) has been introduced by Ether for indicating and controlling the temperature of laboratory furnaces and similar equipment with resistive-power ratings up to 3 kW. No permanent wiring or installation is necessary, and the unit has only to be plugged in to the mains to operate. The signal from a thermocouple is fed into a temperature-compensated chopper-type d.c. amplifier, whose output voltage is compared with a variable reference



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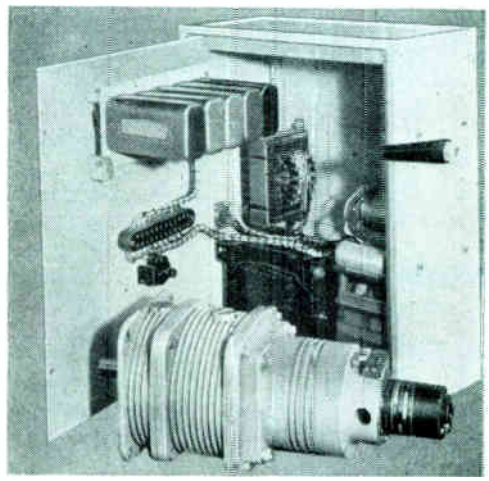

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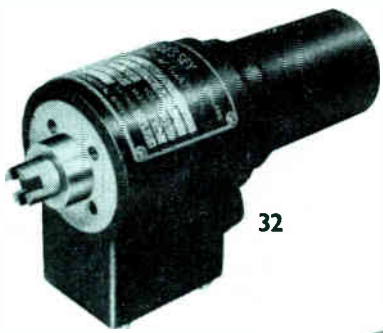

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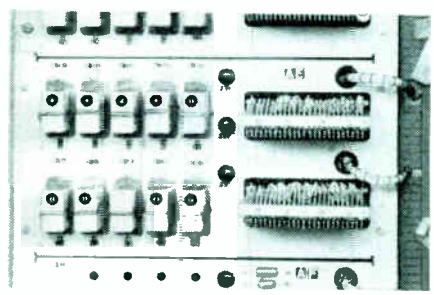

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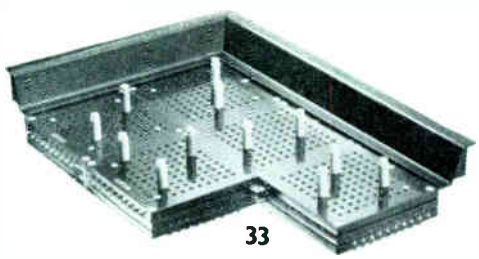

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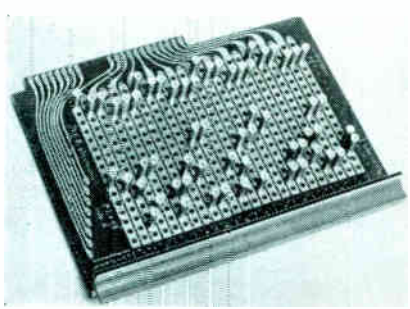

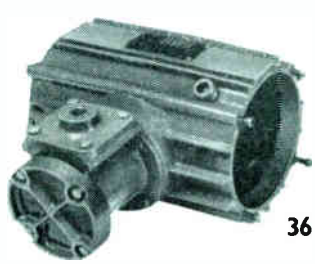

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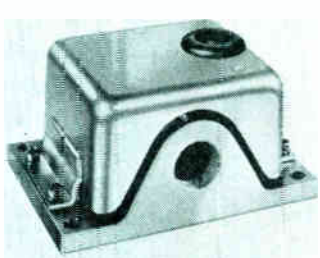

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voltage controlled by the temperature set-point. The differential is fed, via a further amplifier, to a trigger unit providing firing pulses for two thyristors, which are connected in inverse parallel and mounted on heat dissipators; it is these thyristors that control the power supplied to the furnace heaters.

For further information circle No. 38

COMPONENTS

39. Thyristors

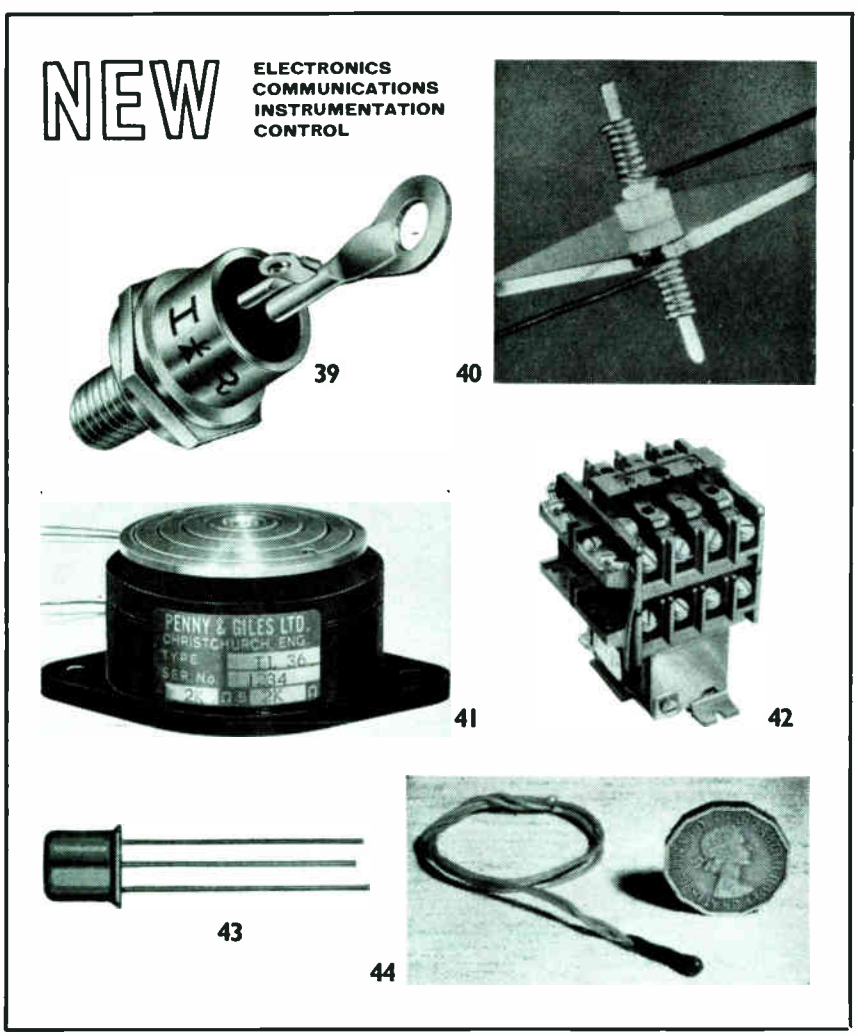
One of the former limitations of thyristors has been the time taken for the device to revert to a high-resistance blocking state from a low-resistance conducting state once the forward voltage has been reversed or removed. International Rectifier have reduced this 'turn-off' time to less than 3 μsec for their type 8RCU thyristor which has a rating of 8 A full-cycle average current. Another recently-introduced type is the 10RCU which has a turn-off time of less than 5 μsec and a current rating of 10 A. Both can be obtained with a voltage rating of 600 V.

For further information circle No. 39

40. Solderless Connector

A p.t.f.e.-insulated terminal for solderless wrapped connections has been introduced by Oxley Developments. It allows leads and cables to be connected with the use of rotary tools. To fit the connector, a p.t.f.e. bush is inserted into a 0·156-in. diameter hole and a barbed conductor is pressed through the bush. The conductor then offers a resistance to pull of 12 lb and a resistance to turning of 12 oz-in. The working voltage of the connector is 1·5 kV d.c. and a maximum current of 5 A can be passed. It introduces less than 1·5 pF capacitance.

For further information circle No. 40



41. Force Transducer

Penny and Giles have added a load cell and force transducer to their range of potentiometric transducers. The unit is available with ranges from 0–3 lb to 0–1,000 lb. Two versions are available, the TL.36 and TL.38, the TL.38 incorporating a longer potentiometer for better resolution. Twin diaphragms operate the potentiometer wiper assembly via a flexure spring linkage. The mechanism has no bearing friction and operates within a sealed chamber giving protection from contaminants. Other features include the use of platinum alloy wipers and nickel chrome windings, a high resistance to shock and an output voltage temperature coefficient of 0·01% per °C.

For further information circle No. 41

42. Multipole Relay

Arrow Electric Switches have developed a relay with wiping contacts giving high reliability in adverse climatic conditions. Known as the 'FPRL' series, it can switch both a.c. and d.c. at 24 V and below. It is available with up to eight poles, and a maximum of four normally-closed poles, and can be supplied with coils for a.c. or d.c. operation.

For further information circle No. 42

43. P.N.P. Transistors

Mullard have added seven p.n.p. types to their range of silicon planar transistors. Five have power ratings of 600 mW and two have power ratings of 350 mW. Because of their linear gain/current characteristics all seven are suitable for both switching and linear applications and can be used with n.p.n. types. The 350-mW devices are numbered BCY70 and BCY72. The former is primarily intended for medium-speed switching applications while the BCY72 is a general-purpose transistor. A low leakage current, low saturation voltage and a high cut-off frequency are features of the 600-mW types.

For further information circle No. 43

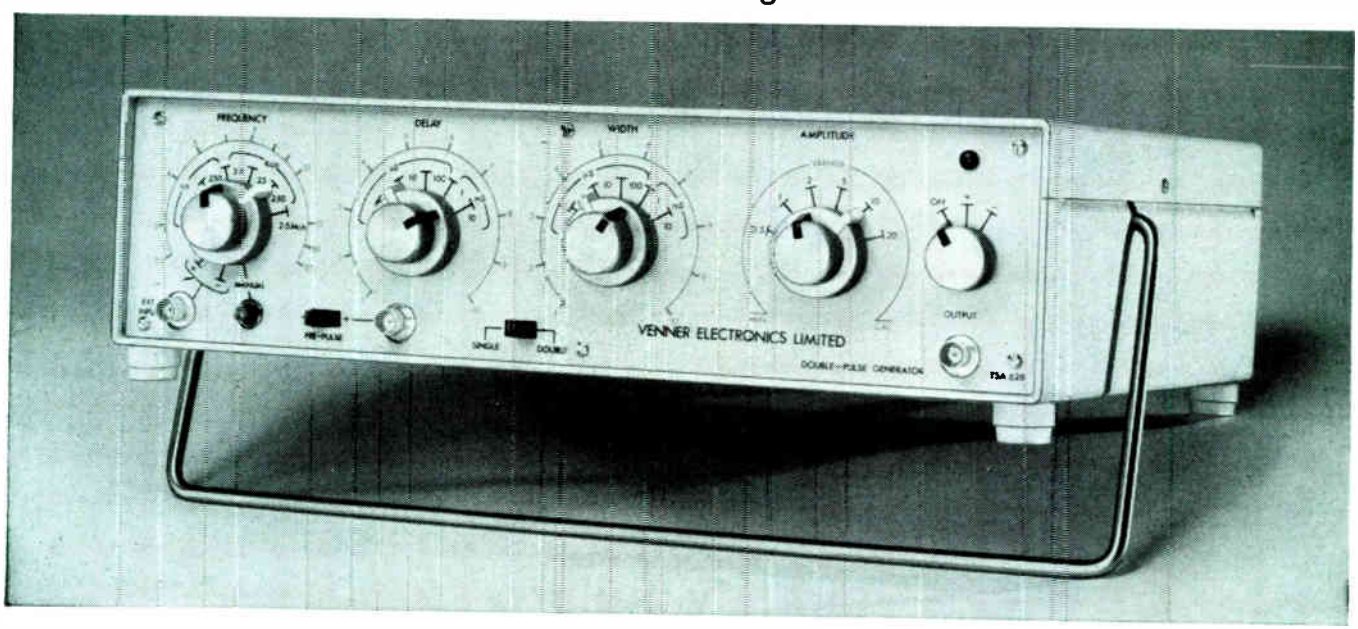
44. Positive Temperature Coefficient Resistors

A range of 'Posistors', resistors with greatly increased positive temperature coefficients, has been announced by Thorn Parsons Co. Ltd. A feature of the 'Posistor' is that its resistance remains almost constant up to a threshold temperature but at higher temperatures increases very rapidly. It is suitable for many

double

PULSE GENERATOR

silicon throughout



✱ One or two pulses up to 20V amplitude, + or − with respect to earth. ✱ Frequency range 2.5c/s-2.5Mc/s. ✱ Vernier and 1:2:5 switched control of amplitude, pulse width, frequency, and delay. ✱ Separate polarity control for pre-pulse. ✱ Pulse width: 100nS to 10mS. ✱ Rise time: 10nS. ✱ Delay: 100nS to 10mS. ✱ Variable tilt for ease of operation. ✱ All these features in a portable unit of compact modern design at remarkably low cost.

Ask for full details of this latest addition to the Venner range of transistorised electronic precision instruments.

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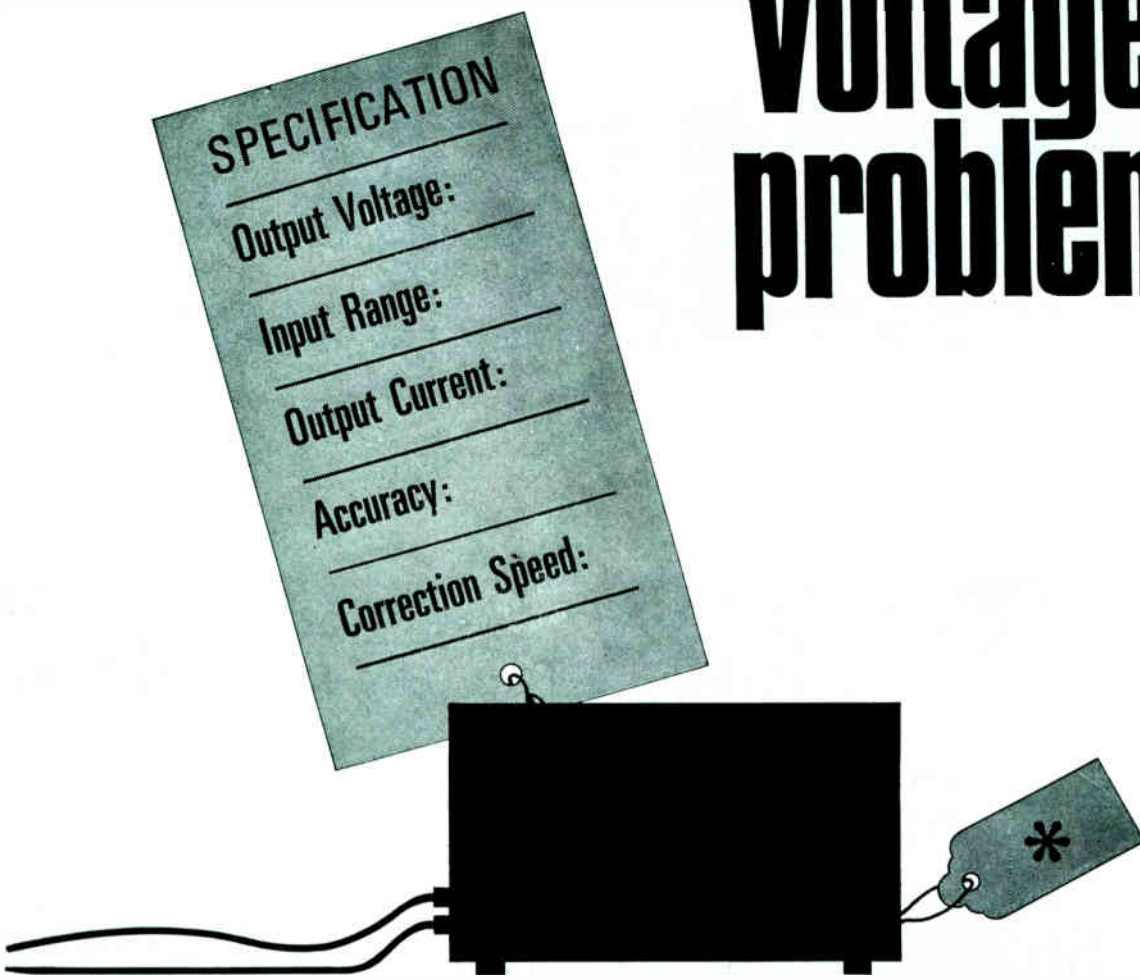
For further information circle No. 238

voltage problems?



there is a standard Claude Lyons voltage stabiliser already built to *your* specification

* *and that includes price*

Claude Lyons make the most comprehensive range of voltage stabilisers available today. You will almost certainly find the stabiliser to suit your application in the Claude Lyons standard catalogue range. Distortionless servomechanical types from 1 to 120 kVA (and 360 kVA 3-phase). Solid-state types from 400 VA to 10 kVA. Simple tap-changing types from 600 VA to 2·4 kVA. All very high quality. All very reasonably priced. Full facts and figures from Publicity Department, Hoddesdon.

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CLAUDE LYONS

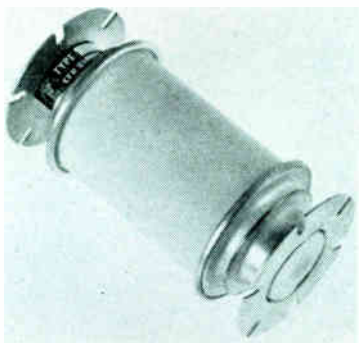
LEADERS IN VOLTAGE CONTROL

ZA 8257 CL 67

For further information circle No. 239

NEW

ELECTRONICS
COMMUNICATIONS
INSTRUMENTATION
CONTROL



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safety and monitoring systems, especially for electric motor protection, and is available for operating temperatures in the range 95 °C to above 165 °C. Besides monitoring temperature, 'Posistors' can be used to limit currents or to sense changes in the environment of the device, for example liquid/vapour changes, rate of flow variations or flame blow-back.

For further information circle No. 44

45. High Vacuum Capacitors

The English Electric Valve Co. has extended its range of high-vacuum capacitors to include a number of fixed capacitance types. A series of the glass-envelope type with ratings of 15 kV peak and 7 A r.m.s. can be supplied in capacitance values up to 10 pF. Another series, rated at 3 kV and 50 A, is in the capacitance range 500–1,000 pF. Much higher ratings are possible with ceramic envelopes and among those of this type available for the first time is a high-current series rated at 30 kV and 140 A with capacitance values up to 34 pF.

For further information circle No. 45

46. Ceramic Disc Capacitors

The 801 series 'Disc Ceramicon' capacitors are among the latest capacitor ranges to be introduced by Erie Resistor. These are available in capacitance values between 6 and 7,000 pF with a working voltage of 500 V d.c., and a 10,000-pF version with a 100-V working voltage can be obtained. Also offered are 'Transcap' versions in values of 33,000 and 47,000 pF with a 25-V working voltage. Measuring 0·36-in. in diameter and 0·156-in. thick, the capacitors are produced in two versions, one with conventional wire leads and the other with short terminations for printed-circuit use.

For further information circle No. 46

PRODUCTION AIDS

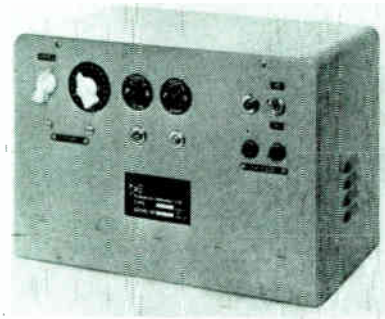
47. Transistor Sorter

A high-speed automatic transistor-handling system (the type 1630) has been developed by the Daymarc Corp. for use with electronic sorters. It has been designed for large-volume sorting, the transistors being placed in a vibratory-feed bowl, transferred to a feed track, tested by associated instruments and deposited in one of 12 bins according to type. The equipment is suitable for TO-5 and TO-18 transistors, with long or short leads, and various epoxy-pack transistors can also be sorted.

For further information circle No. 47

48. Colour-Registration Unit

A colour-print registration unit (the 5APR/2), which incorporates solid-state switchgear to provide response speeds adequate for the fastest of modern colour-printing and packaging equipment, has been introduced by Benson-Lehner; it provides high sensitivity to colour change throughout the visual spectrum, coupled with high stability through a range of mains and temperature variations. Basically, the equipment consists of a dual-directional control unit and a photo-head which incorporates a photo-cell projection lamp and optics. The control unit prevents signals being applied in one direction while the circuit is controlling



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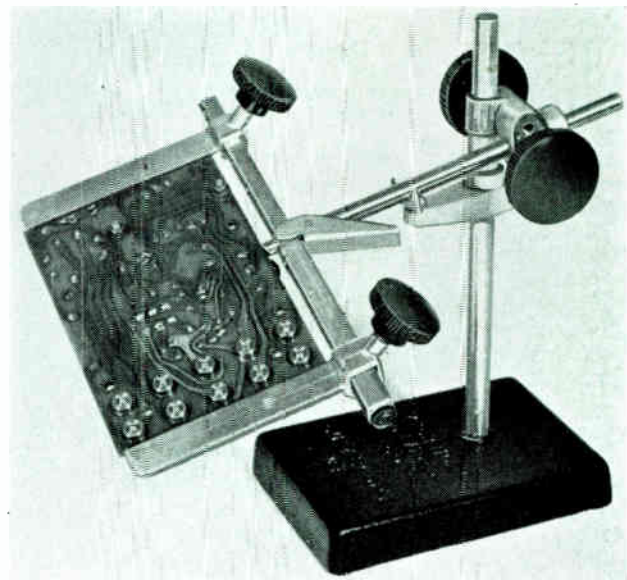

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51

NEW ELECTRONICS COMMUNICATIONS INSTRUMENTATION CONTROL

the opposite direction, and consists of a photo-cell, transistorized amplifier and electronic timer, with solid-state switching equipment and power supplies.

For further information circle No. 48

49. Circuit-Board Holder

A quick-acting rigid work-holding device, which can be easily adjusted to all positions, has been introduced by Technical Representation. Its spring-loaded arms securely hold the workpiece, and release instantly on applying light pressure to a lever; large 2-in. hand knobs provide positive locking, and indexing keys permit rotation of the work in 90° increments. The circuit-board fixture may also be used for holding cable connectors, terminal boards, small assemblies and similar items, its capacity being $\frac{3}{4} \times \frac{3}{4}$ to 7 × 7 in. for length, and $\frac{1}{32}$ to $\frac{3}{32}$ in. for thickness.

For further information circle No. 49

50. Lead-Free Sealing Glass

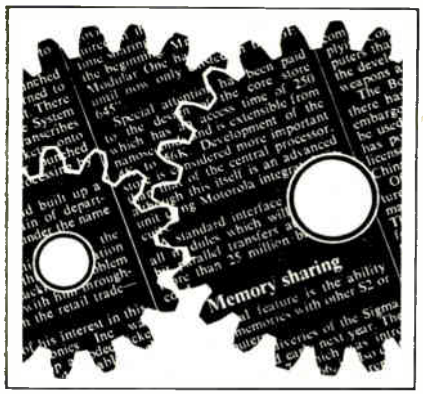
A sealing glass (code 4070) that is lead free, has a low alkali content and can be quickly sealed by infrared energy is now available from Corning Glass Works; using it to encapsulate miniature diodes, electrical degradation due to alkali poisoning is minimized or eliminated. The glass, which seals to molybdenum and tungsten, has a very high absorption of energy in the infrared region from about 0·75 to $4{\cdot}75 \times 10^{-6}$ m wavelength, and non-flame sources (coil or infrared lamp) can be precisely focused on the area to be sealed; heat-sensitive devices are not damaged during encapsulation because heat absorption is localized in the seal area.

For further information circle No. 50

51. Thermocouple Welder

Spembly Technical Products have introduced the model 125 SRL thermocouple welder to their range of miniature welders; it incorporates nine separate time–current combinations, which make it possible to join any combination of metals up to 0·8 mm in diameter. Metals are welded in an inert gas, thus eliminating pre-weld preparation of the surfaces and the use of filler rod, flux, solder or paste. Because no third material is used in the process, the two welded metals are completely alloyed at the junction; as a result, the welded thermocouples exhibit less than 0·01 °C variation from one couple to the next at room temperature.

For further information circle No. 51



INDUSTRIAL NEWS

R.T.E.B. Annual Report

The annual report of the Radio Trades Examination Board for the year ended February 1966 has now been published; it shows that the total number of candidates examined in the four practical tests increased by 24% over the previous year to a total of 3,279.

Candidates for the electronic servicing examinations continue to increase in number, and it is anticipated that this field will soon become as important as the radio and television side of the Board's activities. Meanwhile, there is evidence that many holders of the final radio and television servicing certificate eventually seek and obtain employment in the industrial and professional electronics field.

Joint Organization for Technological Training

Three leading trade associations (the British Electrical & Allied Manufacturers' Association, the Electronic Engineering Association and the Scientific Instrument Manufacturers' Association) have decided to establish a joint organization to co-ordinate the activities of their member companies, and other manufacturers, in the field of technological training and educational aids.

Its purpose is to promote the developing market in this field at home and overseas, provide a liaison with government departments, and establish close co-operation with educational and training bodies throughout the world.

Modular Logic Cards

A range of miniature modular logic cards, developed to simplify electronic-systems design, is now available in the U.K. following a manufacturing and marketing agreement between Advance Electronics Ltd. and the Data Technology Corp. of America.

The cards feature replaceable integrated circuits, have a 5-V common power supply voltage and use NAND logic; they are supplied for operation in the temperature ranges 0–50 °C and 0–70 °C, and have a 5-Mc/s capability.

For further information circle No. 73

Telecommunications Industry Enquiry

The Industrial Reorganization Corporation is to examine (by Government request) the structure of the telecommunications industry and its relations with the Post Office, to see whether they can be improved in the national interest. The great demand for telecommunications equipment that is entailed in the future development programme of the Post Office has created the need to help the industry keep pace with a rapidly changing technology, and so the study will be concerned with as many companies as possible that supply telecommunications equipment (directly or indirectly) to the Post Office. Its findings will, unfortunately, be kept confidential.

Solid-State Control Symposia

Encouraged by the response to their 1966 series of symposia on solid-state control, MTE Control Gear Ltd. are this year organizing six such two-day meetings at Westcliff-on-Sea, Essex. Designed to assist engineers to bridge the gap between conventional and solid-state circuitry, they will cover the fundamental principles of solid-state switching and control, combined logic power circuitry and counting systems, together with their applications to contemporary industrial technology. The symposia will be held at the Westcliff Hotel in March, June, July, August, October and December.

For further information circle No. 74

Regional Computing Centre Project

Details have now been announced of a major computer project to be undertaken by the new regional computing centre at the University of Edinburgh. Master programs for large-scale conversational computer systems are to be developed with the financial assistance (amounting to some £350,000) of the Ministry of Technology and English Electric-Leo-Marconi Computers—the first time that a Government department, a commercial organization and a university have co-operated on such a scheme.

The university has ordered a System 4-75 computer from E.E.L.M., and this will be delivered in the summer of 1968; in the meantime, their rented KDF 9 machine will provide the required facilities. It is intended that the exploitation of the multi-access facilities being developed will not only meet university research and teaching needs, but will also serve local industry and research establishments; the number of those who will have simultaneous access to the computer from remote terminals will eventually exceed 200.

Multi-Purpose Computer Program

English Electric-Leo-Marconi have devised a new multi-purpose computer program, called GENDA, which enables a variety of data-processing tasks to be implemented without the necessity for writing individual programs; it has a wide range of possible applications in the fields of statistical analysis and stock and production control, and is written in Fortran.

The versatility of this general data-analysis and simulation program has enabled the Bureau Division of E.E.L.M. to run such widely-differing projects as a weekly production schedule for a major biscuit manufacturer and a pilot stock-control scheme for a large corporation bus fleet, without spending valuable time on writing and proving individual programs. It has already been used for analysing the optimum utilization of power stations to meet daily demand variations, and used as a simulation program it has been applied to customer-demand forecasting as well as production scheduling.

For further information circle No. 75

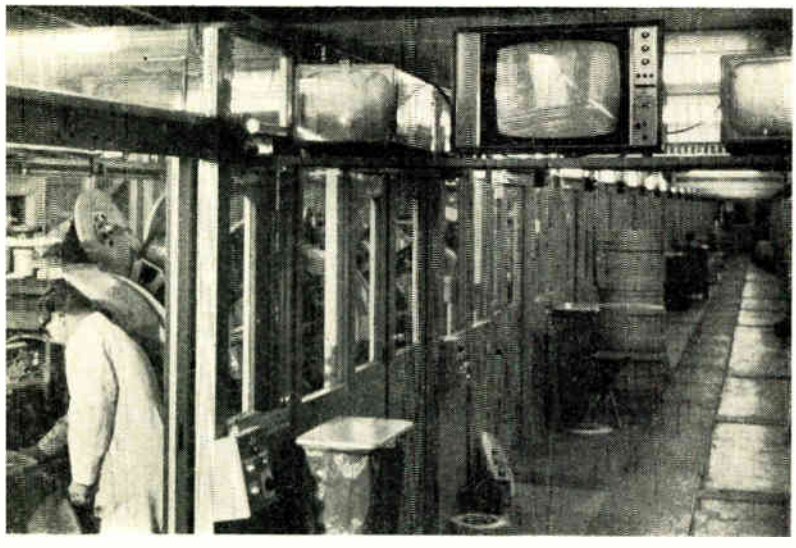
U.K. Licence for Automatic Handling Machine

Hawker Siddeley Dynamics and the American Machine and Foundry Co. have signed a licence agreement for the manufacture and sale of the AMF 'Versatran'.

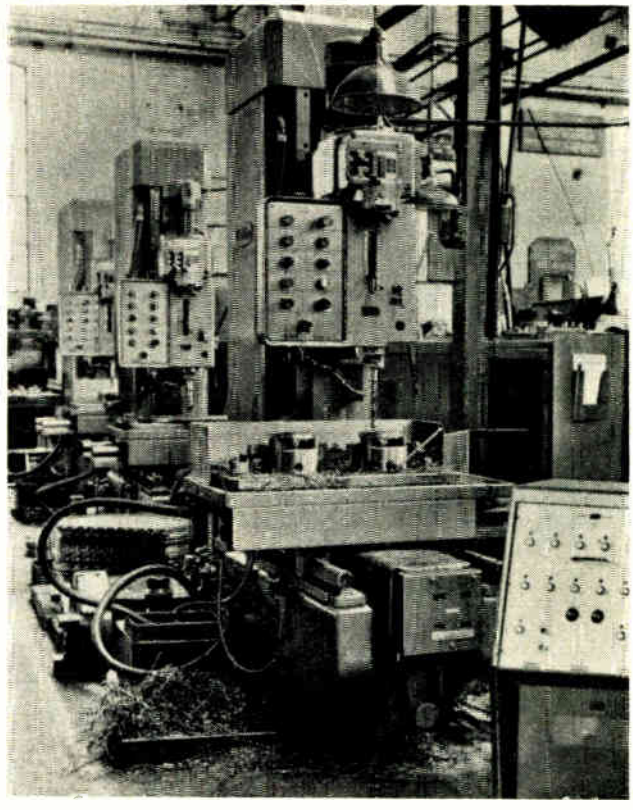
Versatran is a programmed positioning, transfer and handling machine with a wide range of industrial applications. The machine's versatility eliminates the need for costly single-purpose automation, and is readily

The National Physical Laboratory, at Teddington, recently took delivery of an NCR-Elliott 4120 computer that will be used for research into simpler methods of creating computer programs. It is equipped with the on-line graphical-display system shown here, which enables an instantaneous interchange of both graphic and alphanumeric data between the operator and the computer. By means of the light pen instructions can be given to the computer, and their results can be incorporated into the display virtually simultaneously

For further information circle No. 76



Closed-circuit television techniques are being increasingly adopted throughout industry as their advantages are appreciated. Here, c.c.t.v. equipment is shown being used at British Insulated Callender's Cables' Belvedere factory, where super-tension cables are manufactured. The 19-in. monitor and associated cameras were supplied by the Rank Organisation, and they allow the operator to observe, from the control position at the input end of the paper-lapping machine, the 'coiling-on' process that takes place some 70 yds away at the output end. In addition, two 14-in. Pye monitors enable the passage on the far side of the machine to be observed



Numerically-controlled drilling machines are now being employed extensively by Peter Brotherhood Ltd., the Peterborough engineering company. They are using Wadkin TH drills controlled by Airmec N271 Autosets, most of the work being done consisting of short production runs. Results have so far proved very successful—greater accuracy than jig drilling is achieved, fitting time is considerably reduced and almost all machine time is now drilling time

integrated into existing production systems.

Under the terms of the agreement Hawker Siddeley Dynamics will manufacture Versatran in the U.K. and sell it in the U.K., Scandinavia, Western Europe and the Commonwealth.

Experimental Computer-Controlled Processing Plant

The Ministry of Technology's Warren Spring Laboratory is offering to those companies in the chemical, oils, food and other processing industries that are interested in the application of computer control the opportunity to study their problems and requirements in the practical context of a working plant.

The Laboratory's plant at Stevenage is a pilot-scale acetone manufacturing complex, linked through direct digital control to an ARCH 9000 computer, and small groups of interested engineers will be invited to attend a one-week course there. A typical programme may include instrumentation, computer peripherals, programming, control work, modelling, computer and equipment purchasing, practical work with the acetone plant, and process control in the mineral-processing field.

Automation Advisory Centres

The Ministry of Technology is to support the setting up of a number of permanent advisory centres throughout the U.K. as part of the 'Approaching Automation' drive to encourage industry, particularly the smaller firms, to make greater use of low-cost automatic control devices. The centres will mainly be based on universities and technical colleges.

The centres will be used to demonstrate low-cost automation techniques to industrial management and to provide engineers with short courses and advice on practical applications. The lecturers staffing the centres will be available for consultation and will be prepared to visit firms to study problems and to carry out experimental or design work where required. The laboratory facilities in each centre will be available at the discretion of the university or college to engineers who lack their own experimental facilities.

PERSONAL NEWS

The Institution of Electrical Engineers has elected to honorary fellowship **Sir Josiah Eccles, C.B.E., D.Sc., C.Eng., M.I.C.E., M.I.Mech.E., F.I.E.E.,** for service to the electrical supply industry. Also elected as an honorary fellow was **Sir Bernard Lovell, O.B.E., F.R.S.,** for his work in radio astronomy. The 45th award of the Faraday Medal has been made to **Professor H. E. M. Barlow, Ph.D., B.Sc.(Eng.), C.Eng., M.I.Mech.E., F.I.E.E., F.R.S.,** for work in microwave engineering.

H. N. Pemberton, C.Eng., has become the chairman of the Council of Engineering Institutions. He succeeds **Sir Robert Wynne-Edwards, C.B.E., D.S.O., M.C., M.A., C.Eng.,** who has retired.

C. F. Machin, B.Sc., F.Inst.P., has been appointed a director of Mullard Ltd. He continues as head of the Mullard industrial markets division, but relinquishes his directorship of Associated Semiconductor Manufacturers Ltd.

W. H. Sternefeld has retired from the post of export consultant with the Plessey Components Group. Mr Sternefeld was previously export sales manager of the TCC capacitor division. **J. L. Montigue,** formerly assistant to Mr Sternefeld, has become the division's export sales manager.

P. R. Max, B.Sc.(Eng.), M.I.E.E., has been appointed managing director of George Kent (Australia) Pty. Ltd. Mr Max joined the George Kent Group from Cossor Electronics where he was general manager and a director of the radar division.

B. J. Hadley has been appointed deputy managing director of International Rectifier. This is in addition to his position as production director.

The board of Livingston Components has been joined by four further directors. These are **K. E. Owens,** general manager of Livingston Laboratories, **F. R. G. Webb,** who was formerly chief of inspection and test of Livingston Control and who is now general manager of the Bognor printed-circuit factory, **P. D. Davies,** production manager of Livingston Control, and **Martyn Culverhouse,** who is now sales director responsible for printed circuits and electronic components.

Two board appointments have been made by Associated Semiconductor Manufacturers Ltd., which is jointly owned by Mullard and G.E.C. **J. A. Jenkins, M.A., A.Inst.P.,** at present a director and general manager, has become the managing director, and **J. C. Akerman** of Mullard is now a director.

Texas Instruments have announced the appointment of **P. E. Haggerty** as chairman in place of **J. E. Jonsson** who has retired. Mr Jonsson will continue to serve Texas Instruments as honorary chairman and as a director. **Mark Shepherd Jr.** has been elected president.

The Theta Instrument Corp. of the U.S.A. has announced the appointment of **Edward Drollinger** as European marketing director. This is a recently-created post.

Ronald Millership, Ph.D., has become general sales manager and managing director of Varian Associates. Previous to this he was general manager of Elliott Process Automation.

COMPANY NEWS

A Chair in Telecommunications Systems in the department of engineering science at the **University of Essex** is to be established following an agreement between the University and the **Post Office.** The Chair will provide teaching at both undergraduate and post-graduate levels and will conduct research in telecommunications systems engineering.

Research Electronics has been reorganized into two divisions. In future all marketing, sales, publicity, customers' enquiries and outside representation will be handled by Research Electronics (Sales) Ltd., Lee Green, Mirfield, Yorkshire. Research Electronics (Development and Manufacturing) Ltd. will be dealing with all development, manufacturing and servicing and are situated at the existing premises in Bradford Road, Cleckheaton, Yorkshire.

The **George Kent Group** has purchased from **Hawker Siddeley** the 'Pottermeter' business of **Gloster Saro Ltd.** 'Pottermeters' are liquid-flow meters and will be handled by the recently formed Pottermeter division of Kent Industrial Instruments.

The British Electrical Resistance Co. are offering, via an ex-stock sales counter and mail order department at Enfield, immediate sale or delivery of 'Regavolt' variable transformers, C.V.S. voltage stabilizers, 'Bercostat' power rheostat potentiometers and various standard control knobs. A further recently-introduced facility is a repair and replacement service for 'Regavolt' transformers by which damaged units can be immediately replaced.

Plessey and **Ansafone Holdings** have formed, as equal partners, a jointly-owned company, **Plessey Ansafone Ltd.** This will distribute the 'Ansafone' telephone answering and recording machines.

Varian Associates is to start manufacturing advanced analytical instruments and other equipment in the U.K. and it is planned to export half the production output. A 20-year lease has been taken on a factory near Edinburgh and this is to be replaced later by a permanently-owned plant.

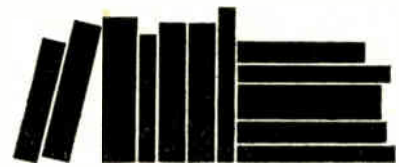
The London Electrical Manufacturing Co. (LEMCO) have changed their address to Beavor Lane, Hammersmith, London, W.6. LEMCO manufacture silver mica, ceramic, polyester, polystyrene and subminiature electrolytic capacitors.

Gawt Distributor Services are now acting as representatives for **G. A. Stanley Palmer Ltd.** and for the **Weller Electric Corp.** They will be distributing soldering and de-soldering tools for Weller Electric and are covering central England and Wales for a range of high-stability composition-film resistors and metallized-polyester capacitors produced by Stanley Palmer.

The capacitor division of **Standard Telephones and Cables** has received full qualification approval to DEF specification 5134/A-5 for their range of etched-tantalum-foil capacitors. These capacitors are miniature components of high capacitance, performance and reliability intended for use where miniaturization is an essential requirement.

The entire capital of **Cadmium Nickel Batteries Ltd.** has been acquired by the French company, **Societe des Accumulateurs Fixes et de Traction (SAFT).** SAFT, a subsidiary of **Compagnie Generale d'Electricite,** have held a minority interest in Cadmium Nickel Batteries since 1962.

NEW BOOKS



Specification for Dimensions of Pot Cores Made of Ferromagnetic Oxides for use in Telecommunication and Allied Electronic Equipment

British Standard 4061 : 1966. Pp. 17. British Standards Institution, 2 Park Street, London, W.1. Price 12s.

This Standard specifies dimensions and tolerances necessary to ensure dimensional interchangeability of two ranges of pot cores made of ferromagnetic oxides.

Range 1 is an established British design, range 2 is in accordance with the international standard given in IEC Publication 133. Dimensions of gauges for both ranges are specified.

Appendices give the method of calculation of the effective parameters of pot cores, notes on the use of the effective parameters and a list of symbols.

Eurolec GB Pocket Guide 1967

Pp. 265. Published by David Rayner Associates, 18 Pentonville Road, London, N.1. Price 32s. 6d.

This directory is a source of basic information on companies active in the electronics and instruments industry in Great Britain. The list of foreign companies forms Part 2 of the guide but the major portion of the directory is taken up with Part 1 which comprises over 1,500 entries on companies engaged in the British electronics and instruments industry and includes manufacturers, agents and distributors. All active companies are given with their addresses, telephone and telex numbers, general product lines, main divisions, parent and related companies, the names of managing director and sales contacts, distributors and principals. The entries are closely linked together with cross references to facilitate the location and background of companies.

Physical Fields

By J. KVASNICA. (English translation edited by G. A. TOOMBS, PH.D.) Pp. 184. Iliffe Books Ltd., Dorset House, Stamford Street, London, S.E.1. Price 17s. 6d.

This book covers the classical theory and general properties of the electromagnetic field, the corpuscular nature of electromagnetic radiation, the dualism of waves and particles, the representation of quantities in the quantum theory, non-relativistic and relativistic quantum mechanics and particles as field quanta. It is the second in the series 'Physics Paperbacks', which is designed to provide a comprehensive introduction to a number of advanced physics subjects for university-level students.

Japanese Miniature Electronic Components Data, 1966-67

Edited by G. W. A. DUMMER and J. MACKENZIE ROBERTSON. Pp. 461 + xxiv. Pergamon Press, Headington Hill Hall, Oxford. Price 126s.

Fifty-four Japanese manufacturers are included in this reference volume. Electrical characteristics, dimensions and other data are provided for a wide variety of components produced by these companies.

Semiconductor Devices, Volume 1 Semiconductors and Semiconductor Diodes

By MAX J. O. STRUTT. Pp. 313 + xv. Academic Press Inc. (London) Ltd., Berkeley Square House, London, W.1. Price 100s.

Based on a book entitled 'Halbleiterbauelemente, 1. Halbleiter und Halbleiterdioden' published in Switzerland in 1962, this book deals with semiconductor physics and the characteristics of various semiconductor devices.

Mathematics for Electronics Technicians

By PAUL L. EVANS. Pp. 392 + vii. John Wiley and Sons Ltd., Glen House, Stag Place, London, S.W.1. Price 56s.

The basic mathematics, up to elementary calculus, required by electronics technicians is explained in this book. The mathematics is related throughout to electronic circuitry.

Critical Path Analysis by Bar Chart

By C. W. LOWE. Pp. 188 + x. Business Publications Ltd., Mercury House, 103–119 Waterloo Road, London, S.E.1. Price 45s.

Critical path analysis of an industrial process or operation can result in large time savings. This book describes one method of critical path analysis and provides examples of its use.

Introduction to Instrument Transformers

By BRIAN D. JENKINS. Pp. 282 + xiv. George Newnes Ltd., Tower House, Southampton Street, London, W.C.2. Price 50s.

Both current transformers and voltage transformers are dealt with in this book. Basic theory, design approach, types of construction, materials used, testing and the use of instrument transformers in measuring and protective circuits are explained with a minimum of mathematics.

Selected Papers 11, PAL, a Variant of the NTSC Colour Television System

By DR. W. BRUCH et al. Telefunken AG, 1 Berlin 10, Ernst-Reuter-Platz 7, Germany. Price DM 6.00.

A special edition of Telefunken-Zeitung, this book contains 13 papers on different aspects of the PAL colour television system.

Modelle und Ersatzschaltungen von Halbleiterdioden

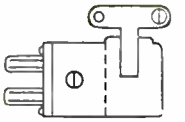
By W. WUNDERLIN. Pp. 64. Birkhäuser Verlag, 4000 Basel 10, Switzerland. Price sFr 9.50.

Introduction to Diophantine Approximations

By SERGE LANG. Pp. 83 + viii. Addison Wesley Publishing Co. Inc., 10–15 Chitty Street, London, W.1. Price 54s.

Introduction to Transcendental Numbers

By SERGE LANG. Pp. 105 + vi. Addison Wesley Publishing Co. Inc., 10–15 Chitty Street, London, W.1. Price 60s.



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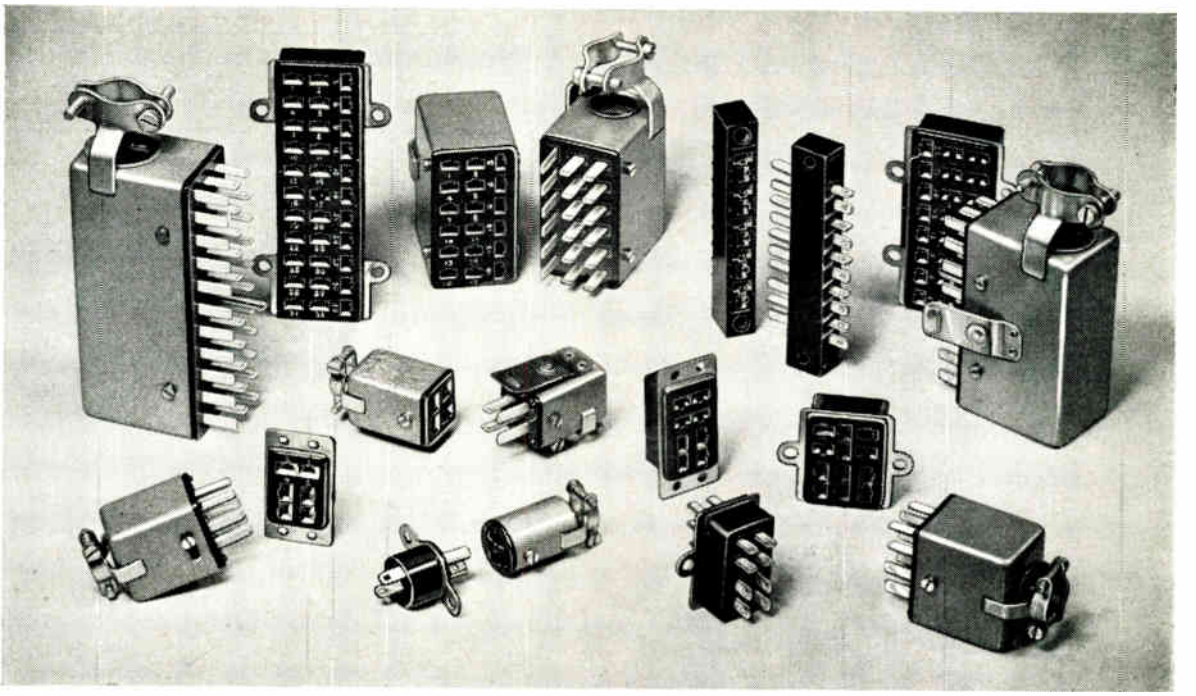

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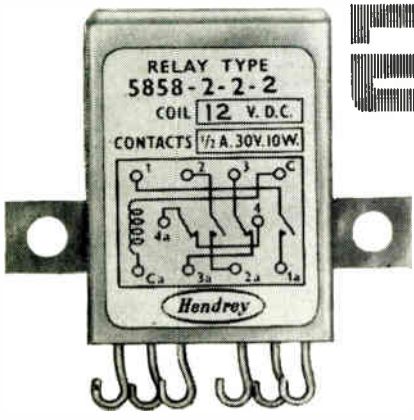

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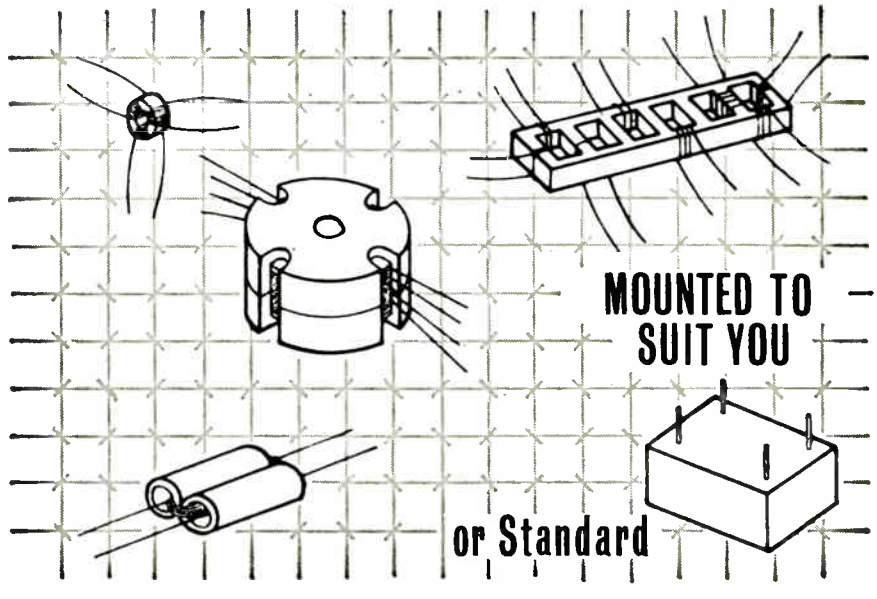

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A. N. Gavrilov, *Institute of Automation and Telemechanics, U.S.S.R. Academy of Sciences, Moscow.*
Translated from the Russian by L. Herdan.

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D. M. Kerns and R. W. Beatty, *U.S. Department of Commerce, National Bureau of Standards, Boulder, Colorado.*

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For further information circle No. 246

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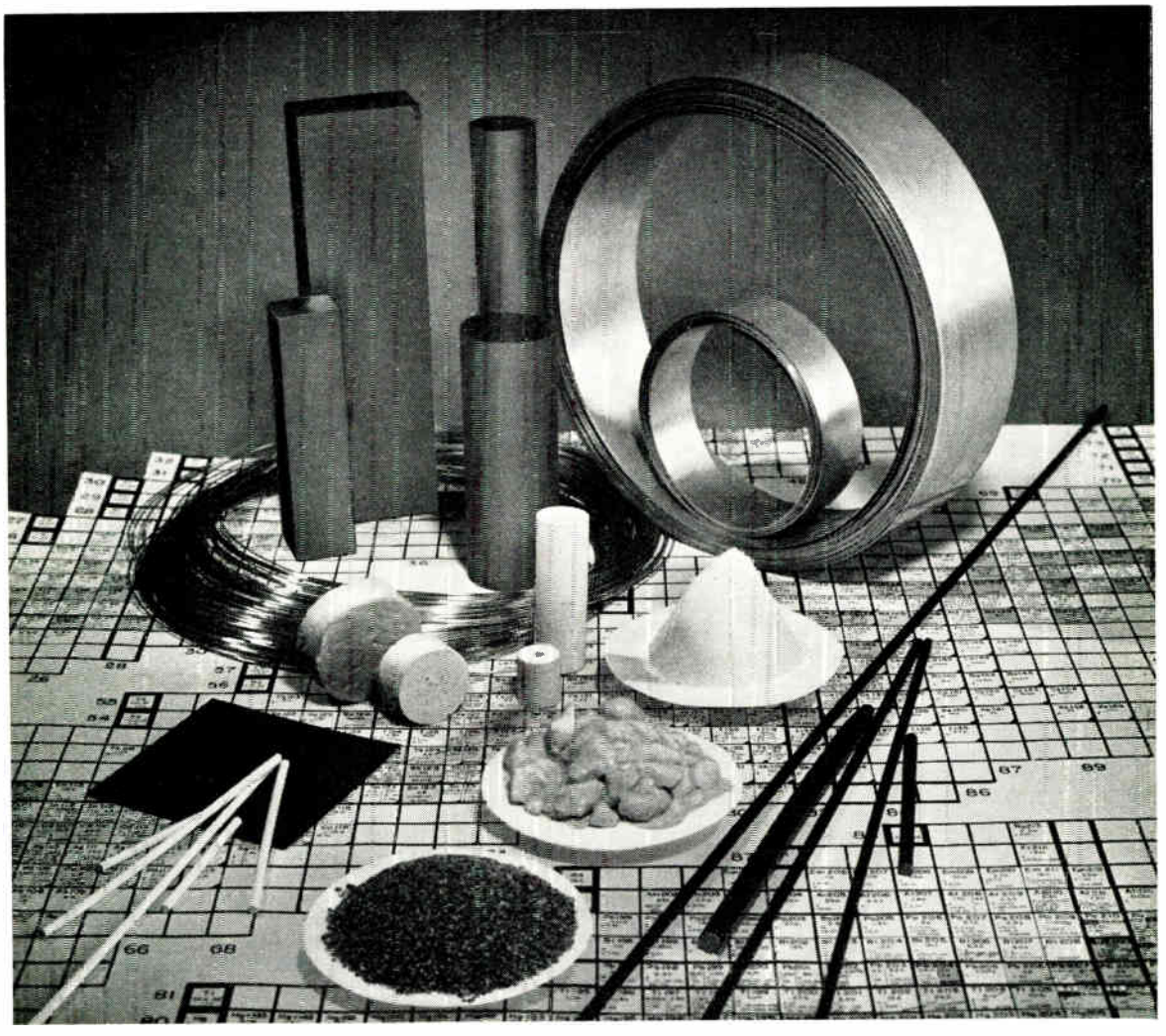

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For further information circle No. 260

WHAT'S ON AND WHERE

Meetings

The Institution of Electronic and Radio Engineers

8–9 Bedford Square, London, W.C.1. (Phone: Museum 1901–3).

2nd March, 7.15 p.m. Lecture on 'Solid-State Devices', to be given at Birmingham University.

8th March, 6 p.m. Lecture on 'Time-Sharing Computer Systems', to be given at the Institute of Mining and Mechanical Engineers, Newcastle.

9th March, 7.30 p.m. Lecture on 'Made-to-Measure Integrated Circuits', to be given at Farnborough Technical College.

14th March, 7 p.m. Lecture on 'Advances in Laser Technology', to be given at the Cornwall Technical College, Cambourne.

21st March, 6.30 p.m. Lecture on 'Electronic Equipment Design', to be given at the University of Southampton.

21st March, 7.30 p.m. Joint meeting with the British Computer Society on 'An Introduction to Microcircuitry', to be given at Bristol University.

The Institution of Electrical Engineers

Savoy Place, London, W.C.2. (Phone: Covent Garden 1871).

All meetings are held at Savoy Place and begin at 5.30 p.m. (tea at 5 p.m.) unless otherwise stated.

27th February. Lecture on 'Storage Systems for Telephone Switching'.

2nd March. Joint discussion meeting with the I.Mech.E. on 'Control—A Unifying Force in Engineering Education'.

6th March. Lectures on the 'U.H.F. Tunnel-Diode Amplifier' and 'Short-Hop Radio-Relay Systems using Tunnel-Diode Repeaters'.

7th March. Lecture on the 'Overall Station Control at Hunterston'.

10th March. Lecture on 'Broadband Transmission by Radio and Cable'.

10th March. Discussion meeting on 'The Future Education of Electronic Engineers'.

14th March. Discussion meeting on 'High-Power Thyristor Invertors for Standby A.C. Power Supplies'.

15th March, 6 p.m. Lecture on 'Ergonomics in Electronic Equipment and Systems Design'.

16th March, 2.30 p.m. Joint discussion meeting with the I.E.R.E. on 'Automatic Processing in Nucleonic Isotope Studies'.

21st March, 6 p.m. Discussion meeting on 'Rapid Fault Diagnosis of the Future'.

22nd March. Lecture on 'The Theory of Oscillators'.

Society of Electronic and Radio Technicians

33 Bedford Street, London, W.C.2. (Phone: Covent Garden 1152).

1st March, 7.15 p.m. Lecture on 'Computer Storage Systems', to be given at the Charles Trevelyan Technical College, Newcastle-upon-Tyne.

16th March, 7.30 p.m. Lecture on 'Lasers and their Applications', to be given at the Southampton College of Technology.

23rd March, 7.30 p.m. Lecture on 'Electronics in Photography', to be given at the Llandaff Technical College, Cardiff.

The Institution of Electrical and Electronics Technician Engineers

26 Bloomsbury Square, London, W.C.1. (Phone: Langham 5927).

1st March, 7.30 p.m. Lecture on 'Thyristor Convertors', to be given at the University of Durham.

9th March, 7.30 p.m. Lecture on 'The Future of Electricity Supply', to be given at the Carlton Hotel, Bournemouth.

13th March. Lecture on 'Recent Development in Education and Training Aids', to be given in the I.E.E. lecture room.

14th March, 8 p.m. Lecture on 'The Future of Aluminium in the Electrical and Radio Industries', to be given at the Guildhall, Plymouth.

Society of Instrument Technology

20 Peel Street, London, W.8. (Phone: Park 3755).

28th February, 6 p.m. Lecture on the 'Control of Distillation Columns', to be given at Manson House, Portland Place, London, W.1.

8th March, 6 p.m. Lecture on 'Computer Control of Chemical Processes', to be given at Manson House, Portland Place, London, W.1.

8th March, 7 p.m. Lecture on 'Digital Control Systems Applied to In-Line Blending', to be given at the Birmingham Chamber of Commerce.

15th March, 7.15 p.m. Lecture on 'Closed-Circuit Television', to be given at the Claremont Hotel, Blackpool.

WHAT'S ON AND WHERE
CONTINUED

16th March, 6.45 p.m. Lecture entitled 'Can We Improve on Three-Term Control?', to be given at the Manchester Literary and Philosophy Society, 36 George Street, Manchester 1.

30th March, 7.30 p.m. Lecture on 'Lasers', to be given at Stanley Palace, Watergate Street, Chester.

Exhibitions

7th–9th March, Melton Mowbray
Exhibition of 'Inspection and Testing Equipment', organized by the Production Engineering Research Association, Melton Mowbray, Leicestershire.

13th–17th March, London
The LABEX international exhibition of laboratory apparatus and materials. Further information from Peter Brooks Associates, 65 Victoria Street, London, S.W.1. (Phone: Abbey 6905).

13th–17th March, London
International Medical Engineering and Automation Exhibition, to be held at Earls Court and sponsored by the Electronic Engineering Association and the Scientific Instrument Manufacturers' Association. Further details from Industrial Exhibitions Ltd., 9 Argyll Street, London, W.1. (Phone: Gerrard 1622).

15th–17th March, Middlesbrough
Exhibition of Industrial Instrumentation and Control Equipment, to be held in the Middlesbrough Town Hall. Organized by Planned Exhibitions Ltd., 10 Carver Street, Sheffield 1.

5th–10th April, Paris
International Exhibition of Electronic Components, to be held at the Porte de Versailles. Details from S.D.S.A.—Relations Exterieures, 16 rue de Presles, 75 Paris 15e.

11th–14th April, Manchester
Industrial Training Exhibition and Symposium, to be held at the Manchester College of Science and Technology. Organized by John Clarke Ltd., 11–13 Bridge Street West, Manchester 3.

14th–21st April, Paris
The Third 'Mesucora' Exhibition and Congress on Measurement, Testing, Control and Automation. To be held in the Palais de la Défense, and organized by Mesucora, 23 rue de Lubeck, 75 Paris 16e.

17th–20th April, London
The Physics Exhibition, organized by the Institute of Physics and The Physical Society. (Phone: Belgravia 6111).

29th April–7th May, Hanover
The 21st International Hanover Fair of industrial products. Further details from Schenkers Ltd., 13 Finsbury Square, London, E.C.2. (Phone: Metropolitan 9711).

Conferences, Symposia and Colloquia

1st March, 9.30 a.m. Colloquium on 'Colour Cameras', to be held at the I.E.E. Organized jointly by the I.E.E., the I.E.R.E., the I.E.E.E. and the Royal Television Society.

2nd March. Symposium on 'Computers in the Textile Industry'. To be held in Manchester and organized by the Textile Institute, 10 Blackfriars Street, Manchester 3.

6th March, 10 a.m. Conference on 'Making the Bosworth Report Work', to be held at the I.E.E. Organized jointly by the Ministry of Technology, the Council of Engineering Institutions and the I.E.E.

13th–15th March. Seminar on 'Non-Destructive Testing', to be held in Bescia, Italy. Further details from the organizers, P. Le R. Morandi 2, Milan, Italy.

13th–17th March. Conference on 'Air Traffic Control Systems Engineering and Design', to be held in London and organized by the I.E.E. (Phone: Covent Garden 1871).

14th–17th March. Second European Symposium on Medical Electronics, to be held at Earls Court during the Medea 67 Exhibition. Sponsored by *World Medical Electronics*, 4 Mill Street, London, W.1.

16th March, 9.30 a.m. Symposium on the 'Presentation of Data', to be held at the Town Hall, Middlesbrough. Organized by the Society of Instrument Technology, 20 Peel Street, London, W.8. (Phone: Park 3755).

20th March, 2.30 p.m. Colloquium on 'Automation in Cartography', to be held at the I.E.E., Savoy Place, London. W.C.2. Organized jointly by the Royal Society, the I.E.E. and the I.E.R.E.

30th–31st March. Conference on the 'Transport Properties of Superconductors', to be held at the University of Kent, Canterbury. Organized by The Institute of Physics and The Physical Society, 47 Belgrave Square, London, S.W.1. (Phone: Belgravia 6111).

3rd–5th April. Conference on the 'Resistive and Dielectric Properties of Thin Films', to be held in Nottingham. Organized by The Institute of Physics and The Physical Society, 47 Belgrave Square, London, S.W.1. (Phone: Belgravia 6111).

3rd–7th April. International Conference on 'Education for Scientific Information Work', to be held in London. Further details from ASLIB, 3 Belgrave Square, London, S.W.1.

5th April. Conference on 'Quality and Reliability and the Technician Engineer'. Organized by the I.E.E.T.E. (Phone: Langham 5927) and to be held at Queen Mary College, University of London, E.1.

Courses

Fluidics
A three-day course on fluidics is to be held at the University of Birmingham from 3rd–5th April. It is intended to provide an introduction to the theoretical and practical aspects of both fluidic components and circuits that are suitable for low-cost automation. Further information may be obtained from the Organizing Secretary, Fluidics Course, Department of Mechanical Engineering, The University, Edgbaston, Birmingham 15.

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INDUSTRIAL ELECTRONICS

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Buyers' Guide no.1

March 1967

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MARCH 1967

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Future Industrial Electronics Supplements

No. 2—JUNE—Component Show Preview and Guide.

No. 3—SEPTEMBER—Modular Electrical Power Supplies.

No. 4—DECEMBER—Closed-Circuit Television.

electronic batch counters

BATCH counters are basically units which automatically count objects passing a detection device. They indicate or initiate control of external machinery when the number of objects counted reaches a preselected number. They are used on conveyor belts and with several other types of automatic machinery to sort objects into batches at speeds and with accuracies unobtainable with manual methods.

In operation, as each object passes the detector, an electrical impulse is sent to the counter to advance the count registered in the instrument by one. The required number for each batch is set by an operator using numbered rotary switches or push-buttons situated on the front panel of the unit. While some counters display the set number on a numerical readout and count until this display reads zero (backward-counting units), most are forward counting; i.e., they count from zero until the counted number corresponds to the set number. A few of the counters available only indicate the count as it proceeds and an operator is required to initiate the required control action when the counter indicates that the set number has been reached. Some of these counters need to be reset manually before recommencing the count but others reset automatically.

Counters with Control Facilities

Most of the batch counters produced incorporate some means of controlling external machinery at the end of each batch count. This facility enables batches to be automatically separated and allows other functions to be performed which may be impossible to perform manually. Frequently built-in relays are used for this, the contacts opening or closing at the end of the batch count. Other units produce a voltage output for energizing an external relay or other equipment and a few combine both a built-in relay with the provision of an output voltage. An added feature on many counters is the operation of a relay or the production of an output at a set number before the end of the batch. This is referred to as pre-batch control, pre-batch contact-closure etc., and compensates for time lags between the instant at which the last object of a batch passes the detector and the instant at which the controlling mechanism operates. Some sophisticated equipments can be set to produce outputs at more than one setting in addition to the output produced at the end of the count.

Most of these controlling batch counters incorporate a display of the count as well as producing an output. Some less complex units produce the control output alone without providing a visual indication of the count.

Sometimes incorporated is a unit known as a totalizer. This is used either to register the total number of objects counted or to register the total number of batches counted.

One of the main types of indicator used for the display of the count is the neon digit tube which contains illuminated numerals. Another common type is the

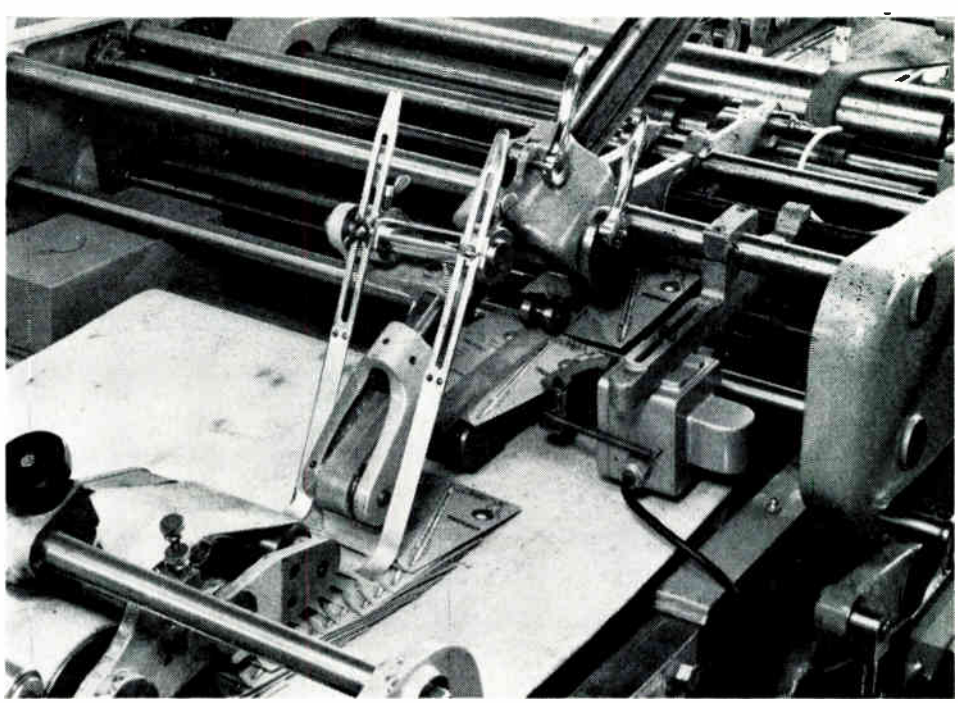


Fig. 1. The 'kicker' shown in the centre of this picture of part of a 'Hunter' cardboard carton folding and glueing machine produced by the SOAG Machinery Co. is controlled by a batch counter to deflect one carton at the end of each batch. The counter also records the total number of batches counted (420)

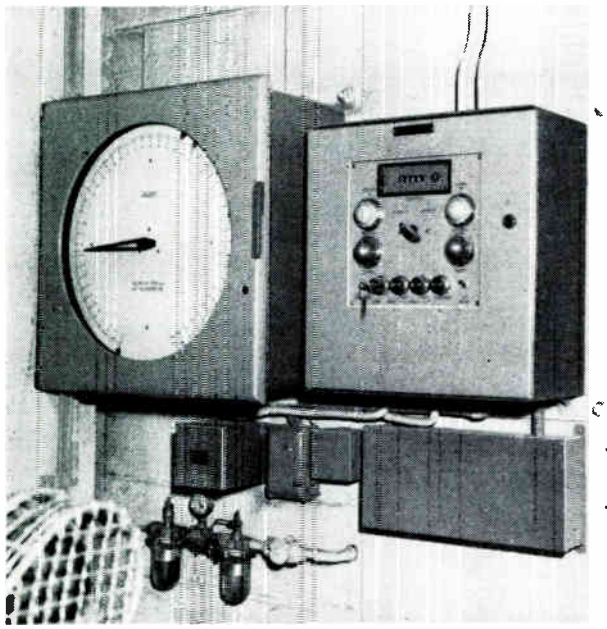


Fig. 2. This shows part of the equipment produced by Elliott Brothers (London) Ltd. and used in an automated bakery. In this type of application, batches of materials are weighed and the number of batches recorded on a counter (421)

Dekatron tube. This is a neon tube which indicates numbers by using a spot of light which moves round the numbered periphery of the tube. Electromagnetic counters are also used and are nearly always employed for the totalizers.

Detectors

Various types of detectors can be used with batch counters. Mechanical switches are among these and would be situated on a machine so that a lever or a button is actuated by the objects as they move by or over it and open or close switch contacts. Capacitive and inductive proximity detectors are another type. These are connected into an electronic circuit so that a current or voltage change occurs when an object of suitable material passes near the detector head. This causes an output to be produced by the circuit which can operate a counter. Photoelectric detectors which depend for their operation on a light beam being broken or deflected by passing objects are also used. A similar type is the ultrasonic detector which utilizes high-frequency sound waves instead of a light beam.

Applications

A typical application is illustrated in Fig. 1. This shows part of a folding and glueing machine produced by the SOAG Machinery Co. and used in the manufacture of cardboard cartons. A batch counter, which can be set for batches of 25, 50 or 100 cartons, counts each carton as it passes a photoelectric detector. On completion of each count, the counter produces an output to operate the 'kicker' shown in the centre of the picture. The kicker deflects one carton to indicate to an operator the end of each batch.

Another application is the blending of foodstuffs and similar materials. The required amount of each material can be set on counters which will automatically ensure that the correct quantities are fed into a mixer. A similar application in a bakery is shown in Fig. 2.

Batch counters are also used to control the numbers of products being dispensed into containers. With the use of vibratory feeders, small objects, such as nails and screws which may be difficult to handle, can be quickly and accurately fed into packets and boxes in the correct amounts. Decca Radar produce a photoelectric counting system, the 'Mastercount', which is a special photoelectric detector combined with a batch counter for counting small objects (see Fig. 3).

Several other applications exist. Some manufacturers produce equipment for particular uses only but the operation of most counters renders them suitable for any situation where objects are required to be counted and sorted into groups.

The following survey gives details of many of the standard batch counters available on the U.K. market.

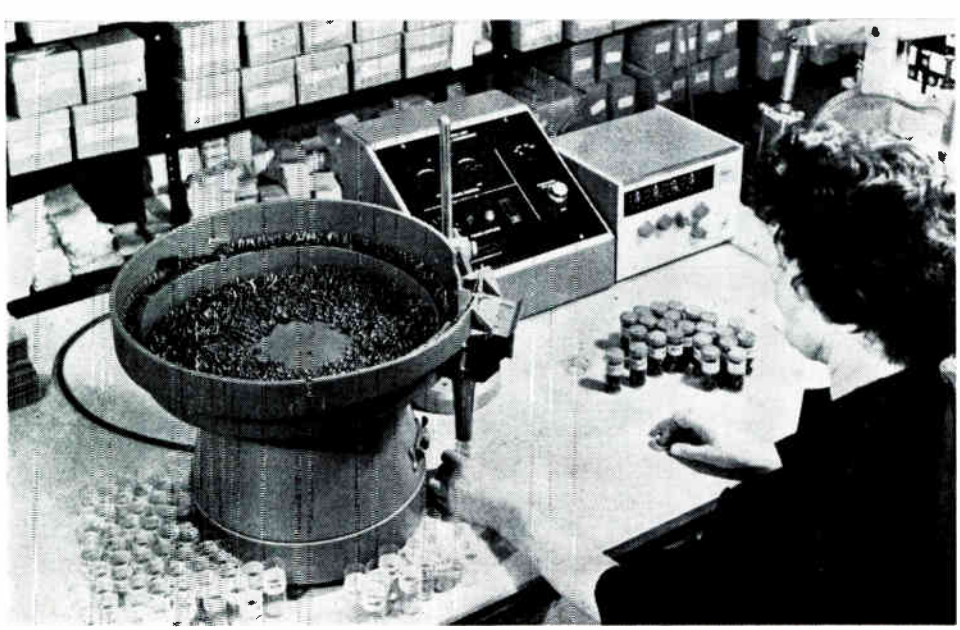


Fig. 3. Here the Decca 'Mastercount' system can be seen being used to count small nails as they are fed into containers and to control the number which goes into each (422)

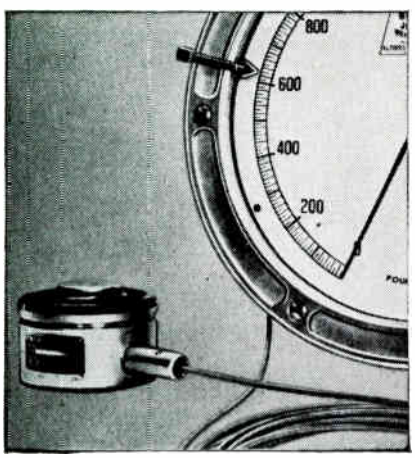
batch counters at-a-glance

This table of brief specifications is followed by more detailed accounts of each item

Manufacturer or Distributor	Model or Type Number	Number of Decades	Counting Speed or Input Frequency	Output	Features	Reply Card Number
Advance Controls Ltd.	Type 3	3, 4 or 5	5 kc/s for sinewave or pulse inputs. 50 c/s for reed switches	Relays	Count display. Pre-batch on some models	423
	Type 4	2, 3, 4 or 5 with display. Up to 10 without display	100 kc/s for sinewave or pulse inputs. 50 c/s for reed switches	Voltage output. Relays available	Count display. More than one pre-batch setting possible	424
Airmec Ltd.	Type N256	Up to 5	3,500 per sec	Relay	Count display. Pre-batch output	425
Bendix Electronics Ltd.	Series 392	2, 3 and 4	350 counts per sec	Relay	Count display. Pre-batch output optional extra	426
	Type 487	4	30,000 counts per sec	Relay	Count display optional. Batch totalizer available	427
Darang Electronics Ltd.	'Digicron' range	2, 3, 4 and 5	1,500 counts per sec	Relay	Count display. Pre-batch output. Batch totalizer optional extra	428
D.E.B. Electronics Ltd.	Modular batch counter	As specified by customer	50 kc/s	12-V pulse	Count display. Pre-batch output	429
Electrical Apparatus Co. Ltd.	Industrial counters	Up to 4	1,000 counts per sec		Count display	430
Electronic Controls Co.	Type HSBC	2	1,000 counts per sec	Relay	Count display. Batch totalizer and count-rate meter included	431
	TBC range	6	20 counts per sec	Relay	Count display. Pre-batch on some models	432
Elesta Electronics represented by Britec Ltd.	Type CP	4	100,000 counts per sec	Voltage	Count display	433
	CPT 1C CPT 2C	4 or 5	100,000 counts per sec	Voltage	Count display. Pre-batch on CPT 2C	434
Flight Refuelling Ltd.	RSC 50	5	500 counts per sec	Voltage	Count display. Pre-batch output	435
Gelma represented by Inglis Knibb & Co.	Type 600	2, 3 or 4	3,000 per sec	Relays	Count display optional. Up to 5 settings for pre-batch and end of batch outputs	436
J. Hengstler Company Great Britain Ltd.	1000 series	3, 4, 5 or 6	100,000 counts per sec standard, 1,000,000 counts per sec available	Relay, reed relay or voltage	Count display. Batch totalizer available	437
Hewlett-Packard Ltd.	Model 5214L	5	2 c/s to 300 kc/s	Voltage	Count display	438
Hird-Brown Ltd.	PD1, PD2, PD3 and PD4	6	1,500 counts per min for PD4. 240 per min for others	Relays	Count display. Totalizer included for total number of items	439
Industrionics Controls	'Watesta' Type 201	4	100,000 per sec	Voltage		440
	'Watesta' Type 701	4 or 5	100,000 per sec	Voltage	Count display. Pre-batch output	441
Jiskoot Autocontrols Ltd.	Type HS	4, 5 or 6	100,000 counts per sec	Relay	Count display. Pre-batch optional	442

Your questions answered

WEIGHT?



Hydrostatic Weighing Unit

This unit has been developed to cover a wide field of industrial weighing applications.

The basic unit consists of a completely sealed hydrostatic load cell connected to a Bourdon tube load indicating gauge by means of a flexible metallic capillary. Loads of 100 lbs. to 100 tons may be displayed on gauges ranging in size from 4" to 24" diameter. The gauge may be located up to a maximum distance of 200 ft. away from the load cell. Accuracy is better than ± 0.5% of scale capacity.

ANGLE?

Minitac Optical Shaft Encoder

The Minitac incremental encoder provides the means of determining precisely the angular position of a shaft, its angular velocity and acceleration.

The output from the encoder is sinusoidal corresponding to discrete angular increments of shaft position. Direction of rotation is also sensed enabling the encoder to be used in digital control systems. Various resolutions are available to suit specific applications.

TOTAL?

Bi-directional Electronic Counter

Designed principally for use with shaft encoders this counter is equally applicable to any linear device giving a serial output. A bank of numerical display tubes are arranged to provide any number of decades. The instrument counts up to any pre-arranged maximum after which the next positive pulse resets the display to zero. A similar sequence follows when negative pulses are applied. A zero setting button enables the counter to operate with the encoder in any selected position.

Any of these individual units may be incorporated in the users system or combined to form the basis of a digital control system in a wide field of applications.

Don't hesitate to send for the technical data sheets, or ask us about your particular needs—that's what we are here for.

Brown

S. G. Brown Limited Chiswick Division: Devonshire Works, Dukes Avenue, Chiswick, London, W.4. Tel: CHI 7494.

A HAWKER SIDDELEY COMPANY

For further information circle No. 402

Manufacturer or Distributor	Model or Type Number	Number of Decades	Counting Speed or Input Frequency	Output	Features	Reply Card Number
Kappa Electronics Ltd.	Model FJ15 Model FJ35	6	1,500 per min. 500 per sec	Relay Relay	Count display Set for batches of 25, 50, 75 or 100, or any four numbers between 1 and 160	443 444
Londex Ltd.	Type EBC	4	2,000 per sec	Relay	Count display. Can be supplied with photoelectric detector	445
Parkinson Cowan Measurement	Preset batch controller	6	20 per sec	Relay	Count display. Totalizer for total number of items	446
	Variable batch controller	4	40 per sec	Relay	Count display. Pre-batch output. Totalizer for total number of items	447
Photain Controls Ltd.	'Binadic' range	2, 3 or 4	3,000 per sec. Higher speeds available	Voltage or relay	Count display optional. Pre-batch available. Batch totalizer available	448
	Type BCM	6	1,500 per min.	Voltage	Count display. Available with photoelectric detectors	449
Research Electronics (Sales) Ltd.	Model 6202B	4	2,000 per sec, 5,000 per sec available	Relay	Count display	450
Smiths Industries Ltd.	Digital batch counters	4	10 kc/s	Relay	Count display. Pre-batch. Batch totalizer available	451
Thorn Electronics represented by M.L. Industrial Products Ltd.	Type CB23	4	Sinewave 25 c/s to 10 kc/s. Positive pulses up to 5 kc/s. Negative pulses up to 10 kc/s. Switch contacts 10 counts per sec	Relay		452
Veeder-Root Ltd.	'Digimaster' range	Up to 6	50,000 counts per sec	Relay	Count display on most models. Pre-batch on some models. Totalizers available	453
Venner Electronics Ltd.	Type TSA 5545	5	10 c/s to 2 Mc/s		Count display	454

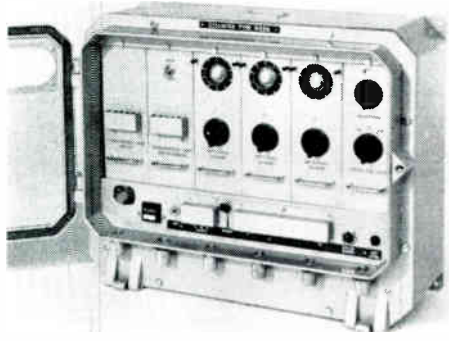
For further information on specific counters circle the appropriate Service Card number

The Advance Controls type 3 batch counter can be used with sinewave or pulse inputs at frequencies up to 5 kc/s as well as with reed switches operating at up to 50 c/s. Three, four and five-decade versions are available and models which count forwards up to a set number or backwards from a set number down to zero can be obtained. Outputs are provided by internal relays and the backward-counting types include pre-batch output relays. Each type incorporates a display of the count.—*Advance Controls Ltd., Cirencester Road, Charlton Kings, Cheltenham, Gloucester (Phone: Cheltenham 23591).*

For further information circle No. 423

Advance Controls' type 4 batch counter can be supplied with up to five decades with a display of the count or up to 10 decades without a display. A 10-V output pulse is produced at the end of each batch and separate output relay units are available. Versions are produced for counting up to a set number or counting down from a set number to zero. Sinewave inputs can be used as well as pulsed inputs at up to 100 kc/s. Reed-switch contacts operating at up to 50 c/s can also be used to produce an input. The unit can be supplied with more than one

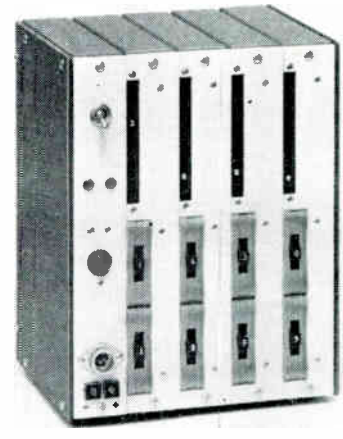
The Advance Controls type 3 counter, this being a four-decade backward counting version with a pre-batch setting



Airmec's type N256 industrial counter

The Bendix batch counter type 487

Darang Electronics' electronic batch counter type 667A



The D.E.B. Electronics' batch counter

One of the Electrical Apparatus Company's industrial batch counters

number setting to provide outputs during a count.—*Advance Controls Ltd., Cirencester Road, Charlton Kings, Cheltenham, Gloucester (Phone: Cheltenham 23591).*

For further information circle No. 424

The industrial counter (type N256) from Airmec is suitable for counting and batching processes, and provides facilities for operating associated equipment; its maximum counting rate is 3,500 per sec, resetting being automatic at the end of each batch. Counting is performed by 'Dekatron' tubes, and their input may be derived from non-contacting switches, photocells or magnetic probes. Of modular construction, the instrument is made up of five types of plug-in unit: a divider unit (for straightforward counting), a batching divider (for batch counting) and three special-facility units. Up to six divider units may be used (to indicate counts up to 999,999), or up to five batching dividers (to give a maximum batch count of 99,999); when batching, an output contact-closure may be obtained at any preselected number before the end of the batch. Available from *Airmec Ltd., Industrial Control Division, High Wycombe, Bucks. (Phone: High Wycombe 21201).*

For further information circle No. 425

The Bendix series 392 range of counters includes three units which offer maximum counts of 99, 999 and 9,999 respectively. Designed for use with photocells or switch contacts, the maximum input rate is 350 pulses per sec. Rotary switches are used to set the batch number and both a digital readout and an output contact closure are provided. Automatic resetting and repetition of the batch count is featured and pre-batch contact closure is available as an optional extra. Spurious counts, which may occur when counting irregularly-shaped objects, are eliminated by suppression of the input for a fixed period after the reception of each input pulse.—*Bendix Electronics Ltd., High Church Street, New Basford, Nottingham (Phone: Nottingham 75115).*

For further information circle No. 426

The Bendix batch counter type 487 has a maximum batch count of 9,999, the number required for each batch being set on four rotary switches. At the end of each batch one normally-open and one normally-closed set of contacts is operated and on the standard instrument a display of the count is not included. A meter recording the number of batches counted can be fitted. The maximum input rate of this unit is 30,000 counts per sec.—*Bendix Electronics Ltd., High Church Street, New Basford, Nottingham (Phone: Nottingham 75115).*

For further information circle No. 427

The 'Digicron' range of batch counters from Darang Electronics includes two, three, four and five-decade types, with optional variations such as an electro-mechanical batch-total indicator. They can be supplied either to count down or count up at rates up to 1,500 per sec, and there are 24 different models in the standard range. The type 667A is a four-decade model with batch total indicator, with which single-batch counting or automatic repeat without loss of count is possible. Main-batch selection is by 10-way rotary switches, and an electrical interlock prevents an incorrect count should the selection switches be operated while a batch is being counted; the pre-batch relay operates at the pre-selected number of counts before completion of the batch, and releases on zero.—*Darang Electronics Ltd., Restmor Way, Hackbridge Road, Hackbridge, Surrey (Phone: Franklin 1140).*

For further information circle No. 428

D.E.B. Electronics' latest batch counter features a modular construction so that it can be supplied with a specified number of digits and extra digits added later if required. Operating at input frequencies up to 50 kc/s, it produces an output pulse of 12 V at 0·5 A. Thumb-wheel switches are used for selection of the batch number and the pre-batch number can be set with a second row of switches. A digital display of the count is provided.—*D.E.B. Electronics Ltd., New Barnes Mill, Cotton Mill Lane, St. Albans, Herts. (Phone: St. Albans 55612/59848).*

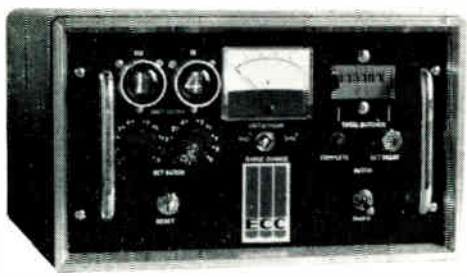
For further information circle No. 429

Batch-counter equipment from the Electrical Apparatus Company is compatible with their 'Solicon' solid-state logic systems and power-switching for industrial-control applications. Forward and reverse counting is possible, with speeds of 1,000 sequences per sec for interference-free operation, and a coincidence switch selector is provided for sequence-switching operation. Available from *The Electrical Apparatus Co. Ltd., New Barnes Avenue, Mile House Lane, St. Albans, Herts. (Phone: St. Albans 54461).*

For further information circle No. 430

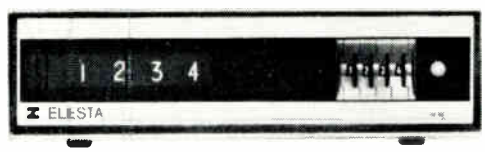
The Electronic Controls Co. produce a batch counter type HSBC which incorporates a two-digit display of the count, a totalizer recording the total number of batches and a count-rate meter which displays counts per hour. This last item can be used to provide an indication of the running speed of the machine with which the counter is being used. With a maximum counting rate of 1,000 counts per sec, the unit is intended for use with photoelectric or switch-contact detectors. An output relay is fitted and the closing time of the contacts can be varied from 0–1 sec. Available for use with the unit are a photoelectric detector and a 'kicker' for use in the batching of cardboard cartons and similar items.—*The Electronic Controls Co., Electron House, Ooze Wood Road, Royton, Oldham, Lancs. (Phone: Main 7309).*

For further information circle No. 431



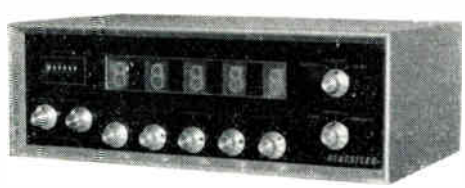
The type HSBC batch counter produced by the Electronic Controls Co.

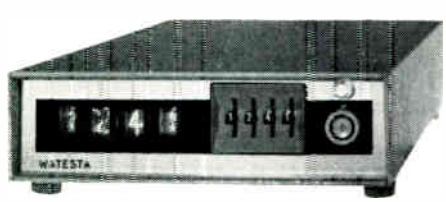
Elesta Electronics' type CPT 1C universal counter



The Gelma controller counter type 600

A unit in the Hengstler 1000 series





Industrionics Controls' type 701 batch counter

The Electronic Controls' TBC range of transistorized preset counters are suitable for batch counting applications where counting speeds up to 20 counts per sec are required. A wide range of photoelectric detectors is available for use with this unit. Six digits are provided and the instrument is obtainable in various forms. All types use a replaceable electromagnetic counter for display of the count. The TBC/M is available with a set of output changeover contacts and is manually reset. Other versions offer automatic resetting and batch totalizers. The type TBC/E2 is equipped with two counters, each of which operate separate relays for pre-batch control and other purposes.—*The Electronic Controls Co., Electron House, Ooze Wood Road, Royton, Oldham, Lancs. (Phone: Main 7309).*

For further information circle No. 432

Elesta Electronics' four-decade preselecting counter type CP provides both a numerical display of the count and output voltages for control of relays and other devices. Set for the required batch number with the use of four thumb-wheel switches, this unit can be used with various types of input and operates with a maximum count rate of 100,000 per sec. Automatic and manual resetting and resetting by an externally-generated signal are all possible. It is available in the U.K. from *Britec Ltd., 17 Charing Cross Road, London, W.C.2. (Phone: Whitehall 3070).*

For further information circle No. 433

The Elesta Electronics universal counters types CPT 1C and CPT 2C can be supplied with four or five decades. Both are set by use of thumb-wheel switches and the 2C has an extra set of switches for setting of the pre-batch control function. Output voltages are produced at the end of each count and the unit can be reset automatically, manually or by externally-generated pulses. A maximum count rate of 100,000 counts per sec is quoted and various types of input devices can be used. The U.K. distributors are *Britec Ltd., 17 Charing Cross Road, London, W.C.2. (Phone: Whitehall 3070).*

For further information circle No. 434

The RSC 50 batch counter from Flight Refuelling has been designed for industrial applications, having a count capacity of 99,999 and a maximum count rate of 500 p.p.s. Reset to zero can be effected at any number within the count capacity by thumb-wheel selection switches, reset button or external reset; a second set of thumb-wheel switches enables a signal output to be obtained at the preset number. Each digit of each decade is wired to a multi-way connector on the rear of the counter in order to obtain additional control signals if required. Available from *Flight Refuelling Ltd., Industrial Electronics Division, Wimborne, Dorset. (Phone: Wimborne 2121).*

For further information circle No. 435

The Gelma controller counter type 600 can be equipped to operate relays at up to five preset numbers. Automatic as well as manual resetting facilities are provided and the number of repetitions of a complete counting sequence can be set at 1 to 10, an infinity setting also being provided. The interval between successive repetitions can also be adjusted. Various types of detectors can be used and an added feature is that the signals from the detector are automatically checked to prevent the counter being triggered by spurious signals. Available with two to four decades, the unit has a counting rate of 3,000 per sec. It can be obtained in the U.K. from *Inglis Knibb and Co., 17a London Road, Bromley, Kent. (Phone: Widmore 5764).*

For further information circle No. 436

The Hengstler 1000 series range of batch counters can be supplied to special order with a maximum counting rate of 1,000,000 per sec although the standard counting rate is 100,000. Three-, four-, five- and six-digit versions are available and a row of rotary switches beneath the in-line readout is used to set the required batch number. Three types of input can be used: closing contacts, photo-diodes or similar devices which produce a variation in resistance when an object passes by, and devices which produce a voltage output as each object passes. Also three types of output are available: a changeover relay, a reed relay, or a positive voltage pulse of 11 V. The unit is reset manually, automatically or with the use of external contacts. A special feature is a built-in battery which ensures continual operation in the event of a power-supply failure. Units can be supplied with batch totalizers.—*J. Hengstler Company Great Britain Ltd., Brooker Road, Waltham Abbey, Essex. (Phone: Waltham Cross 26166/7/8).*

For further information circle No. 437

The preset counter (model 5214L) from Hewlett-Packard totalizes and measures frequency, period and such parameters as r.p.m., p.s.i. etc. It may be used for batching by using the preset function switch, since the gate signal can be used to control external equipment. Separate electrical output signals (gate coincident pulse outputs) that occur when the gate opens and closes are available at the beginning and end of the count. The gate-time can be set from 10 μsec to 1 sec, in 10-μsec, 100-μsec or 1-msec steps, and longer gate times are available up to 100 sec. Available from *Hewlett-Packard Ltd., 224 Bath Road, Slough, Bucks. (Phone: Slough 28406).*

For further information circle No. 438

Hird-Brown produce photo-electric batch-counting systems. In these, the electronic circuitry ensures that only one count is registered for each interruption of the light beam and pulse-forming circuitry provides accurate counting for different sizes of objects. Designated types PD1, PD2, PD3 and PD4, they offer batch numbers up to 999,999 and counting speeds of 240 and 1,500 per min. Output relays are used. The PD3 has an additional set of contacts which operate at the end of the first batch, release at the end of the second batch, operate after the third batch and so on. The PD4 performs a similar function except that alternate batches are counted on two separate counters.—*Hird-Brown Ltd., Flash Street, Bolton, Lancashire. (Phone: Bolton 27311).*

For further information circle No. 439

The 'Watesta' non-indicating batch counter (type 201) from Industrionics Controls is an electronic pre-selecting counter that takes full advantage of integrated circuitry, fitting into a case 4¼ in. wide. The instrument is forward counting up to 9,999 and its pre-selected output can drive a relay or similar device; its standard input (Schmitt trigger) permits the use of photo-devices or contact operation. The counter has a maximum counting rate of 100,000 per sec, and can be used for single or repeat mode operation. Available from *Industrio-*

nics Controls (Romford) Ltd., 44 Pemberton Avenue, Gidea Park, Essex. (Phone: Romford 46191).
For further information circle No. 440

Industrionics Controls' 'Watesta' backward-scaling batch counter (type 701) may be used for such backward-counting applications as coil winding that require one or two presets; the preset number appears on the display when the reset is activated and the countdown commences. A slow-down signal can be obtained between 0 and 99 to give a constant output. The counter is available with 4 or 5 decades in two versions (to give one or two presets) from *Industrionics Controls (Romford) Ltd., 44 Pemberton Avenue, Gidea Park, Essex. (Phone: Romford 46191).*
For further information circle No. 441

Jiskoot Autocontrols' type HS batch counter/controller operates at speeds up to 100,000 counts per sec. It is available with a four-, five- or six-digit display and is set for the required batch number by means of numbered thumb-wheels. Manual and automatic reset facilities are provided and the unit can be used with various types of transducers. A set of output contacts is rated for a maximum power of 50 VA at a maximum current of 1 A, and pre-batch contact closure is available as an optional extra.—*Jiskoot Autocontrols Ltd., 85 Goods Station Road, Tunbridge Wells, Kent. (Phone: Tunbridge Wells 22291/2).*
For further information circle No. 442

Kappa Electronics' model FJ15 batch counter and controller is primarily intended for use with a photoelectric sensor and operates at counting rates up to 1,500 counts per min. Any six-digit number can be set on the unit and on completion of the count an output relay is energized and the unit automatically reset. A transistorized drive circuit ensures that the plug-in electromagnetic counter is operated as soon as the leading edge of each object being counted cuts the light beam of the detector.—*Kappa Electronics Ltd., 159 Hammersmith Road, London, W.6. (Phone: Riverside 7117).*
For further information circle No. 443

The Kappa Electronics' model FJ35 binary counter/controller provides facilities for counting and controlling batches of 25, 50, 75 and 100 objects or, to special order, any four selected numbers between one and 160. Various types of detectors can be used and input pulse rates in excess of 500 pulses per sec can be accommodated. An added feature is the capability for the unit to operate on either the leading or the trailing edge of the input pulse as selected on a front-panel switch. A relay is actuated at the end of each count and a variable delay can be introduced between the end of the batch count and the operation of the relay. The energized time of the relay can be varied from 25 to 250 msec. A totalizer displays the total number of batches counted.—*Kappa Electronics Ltd., 159 Hammersmith Road, London, W.6. (Phone: Riverside 7117).*
For further information circle No. 444

The Londex batch counter type EBC

The Londex batch counter type EBC can be supplied complete with a photoelectric detector circuit to form a complete system. It can also be used with other types of detector. The required batch number is set on four rotary switches beneath the count display and an output relay is operated at the end of the batch. The display is automatically reset to zero at the end of the count and pre-batch control action can be initiated. Up to four batches per sec can be counted and the maximum counting rate is 2,000 per sec. An internal 100/c/s oscillator provides a means of checking the accuracy of the unit and increases its versatility. —*Londex Ltd., Anerley Works, 207 Anerley Road, London, S.E.20. (Phone: Sydenham 3111).*
For further information circle No. 445

The Parkinson Cowan preset batch controller is used in conjunction with such sensors as photocells, microswitches (for solid units) or 'Unipulse' flow meters (for liquid control). At the end of the preset count (up to 20 counts per sec are possible), the counter will stop before automatically repeating the batch, or can be reset for a new batch. The count may be stopped at any time during an operation, and then restarted either to complete the preset count or count a different quantity. Local or remote operation are standard features, and a totalizing counter is provided; the counter capacity is 999,999 counts with a 1 : 1 calibration, or 99,999 with a 2 : 1 calibration. Available from *Parkinson Cowan Measurement, Talbot Road, Stretford, Manchester. (Phone: Longford 1181).*
For further information circle No. 446

Parkinson Cowan's variable batch controller is a solid-state automatic batch counter for use in industrial process schemes. It accepts input signals from such counting instruments as 'Unipulse' liquid-flow meters or digitizers attached to machine-tool shafts, and provides two separate and successive relay-controlled outputs which can be used for directly controlling solenoid-operated valves, contactors etc. The batch-quantity counter will reset to zero, and the presence of input signals is shown by this counter and a totalizing counter; the counting process can be stopped and restarted at any time, remote-control facilities being provided for stop, start and batch-cancel functions. Batch quantities up to 9,999 can be accommodated, with totalizing up to 999,999. Available from *Parkinson Cowan Measurement, Talbot Road, Stretford, Manchester. (Phone: Longford 1181).*
For further information circle No. 447

Photain Controls' 'Binadic' solid-state batch counters are built up almost entirely of printed-circuit plug-in boards and can be supplied with from two to four decades, with or without 'digitron' display and having single or dual outputs. Counting speeds of 3,000 per sec are provided, though higher ones are available, and the reset time is

One of Smiths Industries' two-program digital batch counters

The type TSA 5545 counter produced by Venner Electronics

shorter than the counting speed, thus ensuring no loss of count on reset. The units are suitable for inputs from switches, photo transistors, photo diodes, photoconductive cells, capacitive transducers and inductive transducers. Automatic or manual reset is possible, and pre-batch warning pulses can be provided. Available from *Photain Controls Ltd., Randalls Road, Leatherhead, Surrey. (Phone: Leatherhead 2776).*

For further information circle No. 448

Photain Controls supply a range of counting and batching control equipment that has been designed to provide a complete system for every type of installation. Units operate from photoelectric inputs and are complete with transistorized amplifier and power supply for a light-beam projector unit. With the preselection counters, any number up to 999,999 can be chosen, and when the count reaches the preset figure the process will stop until the unit is manually reset. Alternatively the unit will produce an output pulse to provide a further control operation while continuing counting the next batch. The type-CU unit counts at 2,400 per min, whereas the preset type-BCM has a maximum counting rate of 1,500 per min; both units are mechanically reset. Available from *Photain Controls Ltd., Randalls Road, Leatherhead, Surrey. (Phone: Leatherhead 2776).*

For further information circle No. 449

Research Electronics' batch counter model 6202B is a robust instrument for applications in production control, packaging, coil winding, cutting to length, depth-of-cut control, process programming, hopper filling, flow control etc. Any count from 1 to 9,999 may be preselected by means of four decade selector switches, maximum counting speed being 2,000 per sec (though 5,000 per sec is available on request); maximum batching speed is 1 per sec, the counting time lost per batch being approximately 100 msec. A manual reset button is provided for setting up, but in continuous use the instrument resets and continues counting automatically once the preset-count relay has operated. Available from *Research Electronics (Sales) Ltd., Lee Green, Mirfield, Yorkshire. (Phone: Mirfield 7918).*

For further information circle No. 450

Smiths Industries' digital batch counters are supplied in a range of eight transistorized models, each having maximum and minimum counts of 9,999 and 1 respectively. Magnetic, photoelectric or miniature photo-transistor sensing heads can be used with these counters, thus enabling any type of object to be counted without modification to the basic unit. The basic unit is either a single or double-program counter, but visual 'numicator' tubes and a six-figure resettable batch-total counter may be provided; all indicators and controls requiring adjustment for normal operation are fitted to the unit's front panel. Available from *Smiths Industries Ltd., Industrial Instrument Division, Kelvin House, Wembley Park Drive, Wembley, Middlesex. (Phone: Wembley 8888).*

For further information circle No. 451

The Thorn Electronics type C.B. 23 batch counter is a robust four-decade unit fitted with a two-pole change-over relay operated at the end of each batch count. No display of the count is provided. Set with the use of rotary switches, the unit can be operated from a detector providing a sine-wave signal at 25 c/s to 10 kc/s, from positive pulses at up to 5 kc/s, negative pulses at up to 10 kc/s, or a pair of normally-open contacts closing 10 times per sec. The unit can be reset automatically, manually or automatically after a predetermined delay. It is dustproof and can be hosed down with no adverse effects. The U.K. distributors are *M. L. Industrial Products Ltd., 292 Leigh Road Trading Estate, Slough, Bucks. (Phone: Slough 23838).*

For further information circle No. 452

The 'Digi-master' solid-state electronic predetermining counters from Veeder-Root Inc. are a group of high-speed counting and controlling devices; they operate at speeds up to 50,000 counts per sec and automatically re-cycle at speeds up to 10,000 counts per sec without loss of counts. The range includes four basic models, with or without numerical readout, and with one or two preset rows. 'Digi-master' totalizing counters (the series 1843) are also offered, standard units being rated at 24,000 counts per min; by adding electronic decades, the counting speed can be extended by a factor of 10. Typical applications for the totalizers include the counting of bottles, barrels, razor blades, pills, silicon chips and dust particles. *Veeder-Root Ltd., New Addington, Surrey. (Phone: Lodge Hill 3344).*

For further information circle No. 453

Venner Electronics' type TSA 5545 is a five-digit preset counter which can operate from input pulses at frequencies between 10 c/s and 2 Mc/s. Two input channels are provided and the unit is fitted with terminals for operation from switch contacts. An output for operation of a digital printer is available as an optional extra.—*Venner Electronics Ltd., Kingston By-Pass, New Malden, Surrey. (Phone: Malden 2442).*

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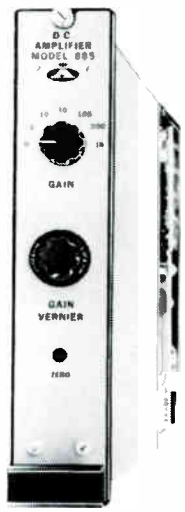

Model 885-235 D.C. Amplifiers
Gain Range : 3 to 3000
Input Resistance : 100 Megohms
Bandwidth : d.c. to 10 kc/s
Output : ± 10 volts at ±100mA
Drift : ±1μV for 40 hours
Temp Coeff : ± 0.2μV/°F
Noise : 2 μV rms

Advanced solid-state **ASTRODATA** Amplifiers for instrumentation applications.

These quality High Gain amplifiers for low level wideband systems are completely transistorized and use field effect transistors (FET) in place of mechanical choppers to achieve a very low drift rate and freedom from microphonics combined with maximum reliability.

Two Differential Models—885-135 and 885-235 incorporate gain range selection facilities up to x 3000 combined with a continuously adjustable 10 turn vernier control as standard features. Amplifier outputs are ±10mA and ±100mA respectively from a low impedance source sufficient to drive long lines, A-D converters, multiplexers, galvanometer—recorders or tape recorders. Transfer characteristic is optimized to provide wide frequency response with minimum overshoot, fastest settling and overload times and minimum phase shift. Common mode rejection is greater than 120 db with up to ±300 volts d.c. or peak a.c. common mode voltage.

The model 886-101 has similar characteristics to the 885 amplifiers but features a wider bandwidth and ±10V. d.c. or peak a.c. common mode voltage.

These amplifiers have built-in power supplies, feature d.c. drift of less than 4μV rms per 1000 hrs; wideband noise of less than 4μV; linearity better than 0.02%. They can be used either separately or in the same rack module with an Astrodata Model 1155 Universal Signal Conditioning Unit or Model 890 Electronic Filter to form complete, isolated, signal conditioning channels.

Model 887-115 d.c. Amplifier is the latest of the Astrodata Wideband d.c. Amplifier range and provides—*dual outputs*, which are mutually isolated, to drive simultaneously such devices as A-D converters, and galvanometer-recorders.

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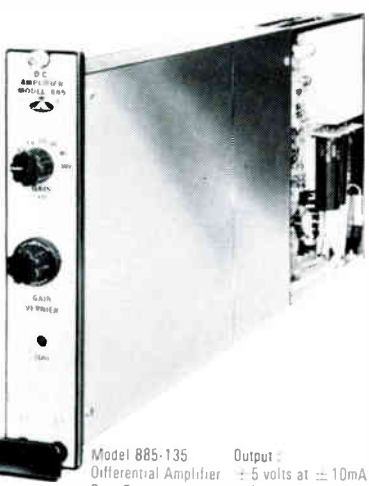

Model 885-135 Differential Amplifier
Gain Range : 1 to 3000
Input Resistance : 100 Megohms
Bandwidth : d.c. to 10 kc/s
Output : ± 5 volts at ±10mA
Drift : ±1μV for 40 hours
Temp. Coeff : ±0.2μV/°F
Noise : 2 μV rms

Model 887-115 Dual Output Differential Amplifier
Gain Range : 1 to 5000
Input Resistance : 25 Megohms
Drift : ±2μV for 40 hours
Temp Coeff : ±0.5μV/°F
Noise : 1 to 7 μV rms (depending on bandwidth)
Output A : ±10V @ ±100mA
Bandwidth A : d.c. to 60 kc/s
Output B : ±10V @ ±10mA
Bandwidth B : front panel selected 10 c/s, 100 c/s, 1000 c/s & 10,000 c/s

Model 886-101 D.C. Amplifiers
Gain Range : 1 to 3000
Input Resistance : 100 Megohms
Bandwidth : d.c. to 50 kc/s
Output : ± 10 volts at ±100mA
Drift : ±1μV for 40 hours
Temp Coeff : ± 0.2μV/°F
Noise : 2 μV rms

Model 1155 Universal Signal Conditioning Unit
Used to supply excitation or bias, attenuation, circuit completion, balancing, filtering and calibration. Used with low-level or high level signals from thermocouples, strain gauges, resistance temperature sensors, thermistors, potentiometers and voltage sources.

Model 120 Nanovolt Amplifier
Gain Range : 200 to 1,000,000
Bandwidth : d.c. to 100 c/s
Noise : 0.05 μV rms
Input Resistance : 1 Megohm
Output Level : 0 to ±5 volts at ±5mA

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