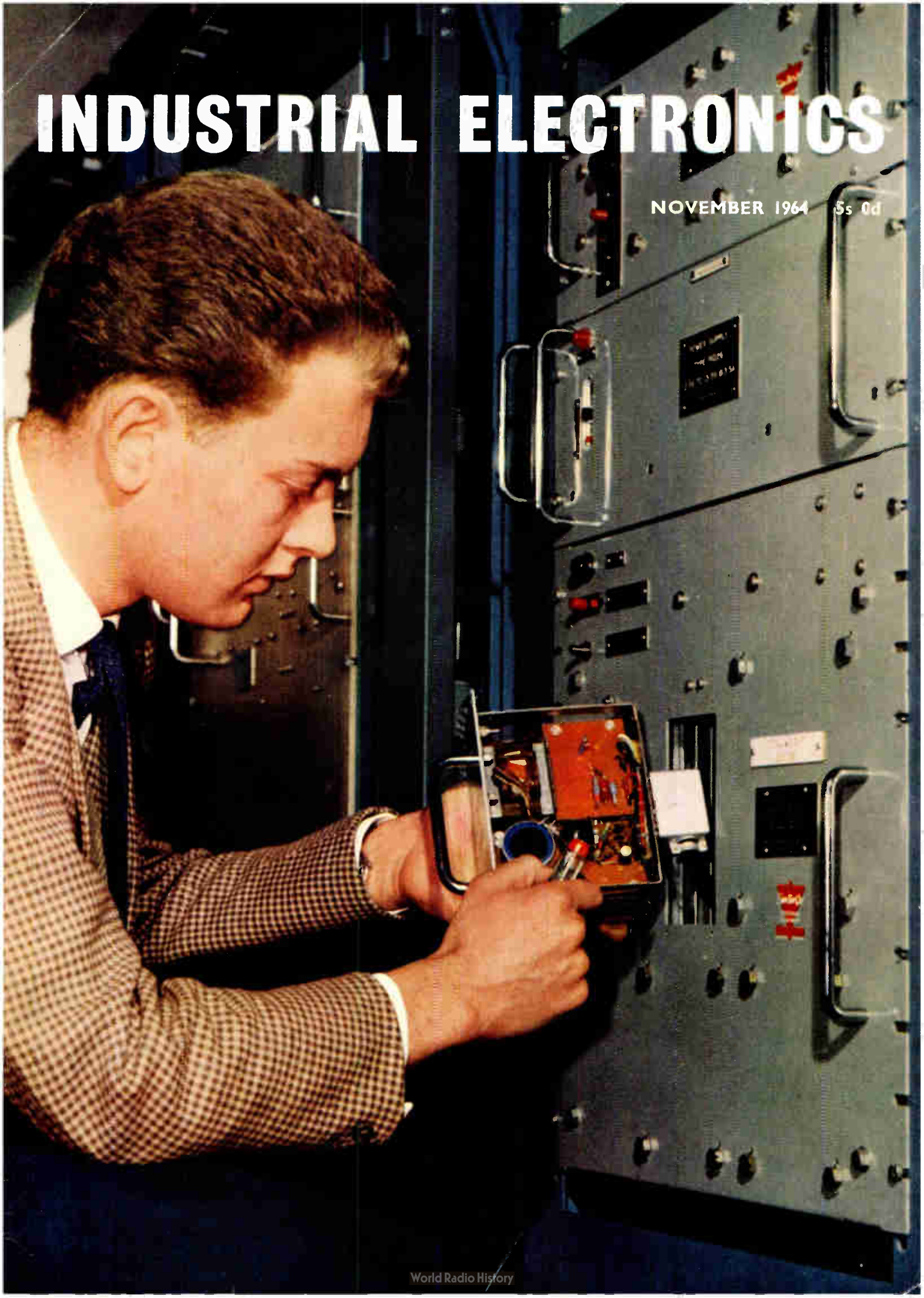


INDUSTRIAL ELECTRONICS

NOVEMBER 1964 \$5 0d



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55swg!



← This is the size of the needle shown in the macro-photograph on the left. It has been threaded with copper wire and fine nylon. We cannot illustrate the wire actual size; no printing process is sensitive enough to show a line .0005" thick.

At BICC we draw wires as fine as this for a wide range of micro-miniature applications.

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INDUSTRIAL ELECTRONICS
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VOLUME 2 NUMBER 11 NOVEMBER 1964

INDUSTRIAL ELECTRONICS

INDUSTRIAL ELECTRONICS
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Comment

An Introduction to Vibration Measurement and Analysis

by *W. G. A. McCormick*

The vibration of mechanical parts can be a nuisance as well as affecting the accuracy of machine tools. This article describes apparatus which enables vibration to be detected and analysed.

505 Coded Magnetic Characters by *G. E. Thorne*

This article describes characters which can be printed in magnetic ink and read by a machine. They are sufficiently like ordinary numbers and letters to be easily recognizable.

509 A Thyristor Firing Circuit for A.C. Power Applications

by *E. R. Orr*

In order to control thyristors in power-frequency circuits a reliable firing method is to provide gate current for the complete conduction period required from the thyristor. Standard single- and three-phase circuits with this type of control are described with applications.

515 A Punched-Tape Controlled Digital Co-ordinate Setter

by *G. T. Ohlsen, B.Sc.*

This article describes an automatic machine-tool control system designed for general machine-shop work. It is a relatively simple system which is designed for reliability and ease of operation and accepts any one of a variety of standard codes for the punched tape, including all British Standard data-processing codes and the British and American machine-tool codes.

518 Business Efficiency Exhibition 1964

This illustrated review of the B.E.E. shows some of the many ways in which electronics is helping to increase business efficiency.

continued overleaf

Published on the first Thursday after the 5th of each month by
ILIFFE ELECTRICAL PUBLICATIONS LTD.
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- 534 **The Effect of Minor Constituents of Soft Solder**
by B. M. Allen and W. Rubin, Ph.D.
A review is given of the effect of minor metallic constituents on tin-lead and similar alloys used as soft solder for electrical joints, with reference to the possibility of modifying solders for special purposes by additions of such metals.

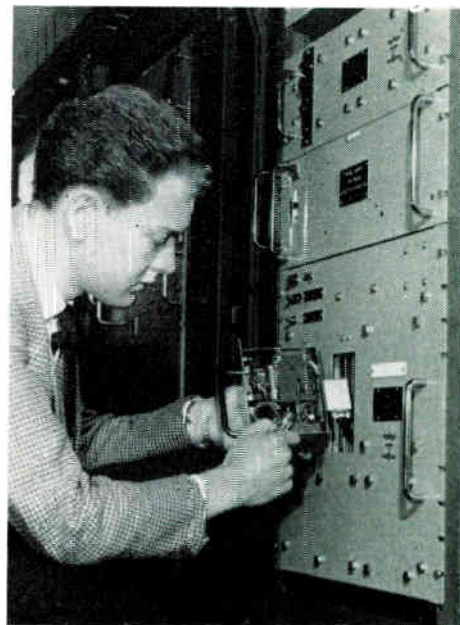
- 537 **Simple Transistor Circuits for Industrial Use** *by F. Bamforth*
This article, which is the first of a short series, describes some basic transistor circuits which are widely used in various combinations to construct quite elaborate apparatus.

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Next Month

The measurement of speed is the subject of an article in next month's issue. The Doppler effect is utilized and one application of the apparatus is to checking the speed of road vehicles. Among other articles, the operation of reed switches by permanent magnets will be discussed.



OUR COVER

The picture shows an engineer testing a thyristor trigger control unit in the power plant of an STC data-transmission equipment. An article describing a thyristor firing circuit for a.c. power applications begins on page 509 of this issue

TO SAVE YOUR TIME

We will assist you to obtain further information on any products or processes described or advertised in this issue. Just use the enquiry cards to be found in the back of the journal.

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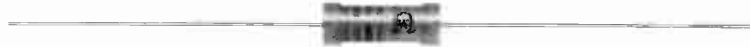
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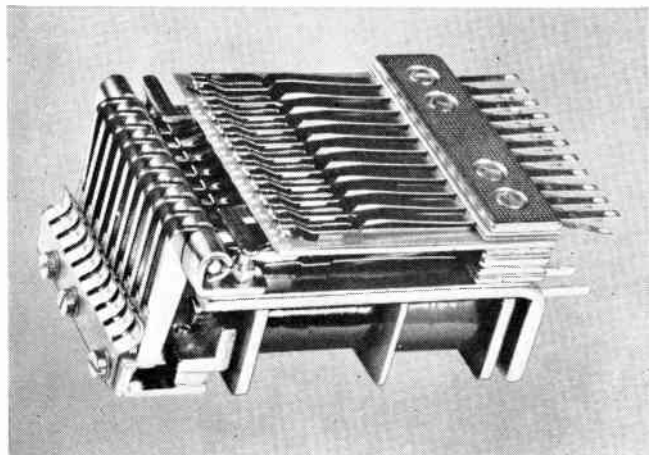
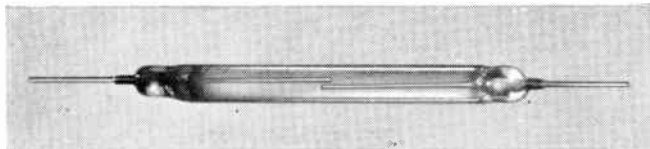
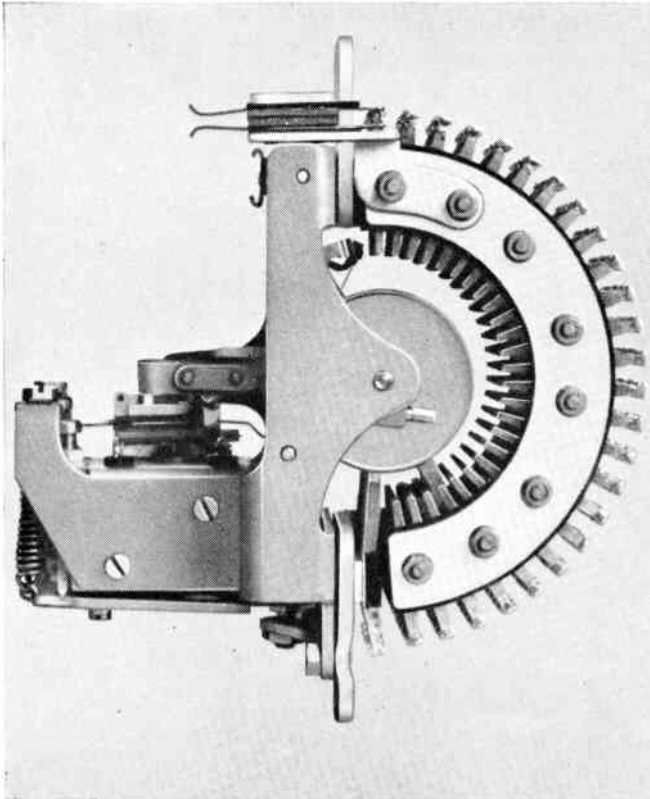
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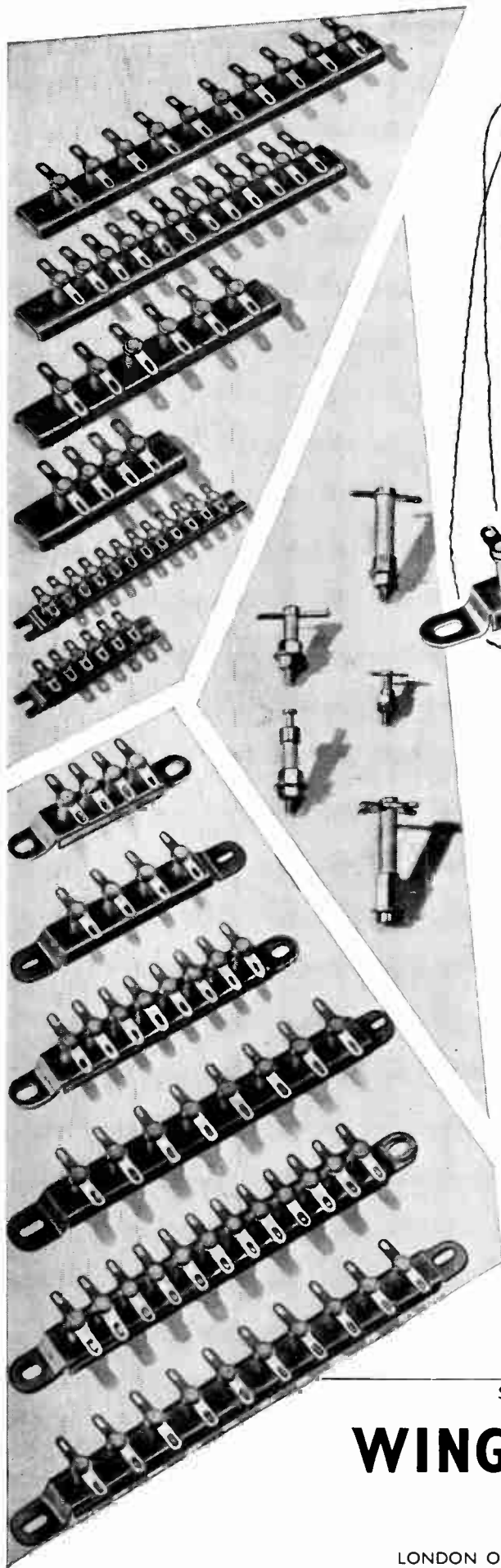
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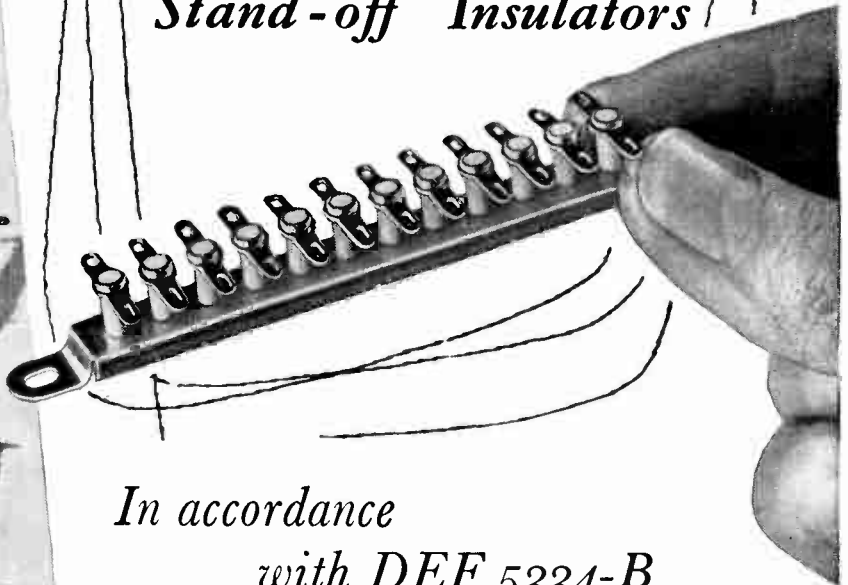


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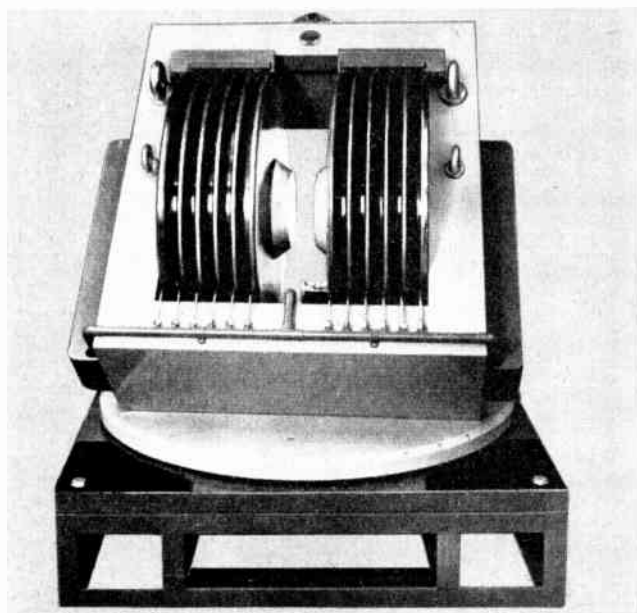
Range of special-purpose magnet assemblies extended

Ten-inch electromagnet and transistorised power system now available

The Mullard range of special-purpose magnet assemblies has been further extended by development of the 10in electromagnet for research laboratory use, and a transistorised power system for the 4in electromagnet already in the range.

TEN-INCH ELECTROMAGNET

The 10in electromagnet has been developed to produce a field strength of 31kGs in a 1in gap between 2in diameter cobalt-iron



10in electromagnet mounted on a turntable.

pole pieces, a performance normally associated with much larger magnets. Using standard iron pole pieces, the field strength is 29kGs. Under optimum conditions, the stability of the field is 5 parts per million over 15min, and the ripple and noise is 10 parts per million over 1 hour.

The electromagnet, which has the type number EE1001, is powered by a 20kW motor-generator set and precision current controller, the complete power system having the type number EE6001. A range of pole pieces for various gap configurations is also available, giving a range of field strengths of 28kGs for a 3in diameter, 1in gap to 14.4kGs for a 10in diameter, 3.0in gap.

This and other magnet assemblies in the Mullard Special Purpose range offer the advantage of a short delivery time.

TRANSISTORISED POWER SYSTEM FOR FOUR-INCH ELECTROMAGNET

A transistorised power system operating from single-phase mains supply is available for the variable-gap 4in electromagnet EE1002 already in the standard range. The 660W system, type number EE4015, will provide a maximum current of 16A in four switched ranges, each range being continuously variable. The current resolution is 10 parts per million, and the current stability is 100 parts per million.

For further information on the 10in electromagnet and the power system for the 4in electromagnet, please use the reader reply card of this journal (see reference number opposite).



Power system for 4in electromagnet

What's new from Mullard

150A silicon rectifier diodes with 3000A surge rating

Introduction of BYX14 series

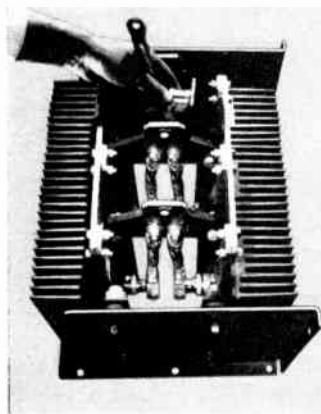
A series of silicon rectifier diodes has been introduced for power rectifier applications with maximum mean forward currents up to 150A. The maximum repetitive peak forward current of all devices in the series is 750A and the maximum surge forward current 3000A for 10ms, enabling these devices to withstand the conditions encountered in heavy-current engineering.

The voltage ratings (maximum repetitive peak reverse voltage) of the BYX14 series are 400, 800, and 1200V. Reverse polarity versions of the three devices are also available. The high-voltage device will

have wide use in power supplies for such diverse applications as factories, cranes, and electro-chemical plant, while the lower-voltage devices can be used for charging accumulators, operating stacking trucks, d.c. motors, and arc-welding equipment.

A special envelope is used for the series incorporating a flange for bolting the diode directly onto a busbar or heat sink. The other connection is made by a clamp onto a cylindrical spigot. The advantages of this method of connection are that not only can the customer make flexible top leads the length he requires, but when diodes are used in series it is possible to have one lead with a clamp either end connecting the devices together.

The illustration shows six diodes of this series used in a three-phase bridge circuit to give 450A from the mains. It shows clearly how these diodes and the associated heat sinks form compact, and highly reliable, rectifier units for industrial use.



Plastic-encapsulated photocell for low-voltage applications

The first plastic-encapsulated cadmium sulphide photoconductive cell with a high sensitivity for use in transistorised circuits has been introduced by Mullard. The resistance of this cell, type number RPY28, is an order of magnitude lower than any conventional cadmium sulphide cell.

The small size and high sensitivity of the RPY28 will enable it to find wide application in the motor industry. Typical uses of this small cell (approximately 1.5 by 1cm) include the automatic dipping of headlights, the switching of side lights at pre-determined light levels, and mirror dipping.

Other low-voltage applications in which the RPY28 can be used include electrical toys and transistor control equipment.

NEW FERRITE INFORMATION SERVICE INTRODUCED

Performance and applications information which will assist designers in the use of ferrite materials in a wide range of communications and allied equipment is being published each month by the Mullard Ferrite Design Advisory Service.

The subjects covered by the first series of articles include High Q-factors, Iso-Q curves, Recording Heads, and the operation of ferrites above 2000Mc/s.



NEW LIGHTWEIGHT RUGGED MAGNETRONS

Two new rugged lightweight magnetrons, particularly suitable for military applications, are now available from Mullard. These devices, type YJ1100 and YJ1101, extend the range of special type magnetrons introduced earlier this year. The YJ1100 and YJ1101 are similar in design to the established types YJ1090 and YJ1091 but offer higher pulse power output.

Both the YJ1100 and YJ1101 weigh 200g. They are mechanically tunable and ruggedly built to sustain repeated shocks of the general order found in airborne radar, missile and target aircraft applications. Excellent frequency stability is maintained even under the arduous conditions encountered in these applications. Their low temperature coefficient is a further important feature; this is less than 100kc/s per degC.

The YJ1100 provides a 150W minimum pulsed output over the 9.0 to 9.5Gc/s frequency band for an input pulse of 1.2kV at 0.9A. Under similar conditions, the YJ1101 provides the same pulsed output in the 8.5 to 9.0Gc/s frequency band.

Mechanical tuning is effected by a simple screwdriver-slotted adjuster on the magnetron housing; vibration-proof locking facilities are provided for this mechanism. Connections to the magnetron are made via a standard 50-ohm coaxial plug.

Cold-cathode diodes have controlled difference between breakdown and maintaining voltages

Plans have been made to introduce a range of cold-cathode gasfilled diodes which have closely controlled breakdown and maintaining voltages. The voltage and characteristics of each type have been carefully chosen to make them suitable for particular applications.

The first type to be introduced is the ZA1001 which has characteristics that make it suitable for use in audio-frequency relaxation oscillators without elaborate synchronising circuits, enabling low-cost oscillators to be built. It will have particular application in frequency dividers of electronic organs where its small size and stability will enable compact units to be built.

Another diode in the range which may be used as an indicator for transistor circuits will be introduced shortly. Other types are being developed and will be released later.



FURTHER DETAILS of the Mullard products described in this advertisement can be obtained from the address below or through the Reader Enquiry Service of Industrial Electronics using the appropriate code number shown below.

Special purpose magnet assemblies.....	206
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Lightweight magnetrons.....	208
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Mullard Limited, Mullard House, Torrington Place, London WC1. Telephone: LANgham 6633

CAM16

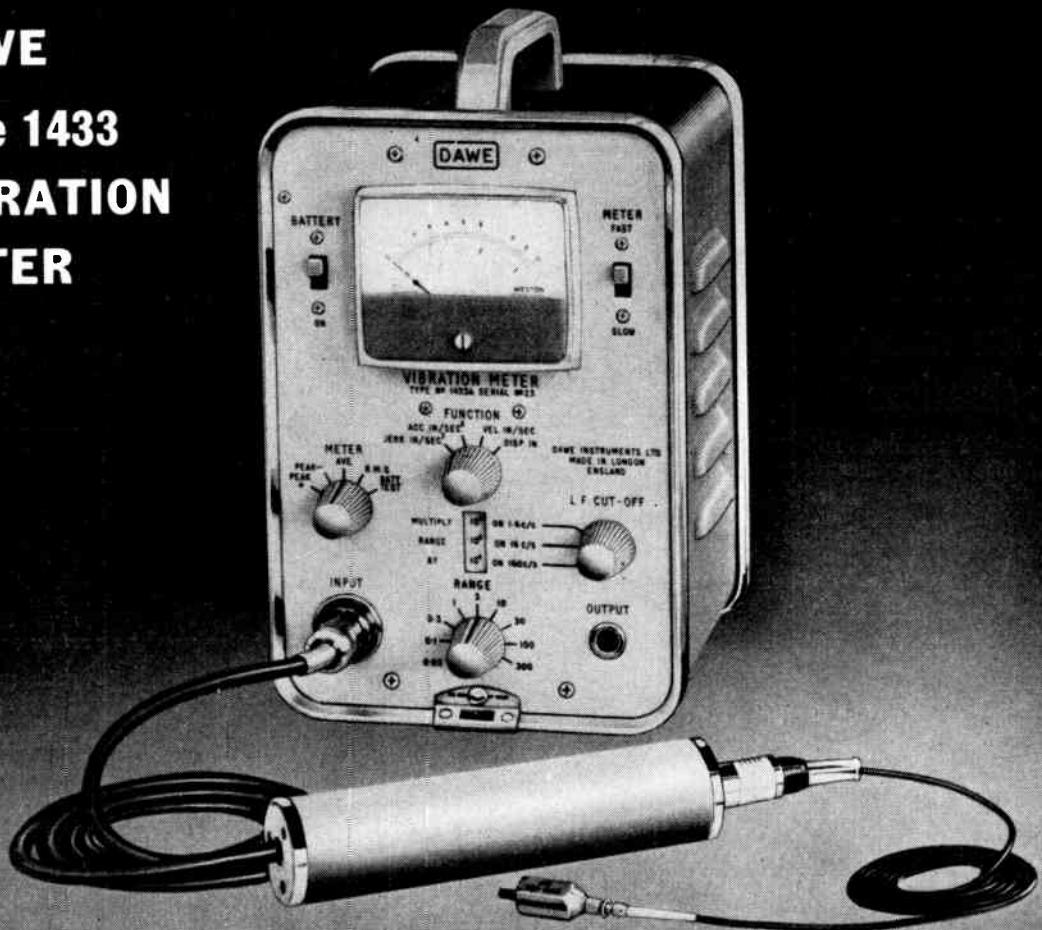
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Full-Scale Sensitivity	Displacement from 3µin. or 0.1in. Velocity from 0.003in/sec or 0.001in/sec. Acceleration from 3in/sec ² or 0.1in/sec ² . Jerk from 30in/sec ³ or 1in/sec ³ .
Meter Response	Average, r.m.s., peak +ve or peak -ve.
Power Supply	Self contained batteries. Battery life 100 hrs approx.
Weight	Standard Accelerometer 0.7 oz Sensitive Accelerometer 8 oz Cathode Follower 1 lb Electronic Unit 7 lb
Price	£190 (with standard accelerometer) complete with cathode follower probe and durable plastics dust-cover.

The Dawe range includes a complete series of instruments for measuring, analysing, and recording sound and vibration. Ask for details.

DAWE Type 1433 VIBRATION METER



DAWE

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New developments in electron tubes are very much on the EMI menu! And new techniques unthought of a few years ago.

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REPLY CARD

Please send data sheets and application information for the following:—

- Cathode Ray Tube Type MX51
- Photomultipliers Type 9558B and 9558Q
- UV Vidicon Type 9677 UV
- 'O' Band Klystron Type R9653

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- Photomultiplier Tube Short Form Catalogue
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CATHODE RAY TUBE TYPE MX51

The MX51 is a 5 inch, high sensitivity, high brightness oscilloscope tube, using post deflection acceleration, for applications where fast response time is essential.

Characteristics

Phosphor Green sulphide, short persistence (equivalent to P.31)
Useful screen area 100 mm X by 60 mm Y
Electrical

(All voltages are referred to cathode)

Heater voltage V 6.3 Typical

Heater current A 0.55 Typical

A1 voltage kV 1.5 Typical

PDA voltage kV 12.0 Typical

PDA ratio to A3 10:1 Max.

Deflection sensitivity

X plates 10.5 V/cm

Y plates 3.1 V/cm



PHOTOMULTIPLIERS TYPE 9558B AND 9558Q

The 9558 photomultiplier has an end window trialkali cathode giving high response at wavelengths up to 0.8 microns. The high quantum efficiency at wavelengths between 0.6 and 0.8 microns, compared with other types of cathode, makes the tube of great interest to spectroscopists and astronomers and workers in the laser field. The dark current from the trialkali cathode is very low and is around 500 electrons per second per cm² (at room temperature).

Characteristics

Dimensions Cathode diameter 44 mm min.

Seated height 140 ± 3 mm.

Bulb diameter 51.5 mm max.

Photocathode Trialkali—Caesium Sodium

Potassium Antimony.

Window 9558B—Pyrex (0.3—0.85μ)

9558Q—Fused Silica (0.16—0.85μ).

Dynodes 11 Venetian Blind, SbCs coated.

Photosensitivity 130 μA/lm typical

100 μA/lm minimum.

Voltage for 200 A/lm* 2000V typical,

Dark current at 200 A/lm† 10⁻⁸ A max,

2 x 10⁻⁹ A typical.

*Measured with 2870°K Tungsten lamp;

150V C-D1, uniform dynode chain

thereafter. 200 A/lm corresponds to a gain

of circa 1.5 x 10⁶ in a median tube.

†At 20°C, measured after one hour

operation in dark.



ULTRA-VIOLET VIDICON TUBE TYPE 9677 UV

This new ultra-violet sensitive television camera tube can be used to observe cracks and other defects in the surfaces of red hot ingots. It has equally significant applications in medical diagnosis and biological research.

EMI Vidicon Type 9677 UV has a specially developed target layer to give high sensitivity in the ultra-violet region of the spectrum to at least 2500 AU. The high ultra-violet sensitivity of the tube allows a television camera to be fitted directly to a UV microscope, so providing a continuously visible image of the material being studied. High sensitivity also enables the UV radiation to be reduced to a sufficiently low level for living cells to be studied.

Type 9677 employs the latest EMI electrode structure which increases the ease of operation by allowing it to be overbeamed without loss of resolution, so enabling it to cope with a wide range of light levels.



O-BAND KLYSTRON TYPE R9653

This Reflex Oscillator is a recent addition to the range of EMI millimetre tubes. Applications include electron spin resonance, materials research, and microwave testing and development work, including scaled aerial experiments.

The tube has a mechanical tuning range of about 4 Gc/s in the 4 mm band and variants are being developed to cover the frequency range 65 Gc/s to 85 Gc/s.

A resonator voltage of between 2.0 kV and 2.5 kV at 25 mA produces a power output in excess of 10 mW and electronic tuning is of the order of 100 M/cs between the half-power points. Output is taken from waveguide size WG 26 (RG 99/U) and the standard flange is the American type UG 378/U, although other types can be fitted by special request.

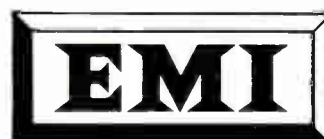
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


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-  $x = \log f$ Frequency controlled, horizontal deflection.
-  $y = \text{dB}$ Y-deflection logarithmic or linear.
Ranges: 20 c/s-20 kc/s, 200 c/s-5 kc/s.
-  **Accuracy 1%**
-  Automatic frequency sweep in conjunction with B.F.O. Type 1022.

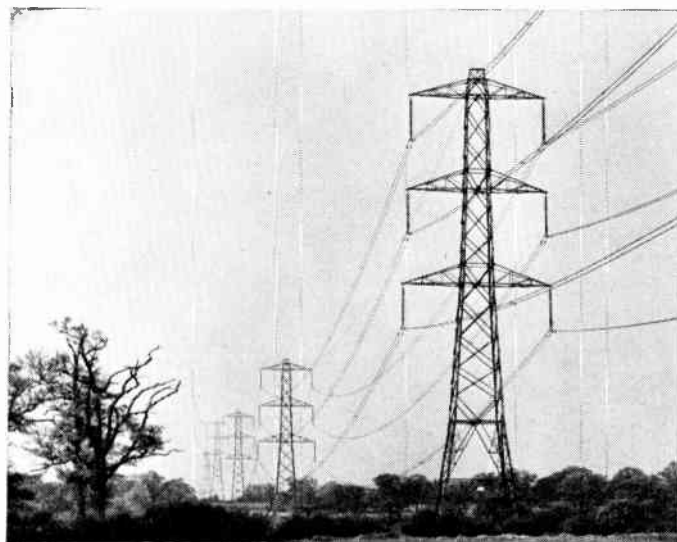
Displays frequency response curves on the screen of a 14" long persistence picture tube

Detailed literature on request



B & K Laboratories Ltd. 4 Tilney Street, Park Lane, London W. 1.
Tel.: GROsvenor 4567 . Cables: Banklabs London

G.E.C. MODULAR EVERY PROBLEM OF



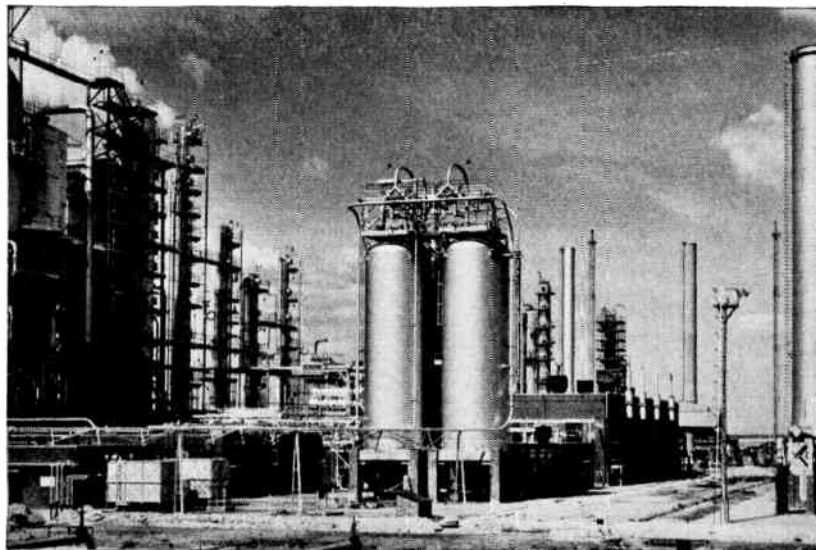
Electricity Supply G.E.C. equipment has been installed by many electricity supply undertakings for control and alarm purposes. A recent example has been for voltage control and monitoring at all distribution sub-stations by one of the largest area boards.

G.E.C. Electronics' modular systems provide the economic answer to any remote control problem. Whether the distance involved is one mile or hundreds of miles, G.E.C. (Electronics) Ltd. can build up from its comprehensive range of standard frequency and time division multiplex modules the ideal system for any application. This rational, modular approach gives fullest design flexibility and cuts costs by eliminating expensive special engineering. Simply by adding extra modules the systems can grow as the plant they control grows.

G.E.C. modular systems outmatch conventional methods on cost, on versatility and on reliability.

These are some of the basic G.E.C. modular systems

- ★**Teledata**—data and control transmission equipment which operates between a number of points over a single pair of wires.
- ★**Comantel**—automatic answering unit for use with Teledata transmitters and receivers over the telephone system.
- ★**Teleshift**—transistorised frequency shift transmission equipment for faster signalling under adverse conditions.
- ★**Telecode**—scanning equipment which economically transmits digital control information over long distances.
- ★**Teleducer**—transistorised equipment for transmission of analogue quantitative measurements over line or radio circuits.

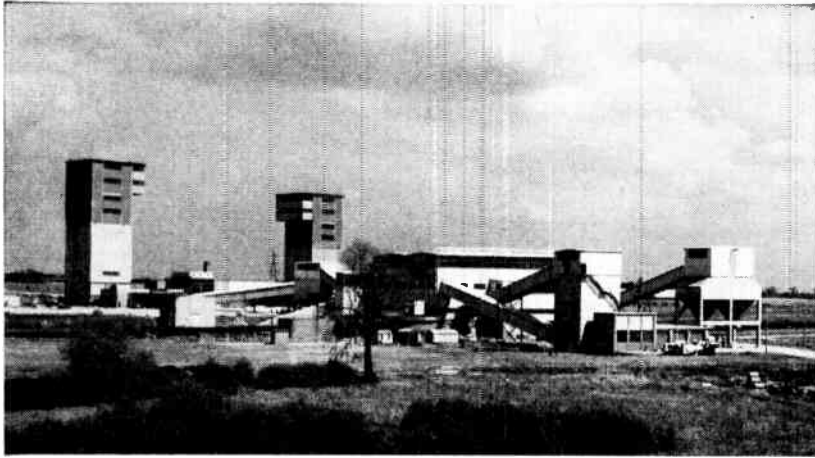


Refineries and Pipelines G.E.C. (Electronics) Ltd. has installed remote control systems for many different applications on behalf of major oil companies. A typical example is the use by Shell-Mex and B.P. Ltd. of G.E.C. equipment to operate motorised valves at isolated points on pipelines. Control in this instance is exercised over the G.P.O. telephone system.

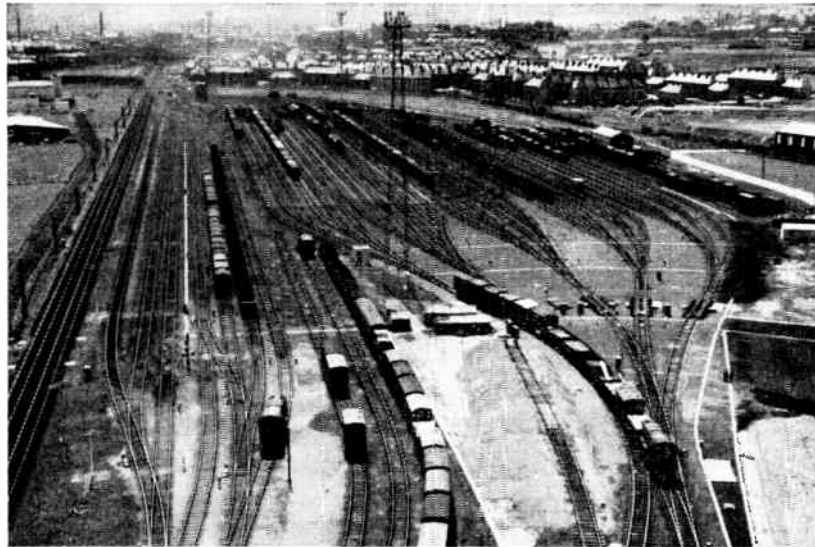


Airfields G.E.C. equipment is extensively used on Airfields for centralised control of lighting, aircraft arrester barriers, fuel pumps and other airfield services.

SYSTEMS SOLVE REMOTE CONTROL



Mining G.E.C. equipment has received Certificates of Intrinsic Safety from the Ministry of Power and is therefore particularly suitable for use in coal mines, oil refineries and other hazardous areas. Systems have been provided for the N.C.B. for use with mining machinery, coal cutting machines, etc.



Railways British Railways has commissioned large signal projects which make extensive use of G.E.C. modular equipment to provide electronic remote control of signals and points, and operations of train describers. It also gives indications back to the control point. As it is fully transistorised and can be relied upon to operate for long periods without attention, it is particularly suitable for railway use.



Communications Control Some miles from Goonhilly, aligned with Telstar's orbit, a static transmitter has been set up to simulate Telstar transmissions for testing the main receiving equipment. This transmitter is operated from Goonhilly by means of G.E.C. remote control equipment. Similar applications include the remote control of the master transmitter on the South Yorks Mobile Radio-phone scheme; and the operation from Prestwick Ground Control Station of radio transmitters at Stranraer.

CONSULT G.E.C. ELECTRONICS NOW

This coupon attached to your letterhead or a phone call to ARNold 4353 will put you in touch with the G.E.C. Electronics' team of systems engineers who will gladly help you solve your remote control problems.

NAME

POSITION

I.E.2



**modular
remote control
and telemetry**

INSTRUMENTATION & CONTROL DEPARTMENT, EAST LANE, WEMBLEY, MIDDLESEX.

ARNold 4353

Continuous Frequency Coverage from 1.5 c/s to 150 kc/s in 5 Ranges at Decade Intervals

TRANSISTOR R.C. OSCILLATORS TYPES TG150: TG150M TG150D & TG150DM

SPECIFICATION:

FREQUENCY

1.5 c/s to 150 kc/s
± 3% + 0.15 c/s.

STABILITY

< 0.05% drift after 30 seconds.
< 0.3% drift for 30% fall of supply voltage.
< 0.05% drift per °C at 1 kc/s.

DISTORTION

< 0.1% at 1 kc/s;
< 0.3% from 50 c/s to 15 kc/s;
< 1.5% below 50 c/s and above 15 kc/s.

SINE WAVE OUTPUT

Variable up to 2.5V into 600Ω
< 1% variation with frequency.
< 0.5% change for 30% fall of supply voltage.

SQUARE WAVE OUTPUT

Variable up to 2.5V
Rise time 1% of period + 0.2μs

ATTENUATOR

20dB, 40dB and 60dB; 600Ω

SUPPLY

Self-contained PP9 batteries, life 400 hours, or, 200/250V A.C. when Power Supply Unit is fitted.

SIZE

10" high × 6" wide × 4" deep.

WEIGHT

6 pounds.



TYPE	TG150	TG150M	TG150D	TG150DM
Output Waveforms:	Sine only	Sine only	Sine and Square	Sine and Square
Output Meter:	None	0-2.5V and dB	None	0-2.5V and dB
Price with batteries:	£32	£42	£35	£45



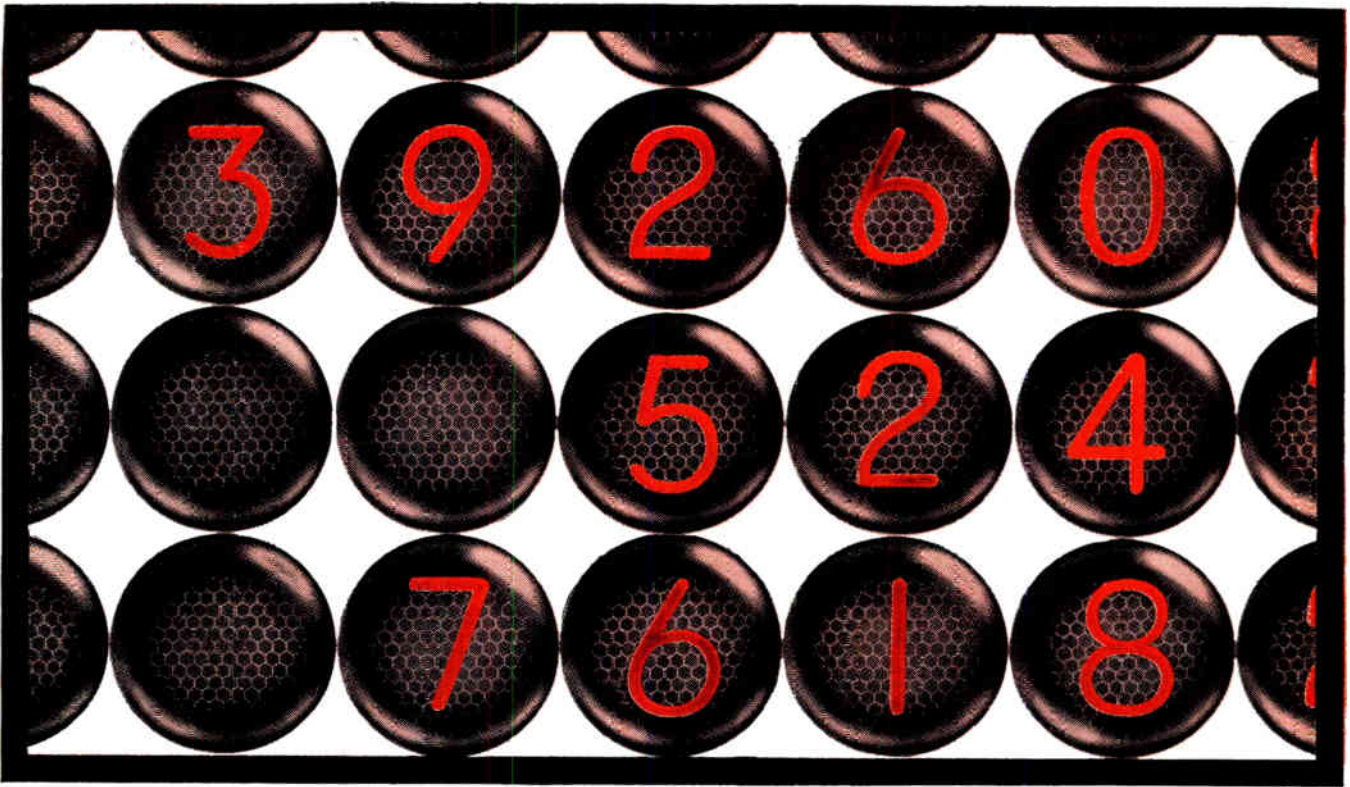
Mains Power Supply Unit **£7.10.0**

Leather carrying case **£3.10.0**

Fully detailed leaflets available on our complete range of portable instruments

LEVELL ELECTRONICS LIMITED

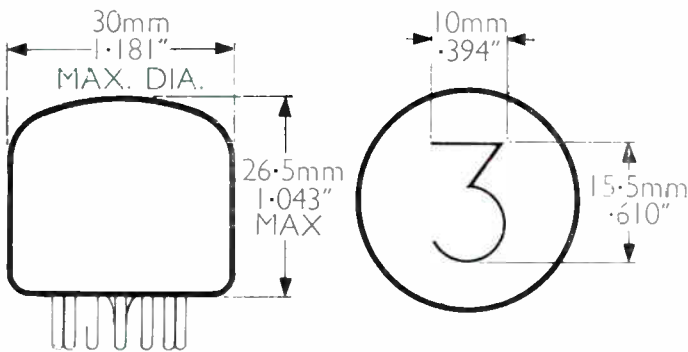
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DIGITRON* GR 10 M. FOR ALL READOUT APPLICATIONS

Close control of manufacturing processes and the introduction of new gas mixtures has led to tremendous improvements in the reliability and life of Cold Cathode Indicator Tubes. Their vivid, unambiguous display, even under adverse ambient lighting conditions, has led to an ever increasing demand in the Instrumentation and Industrial fields. Low power consumption and simplicity of access makes them adaptable to all forms of switching, whether electro-mechanical or electronic.

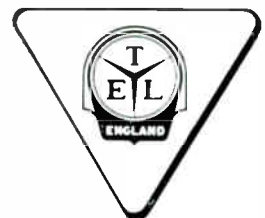
The GR10 M is the latest addition to the Ericsson range of Digitron Display Tubes. This new and aesthetically satisfying, end-viewing tube, with plug-in 13 pin glass base, presents an economical answer to all your digital readout problems. For further information please contact Tube Division, Technical Services Department, Ericsson Telephones Ltd., Beeston, Notts. Tel: Nottingham 254831.



OTHER DIGITRON TUBES AVAILABLE

	CHARACTERS	CHARACTER HEIGHT		NOM. CURRENT	VIEWING
GR 7M	+ - VA Ω % ~	15.5 mm.	.610 ins.	2 mA	END
GR 10K	0 - 9	19 mm.	.748 ins.	2 mA	END
GR 10J	0 - 9	30 mm.	1.181 ins.	4.5 mA	SIDE
GR 10N	0 - 9	60 mm.	2.362 ins.	14 mA	SIDE

* Digitron is an Ericsson Registered trade mark.



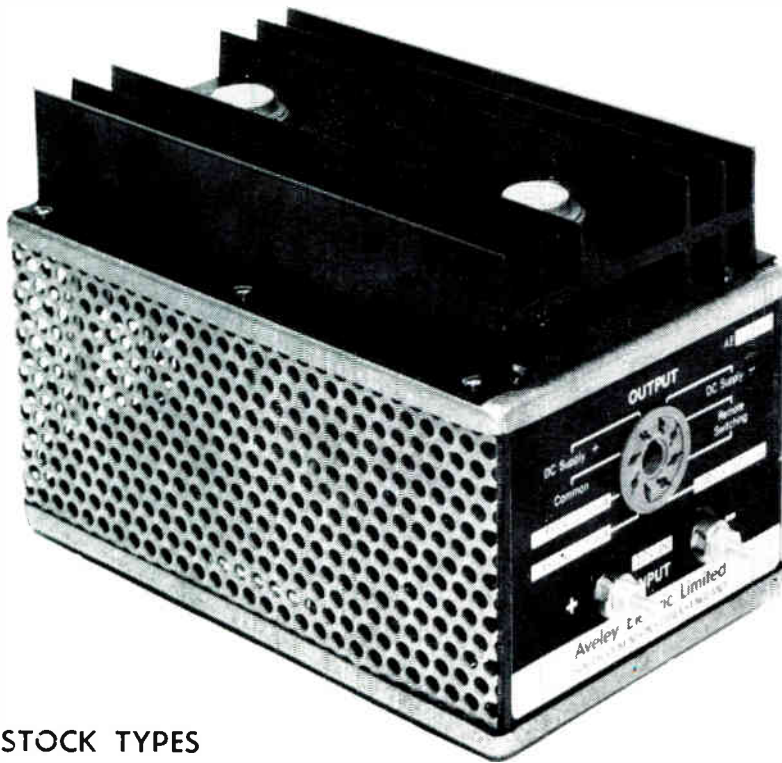
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IN 5 YEARS**



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SOLID STATE
VOLTAGE
CHANGERS**

**Noiseless
No Moving Parts
Fast Switching
Long Life
Low Weight
Self Contained
Robust**

STOCK TYPES

Type	Rating (watts)	Input (V. D.C.)	Output (V. D.C.)	Facilities	Weight	Case Type	Price
C/12/60/300	60	12	300 tapped 200 & 250.	RF	2 lb. 8 oz.	543	£13 15 0
C/24/60/300	60	24	300 tapped 200 & 250.	RF	2 lb. 8 oz.	543	£13 15 0
KW 2000 PSU	...	12	700 v.: 200 v.: -80 & -50.	RF: PR: RC.	3 lb. 0 oz.	744	£29 0 0
C/12/125/425	125	12	425	RF	2 lb. 8 oz.	543	£16 15 0
C/24/125/425	125	24	425	RF	2 lb. 8 oz.	543	£16 0 0
C/12/130/425	130	12	425: 235	RF: PR: RC.	3 lb. 0 oz.	744	£22 0 0
C/12/130/600	130	12	600: 300: 300.	RF: PR: RC.	3 lb. 0 oz.	744	£22 10 0
C/24/250/500	250	24	500	RF: PR: RC.	8 lb. 12 oz.	963	£29 0 0
C/24/500/1000	500	24	1000	RF: PR: RC.	17 lb. 8 oz.	963*	£57 0 0

Case Sizes: 543 = 5½" L. × 4" W. × 3" H.
744 = 7⅜" L. × 4⅝" W. × 4⅝" H.
963 = 9½" L. × 6½" W. × 2½" H. (*5" H.).

RF = Radio Frequency Filter.
PR = Polarity Reversal protection.
RC = Remote switching.

Enquiries are invited for quantity and export orders and special-purpose units. Further details on request.

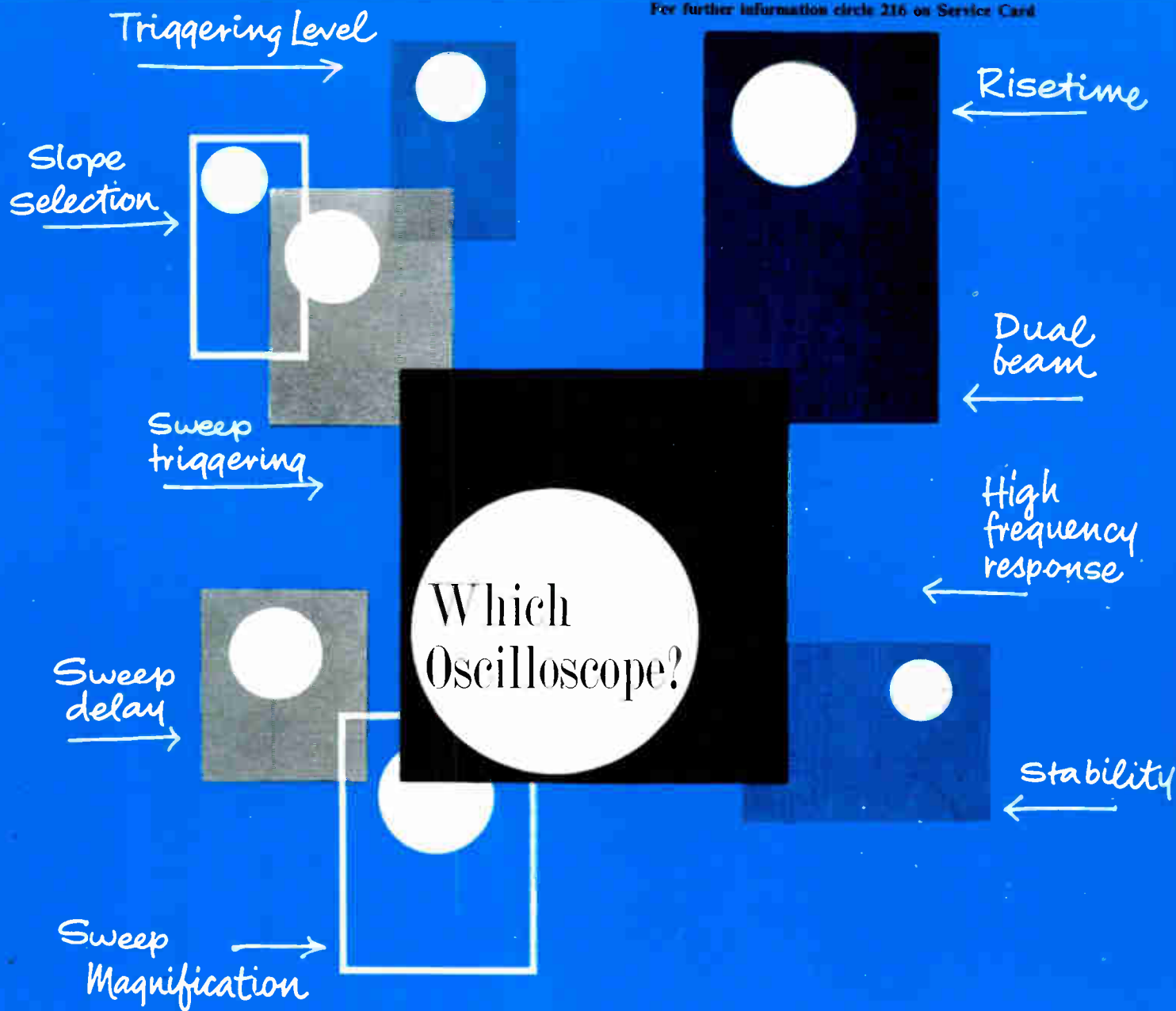
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Distributors in United Kingdom for

Measuring instruments of quality

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Choosing the right Oscilloscope is sometimes confusing.

The choice seems so large. For example, Tektronix offers over fifty different types. The choice of an oscilloscope narrows considerably, however, once the application is known. Determining the type which best suits the application then becomes a matter of understanding the various features of the oscilloscope.

To help you better understand oscilloscope features, Tektronix offers you a free booklet. The booklet, **FUNDAMENTALS OF SELECTING AND USING OSCILLOSCOPES**, can be an invaluable aid in furthering your knowledge of oscilloscopes and in learning more about how these precision tools might help you in your studies of changing phenomena. Also, in addition to explaining oscilloscope features, this informative 16-page booklet designates differences in oscilloscope types and describes factors affecting validity of waveform displays.

For your free copy of the booklet, please write to Tektronix.

Tektronix U.K. Limited

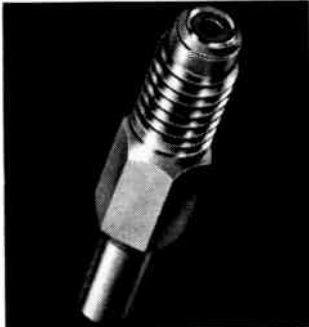
Beaverton House - Station Approach - Harpenden - Herts
Telephone: Harpenden 61251 · Telex 25559

For overseas enquiries:
Tektronix Ltd, Albany House, St. Peter Port, Guernsey, G.I.
World Radio History

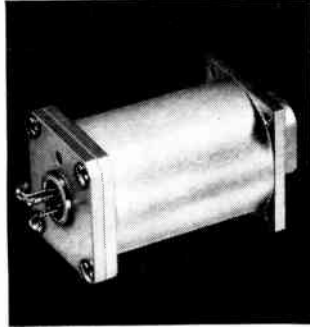


ROTAX COMPONENTS & TRANSDUCERS

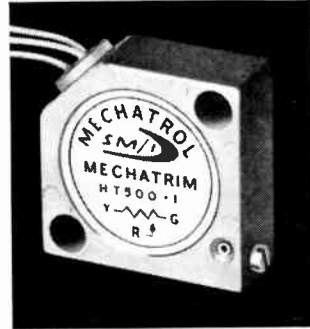
ROTAX C.A.V. Transducer



401 Transducer



200 Series Encoder



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Rotax produce a specialised range of equipment to very high standards of precision and reliability. Existing stocks provide for most normal needs. If your specification cannot be met exactly, Rotax will manufacture to your requirements.

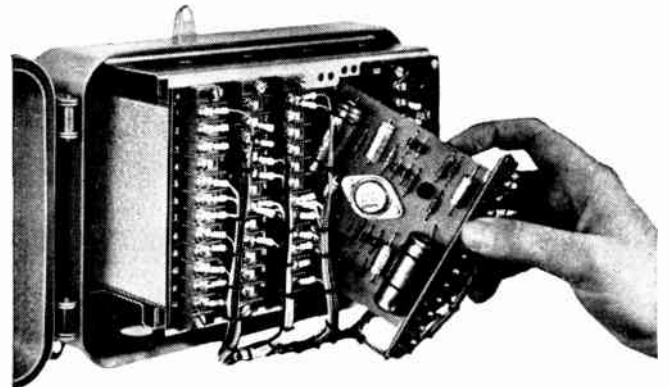
Pressure transducers	potentiometric
Strain gauges	pressure transducer type
Digital shaft encoders	photo-electric
Trimmer potentiometers	miniature, metal-film

These instruments are designed to meet military environments. To find out more about Rotax Components and Transducers, ring Elgar 7777, Ext. 302—now.

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You'd
hardly expect
a process plant
amplifier
like the ER 500
to perform as well
as a research
amplifier



but it does!

FIND OUT ABOUT the Evershed Series 500 DC amplifier—performance worthy of a 'special' at the price of a field amplifier. Accuracy and flexibility characterise the ER 500. Stability is good: high gain is coupled with high negative feedback. Drift is negligible; linearity error is less than 0.1% Series mode error is less than 0.1% for 5 mV r.m.s., 50 c.p.s. Common mode error is less than 0.1% for 250 V, 50 c.p.s. The new Evershed amplifier offers the full advantages of printed circuitry and solid state techniques.

Write for leaflet ISS5/67.

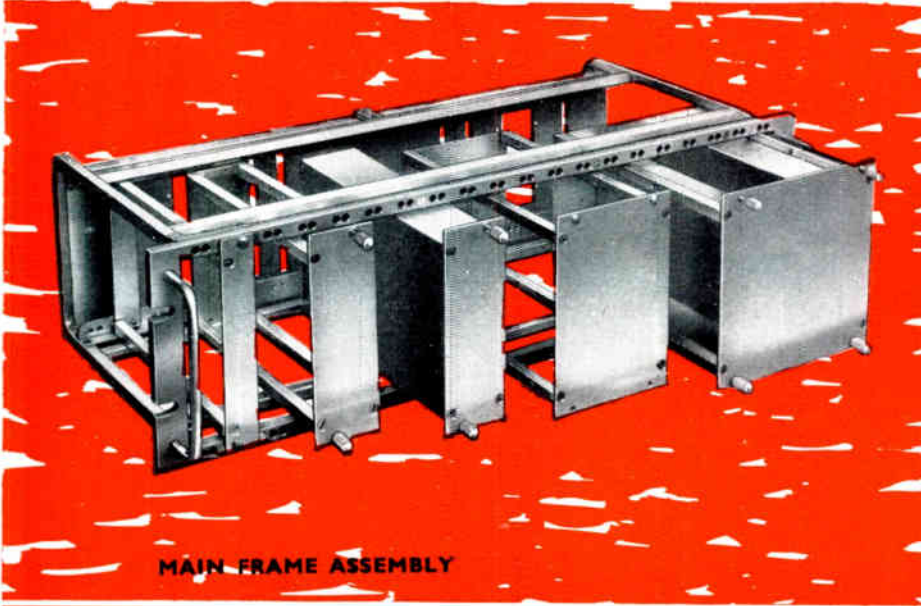
Evershed and Vignoles Ltd.,
Acton Lane Works, Chiswick, W.4.

Tel: Chiswick 3670

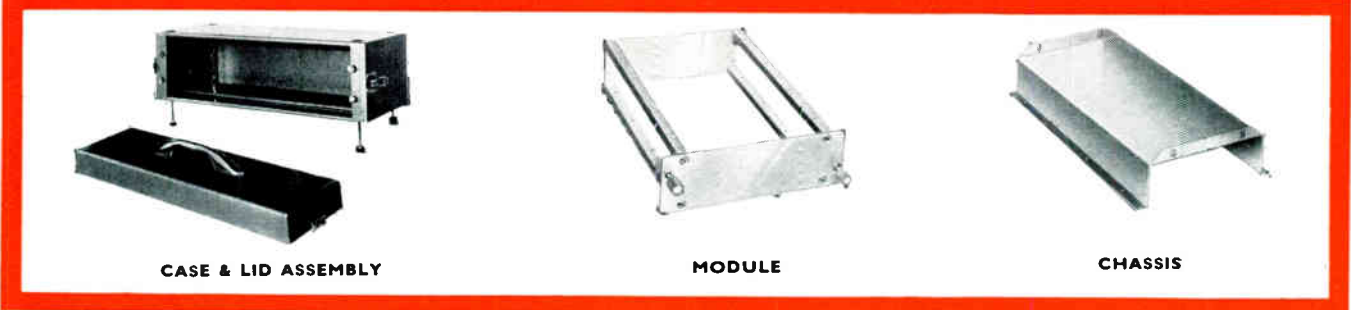
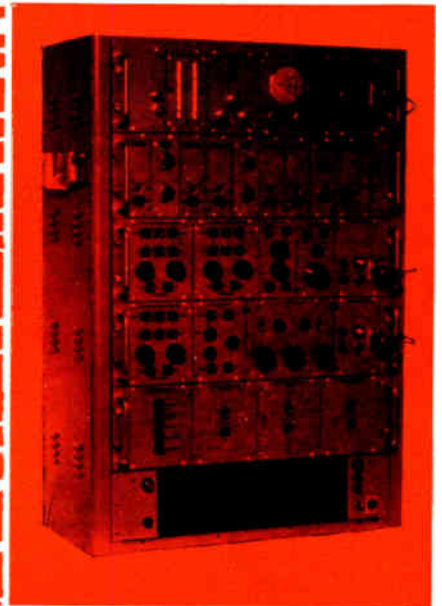
Minar

a NEW modular chassis system designed by the

BBC



MAIN FRAME ASSEMBLY



CASE & LID ASSEMBLY

MODULE

CHASSIS

Minar is based on a standard 19 inch x 5¼ inch panel in the form of a miniature rack into which units of various sizes may be inserted. The mechanical construction is straightforward and the overall assembly of units is capable of being used either in a standard 19 inch bay or in a portable carrying case. Space does not permit listing the numerous advantages this design affords when compared with similar systems. *We acknowledge our indebtedness to the British Broadcasting Corporation for permission to manufacture to their design.*



ELECTRONIC INDUSTRIES LIMITED

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PLEASE SEND ME FULL INFORMATION ON THE MINAR SYSTEM

Name

Company

Address

Position

IE864/LEE

New range of AEI HALL EFFECT DEVICES now includes

FIELD PROBES

(now with thinner, more sensitive, semiconductor, encapsulated in beryllia)

Typical applications:

Direct measurement of computer magnetic field, Clip-on type ammeter, Proximity sensor, Sine-cosine function generator, Displacement transducer, Power measurement, Magnetic mapping, Multiple read-out heads for computer magnetic memory drums.



MULTIPLIERS

Typical applications:

Analogue computers, Watt-meters and volt-ampere meters, Carrier-suppressed modulators, Squaring, Harmonic analysis.



DC-AC CONVERTORS

Typical applications:

Low input impedance DC amplifiers, Regulated DC power supplies.



RF MODULATORS

Typical applications:

Double sideband suppressed carrier modulator, Contactless RF potentiometer, Frequency translation.



AEI Hall effect devices use the semiconductor Indium Arsenide and give a very stable performance over a wide temperature range.

WHAT CAN YOU DO WITH AN AEI HALL EFFECT DEVICE? Some of the known applications are listed above, but there are many others. Write now for the new leaflet which gives full specifications and characteristics of these devices; it may give you some ideas.

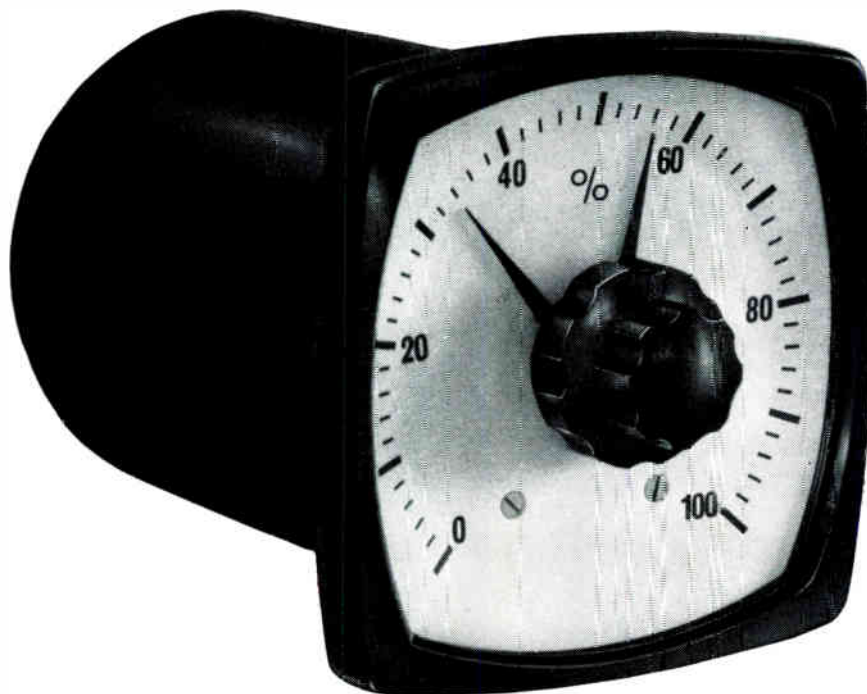
WRITE TO AEI SWITCHGEAR DIVISION, POWER PROTECTION & METER DEPT, TRAFFORD PARK, MANCHESTER 17, or your nearest AEI office



Associated Electrical Industries Limited
Switchgear Division













CONTROL - PROTECTION - ALARM



FOR
 VOLTAGE
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 TEMPERATURE
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SOLID STATE CALIBRATED CONTROL INSTRUMENT

KENT PRECISION ELECTRONICS LTD. has developed this unique Calibrated Control Instrument which replaces the 'Contact Meter' type of control, in all forms of control, protection or alarm systems operating from A.C. or D.C. inputs, μV to kA , mV to kV , for Solid State Proportional or on/off control of loads up to the kilowatt range, or alternatively, operation of an electromagnetic relay with isolated change-over contacts for versatile operation.

-  Solid State Reliability
-  Proportional or on/off Control
-  Sensitive
-  Plug-in Facility
-  Accessible Preset Zero & Calibration
-  D.C. Operational Amplifier Input
-  Versatile & Adaptable
-  Low Cost
-  Compact
-  Attractive Standard Case

Specifications

Voltage — D.C.:—0 — 25 mV min. A.C.:—0 — 10 V min.
 Current — D.C.:—0 — 25 μA min. A.C.:—0 — 1 mA min.

Temperature Coefficient: 0.05%/°C Max. Ambient Temperature: 85°C Regulation: $\pm 1\%$ for $\pm 20\%$ mains variation
 Repeatability: 0.25% Hysteresis: 0.25% Linearity: Normally 2% Operating Speed: 25 mS
 Standard Relay Contact Ratings: 5A at 240 V A.C. Max. Thyristor Ratings: 415 V Rms, 100 A Rms
 Price: From £35 for single and £45 for dual instruments. Availability: Immediate

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KENT PRECISION ELECTRONICS LIMITED

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Telephone: TONBRIDGE 4231 Grams: KENTRONIX, TONBRIDGE





SHELL TANKER PERFORMANCE LOGGED AUTOMATICALLY

**HONEYWELL SYSTEM IN S.S. SOLEN REDUCES
DATA COLLATION FROM 1½ HOURS TO 3 MINUTES**

A Data Logger System, designed to a Shell Tankers Ltd. specification, has been installed by Honeywell in S.S. Solen to monitor and record all data relevant to the ship's performance while at sea.

The logger accepts a total of 52 inputs from Honeywell transducers mounted in various locations in the Solen, and automatically records the vital information on punched tape and a strip printer. The information is then relayed by the Solen radio transmitter, operating on new wide band telegraphy channels, to the Shell Centre in London.

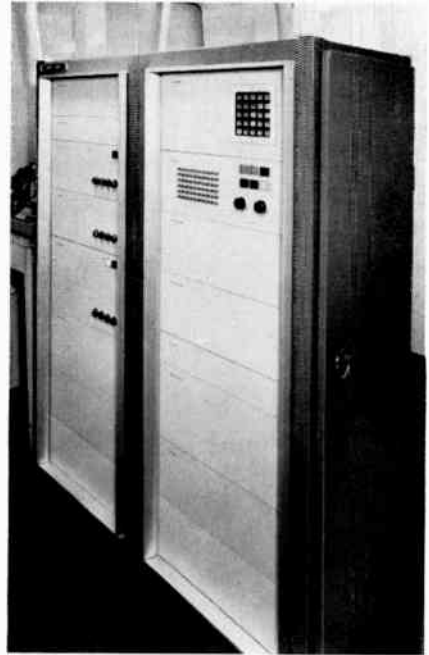
The system enables the full Solen log to be collated in about *three minutes* including integration time—compared with the one-and-a-half hours previously needed even under ideal conditions. Log cycles can be recorded automatically at periodic intervals or on demand in such conditions as heavy seas or during watch changes.

Aim to eliminate costly routine performance tests

The telemetry system for recording data on board ship anywhere in the world is part of a two year experiment by Shell International Marine, involving 15 tankers. Three of the tankers are already equipped with this automatic means for logging the data, taking readings every four-hour watch.

A ship's performance changes as a result of deterioration of the boilers and machinery, and because of marine growth and corrosion on the hull or damage to the propellers. Until now the only means of measuring the result of these changes has required taking the ship out of service and putting it through repeated tests over an accurately measured mile. If the new techniques prove effective, Shell may eventually replace the time consuming 'measured mile' method with the telemetering system in their entire fleet.

For further information circle 219 on Service Card



All information collated

Inputs to the Honeywell Data Logger are:

A year and date signal, derived from a counter system in the logger, which is stepped on from a 24-hour clock.

A time signal by means of a counter system giving 24-hour readout fed from crystal clock impulses.

Seven manually set readings comprising factors important to the tanker's performance, such as swell frequency and direction, ship's speed, forward and aft draft, flue gas analysis, tank clearing or ballasting and hull fouling. These are simulated readings set up on a pin board in the Data Logger.

Ten permanent readings generated in the Data Logger and used for collating the tape punch data after transmission to headquarters in London. These comprise such factors as ship reference number, card identity, fill up zero, watch identity.

Thirty-two signals in analogue or digital form, from a variety of transducers. Some of the signals are specially processed or averaged before logging. These include wind speed from a cup anemometer which gives a d.c. output that is fed into a 2-minute averaging circuit; wind direction from a wind vane which operates a d.c. potentiometer

Continued on next page





NEW HONEYWELL SERIES 600 CONTROL VALVES

The new range of Honeywell Series 600 control valves has a number of advantages which make them a superior choice for most process applications. They are single seated, and are fitted with pneumatic actuators of high thrust. When required, a Series 600 can be furnished with a pressure balanced plug which provides still higher close-off forces—similar to those normally only found in double seated valves. The universal actuator is used for direct as well as reverse valve action: change of valve action is extremely simple and can be accomplished in a very short time without any special tools. The springloaded packing of the stuffing box is self-adjusting and requires no servicing. Fitting 40% capacity trim is particularly easy—seatings need not be changed, since there is only one seating for standard and 40% trim.

Briefly:

The Actuator is a pneumatic spring type power device, adjustable for direct or reverse action.

The Diaphragm is of Neoprene, strengthened with fabric insert for ambient temperatures from -30° to 70°C .

The Spring Range is 3–15 p.s.i. or 6–30 p.s.i. Split ranges can very often be obtained without the use of a positioner. Plastic bellows to protect the actuator spring in corrosive atmospheres are available.

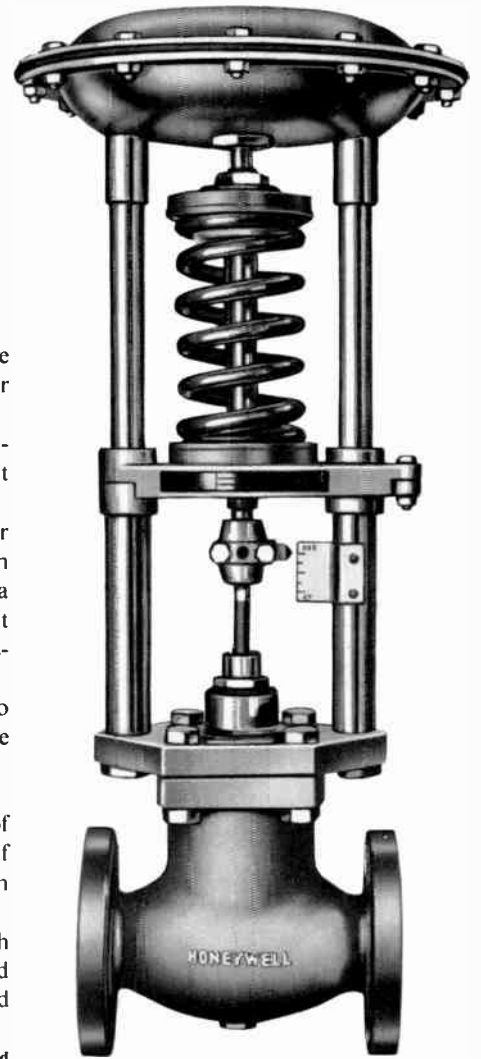
The Air-To-Diaphragm is 18 p.s.i. to 36 p.s.i.: maximum permissible pressure -52.5 p.s.i.

The Air-Connection is $\frac{1}{4}$ " BSP.

The Temperature Range for valves of cast iron is up to 220°C ; for valves of cast steel, up to 450°C or 750°C with radiating fins.

Closure Leakages for a valve with standard plug is 0.01% max. of rated k_v ; for a valve with a pressure balanced plug—0.3% of rated k_v .

For further information circle 221 on Service Card

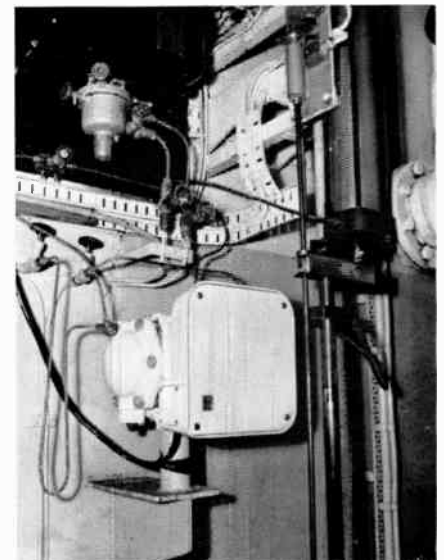
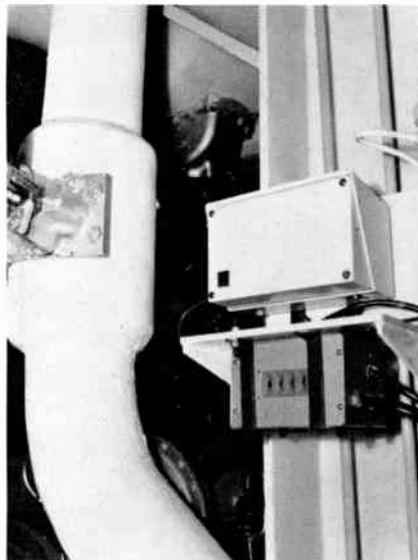


Honeywell Data Logger *Continued from previous page*

system; ship's speed from a signal generated by a square root and averaging circuit; rudder angle, generated from two potentiometers of which one is arranged to store maximum port rudder angle, the other maximum starboard angle—the greatest reading in the two minutes before read-out being recorded. Other signals recorded provide information on pressures, temperatures, fuel specific gravity and viscosity, engine speed, shaft horsepower, thrust . . . and so on.

This centralised monitoring system replaces the conventional method of recording variables on individual instruments located at source. It is based on modules from the Honeywell Series 3000 Data Acquisition system, which provides data logging, alarm scanning, and visual digital indication with computing functions as available options.

For further information circle 220 on Service Card





HONEYWELL 5060 OUTDATES FILLED SYSTEMS IN PIE-MAKING

Advantages of servo techniques at no extra cost

Honeywell 5060 Temperature Recorders, exploiting the advantages of null balance systems, are being used at Thomas Walls Ltd. to record and control meat pressure cooking cycles. These leading pie manufacturers are one of the many industries using process control methods now taking advantage of the inherent reliability in Honeywell's 5060

development—which costs no more than the capillary tube measuring system.

5060 more robust, more flexible

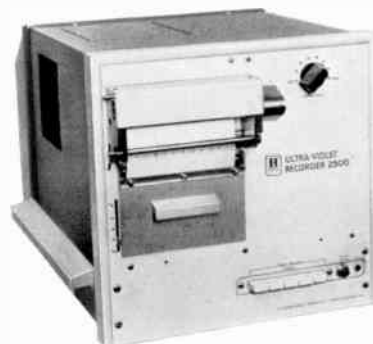
Honeywell 5060's bring new simplicity, greater flexibility and big instrument reliability to temperature recording/control—by eliminating the troublesome limitations of capillary tube systems. A wide variety of electric and pneumatic control forms are available, with . . . comprehensive selection of easy-to-change-on-site range cards . . . resistance bulb actuation . . . suppressed zeroes . . . independence of lead length—and simple on-site change of application. All plus points which make 5060 one of the most important advances in the field of instrumentation, and which enable immediate and future requirements to be met fully *with one instrument*.

For further information circle 222 on Service Card

15% price cuts on U.V. ranges

Improved manufacturing facilities have enabled Honeywell to reduce the price of the 2500 and UV31 range of recorders. This constitutes a reduction of £50 on the 2500 range and £200 on the UV31 range.

For further information circle 223 on Service Card



Up to 36 channels with 21 speeds

. . . these are just the basic features of the Honeywell UV31. This 12" chart recording Oscilloscope Recorder incorporates speeds from 0.5 to 120 in/sec, has 5 speed electronic timers giving full width timing lines, and control from 1–25 feet of paper for paper economy.

For further information circle 224 on Service Card



NEWS IN BRIEF

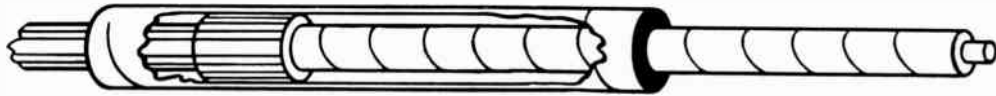
Honeywell Appoint Two New Directors

With the continued growth and increased responsibilities of Honeywell Controls Limited, it has been decided to broaden the top management base by appointing J. F. McNeill and P. R. Prior as Directors. Jim McNeill, who during his 15 years with Honeywell has

performed a variety of financial and administrative tasks, will continue his position as Company Secretary. Peter Prior has been with Honeywell for 19 years in various sales assignments, and will continue to direct the sales activities of the Industrial Products Group.



NEW DISPOSABLE THERMOCOUPLE OFFERS IMPORTANT ADVANTAGES



Honeywell's new Molten Steel Disposable Thermocouple, with its 30" outer sheath and 22" inner sheath, incorporates valuable features which give it a number of advantages over others currently available. Because of the 22" inner sheath, the lance connects to the tip 22" from the hot junction and therefore, in the majority of applications, the connector does not enter the molten metal. Hence maximum protection against burn through is provided.

Also, the 22" inner sheath enables a shorter and easier-to-handle lance to be used.

The small mass at the hot junction provides an extremely fast response, coupled with maximum reliability. The response speed is even more noticeable if the thermocouple is used in conjunction with the new high speed Honeywell recorder. The thermocouple has a rugged, straight-through connector which provides positive, foolproof connection.

Most customers prefer to fabricate their own lances, and the Honeywell Disposable Thermocouple can be used on any $\frac{3}{4}$ " lance. However, 9' lances are available, specially designed and constructed to eliminate moisture condensation troubles, for those who prefer to purchase lances.

Disposable thermocouples, connectors and lances can be ordered through any of the Honeywell Branch offices, and demonstrations can be arranged.

For further information circle 225 on Service Card

HONEYWELL HELP WATER FIND THE RIGHT LEVEL

A simple yet effective automatic system for remotely controlling water level in the Knowle Hill reservoir of the South Warwickshire Water Board has been designed and installed by Honeywell Controls Limited.

At the Board's Mill End pumping station is a Honeywell control box with an indicator dial which enables the station attendant to read the reservoir level. The control box houses a monitor switch which allows pre-setting of the required level. This is connected via GPO lines to a Honeywell ElectriK Tel-O-Set transmitter at Knowle Hill.

Force acting over 1-mile distance

The 500,000 gallon reservoir about one mile from the pumping station, is completely enclosed. The transmitter senses changes in water level by means of a bellows measuring element located at the bottom of the tank, and gives a d.c. signal of 4 - 20 mA proportional to the depth of water. The unique feature of this system is that no electric power is required at the transmitter end: only two wires connect the transmitter to the receiver.

When the water in the reservoir reaches its preset high level, the three pumps feeding it are automatically switched off. As the level of water drops, the pumps automatically start up again.

The heart of the system

A similar system has been installed by Honeywell at the Board's Red Lane, Kenilworth, booster pumping station. Again the heart of the system is a Honeywell ElectriK Tel-O-Set—the miniature recorder, controller that offers most reliability in the smallest possible space.

For further information circle 226 on Service Card



COMPUTER COMPATIBLE TAPE RECORDS -IN JUST ONE STEP WITH THE HONEYWELL 6200

New Honeywell Incremental Digital Recorder eliminates tape-to-tape conversions, eliminates need for additional equipment, saves time and money and greatly simplifies acquisition of medium speed synchronous or random data.

Systems engineers working with paper tape machines and paper-to-magnetic tape converters, or with buffers and fast start-stop recorders, have had a common complaint: "There just has to be a better way of preparing computer compatible tape."

Now, there is . . . the Honeywell 6200. This incremental digital recorder records synchronous or asynchronous data with the same ease to produce tape with the proper bit spacing for direct use by a 7-track computer tape handler.



Uniform Packing Density

The Honeywell 6200 steps the tape past the record head the precise distance necessary for proper bit spacing, rather than drawing it past at a steady speed. In operation, a write command causes a data line to be written on the tape, then the tape is stepped the distance required to yield a packing density of 200 bits per inch (i.e. 0.005 inches), by accurate control of the capstan's angular rotation. The tape then comes to rest in the correct position to record the next character. This process can be repeated at any rate up to 100 characters per second for asynchronous data, or 200 characters per second for synchronous data. A uniform packing density is maintained regardless of how slowly the write commands are received, so that indirect control of bit spacing by tape speed and data rate is eliminated.

Data to be processed by a computer must be in discrete blocks along the tape, the blocks being separated by gaps of suitable length. If required, the 6200

can generate these inter-record gaps by internal circuitry. Parity check options are also available.

Among the many valuable design features are: *Brushless Capstan Motor*—positive magnetic detenting at 1.8° intervals provides a gearless, beltless drive system; *Welded Module Electronics* for compact ruggedness and continued reliability; *Tape Tensioning* by low mass follower arms to ensure constant tension; *Ergonomic Controls*—local backlighted push buttons show operational state at a glance (remote control facilities are provided); *Photo-Sensing* actuated from standard markers to provide output indication of load point, end-of-tape and tape breaks; *Echo-Check*—logic gate output for each channel verifies writing of data.

Diversity of Application

The Honeywell 6200 is the ideal recorder for acquisition of all low and

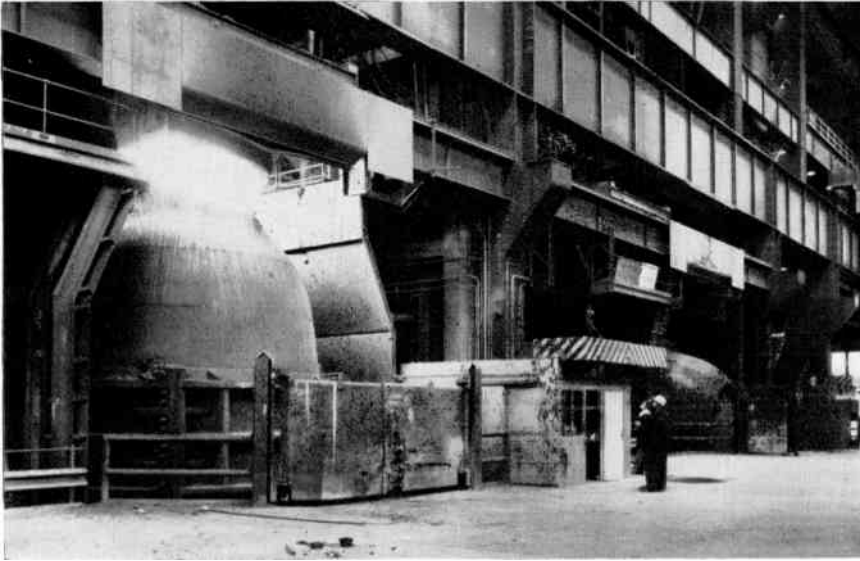
medium speed data, making it suitable for applications such as communication links, business and accounting, inventory monitoring, record keeping, data logging, process monitoring, and so on. It can be used to record only required data—out-of-limit variables, for example—so greatly reducing record quantity and cutting down computer processing time. In process monitoring, slowly changing variables can be recorded over a long period in a very compact form—at 10 characters per minute for example, the recorder will store 13 months of data in one 2400ft. reel of tape. The 6200 will receive data from such sources as Data Encoding Typewriters, Digital Measuring Instruments (Counters, Digital Frequency Meters, Time Interval Meters) and Analogue-to-Digital Converters (Digital Voltmeters, Shaft Position Encoders, Special Purpose Converters, Punched Tape Readers).

For further information circle 227 on Service Card



Window on a New World of Steel

Critical temperatures, flow mixtures and lance positioning at Colville's basic oxygen steelmaking plant are safely under Honeywell control



The recently commissioned basic oxygen steelmaking plant at the Ravenscraig, Motherwell, works of Colville's Ltd., represents the completion of the last major production unit of this £10 million strip mill scheme.

The new L.D.(A.C.) steelmaking plant has two 100-ton crucibles to give an annual output of 700,000 tons, with provision for doubling this figure. The plant was engineered by Voest, of Vienna, and incorporates a Honeywell control system for regulating critical temperatures and flow mixtures and positioning the two lances during "blows". This control equipment was ordered from Honeywell's office in Vienna and supplied by the company's plants at Newhouse, Lanarkshire, and Hemel Hempstead, Herts.

Two identical Honeywell panels are the control centres for the systems, which govern each crucible and operate alternately. While one is being used the other undergoes relining. The sequence of each "blow" is completed in approximately one hour.

The crucible is charged, the lance is lowered into the molten metal and a mixture of oxygen and limestone is

blown through it at a rate of 7,000 cubic feet per minute for twenty-two minutes. The positioning of the lance over the molten metal is critical. After each "blow" the vessel is tipped and the

metal and slag samples are taken, and the metal temperature is measured.

Continual check of important variables

The instruments in each Honeywell control panel indicate and record critical variables to the operator, who can take action by pushing a series of buttons sited on the console desk. Across the top of the panel is a series of 12 alarm lights, ten of which operate klaxons and bring in an automatic cut-off device in an emergency. The temperature of the cooling water to and from the lance is measured by two millivoltmeters and the difference between these temperatures is also checked. If a variation of the readings reaches 20°C an alarm is given. Water and secondary oxygen flow are indicated and recorded by means of Honeywell 3-inch Tel-O-Set instruments.

A Class 15 instrument records the last six feet of travel of the lance. The lance is positioned by manual control; its amount of vertical movement is passed mechanically through a gearbox to a potentiometer, and a signal is then transmitted to the Honeywell Class 15 instrument, which can then control the lance position. Oxygen pressure is recorded by means of a PP/I transmitter positioned
(Continued on next page)



Window on New World of Steel *Continued from previous page*

in the valve station. Mass oxygen flow, temperature and pressure in the main line is also recorded.

Oxygen and lime quantities logged

In the centre of the panel two digital displays indicate the amount of oxygen and lime used. Each display records the total and the amount to be used in each "blow" in increasing and decreasing totals. Amounts fed in are dialled up by the operator. Honeywell shut-off return and pressure-reducing valves in the

valve station regulate the flow of mixture under pressure, on-flow in the oxygen line and cooling water line.

The temperature of the molten metal in each crucible is around 1600°C and is measured by introducing a thermocouple which has a protective expendable cover. When this operation starts, a warning hooter indicates the vessel is being tipped. As the thermocouple is inserted a green light indicates that all is well to take the temperature; this changes to white then red, as the tem-

perature of the inserted thermocouple rises. On red, the operator retracts the thermocouple.

When the slag has been removed, the vessel is tipped again and a steel sample is taken. If a spectrum analysis shows the properties of the steel are of the desired quality, the vessel is tipped the other way and the metal is poured into moulds. After cooling it is taken in ingot form to the strip mill for further processing.

For further information circle 228 on Service Card



Honeywell Visicorder takes the strain for **BBC 2** Midlands aerial

In preparation for the BBC-2 Midland service, Marconi engineers are investigating the behaviour of an existing 750 foot mast. This is in connection with the installation of an additional aerial and it is being carried out in accordance with BBC contracts. A Honeywell 1706 Visicorder oscillograph is being used in vital tests to establish the natural resonant frequency of the top of the mast as it oscillates in the wind. An anemometer and three strain gauges feed information

to four independent channels of the Visicorder; by comparing the resulting traces with a known simulated strain, the oscillatory strains at various wind speeds can be determined. A Honeywell 1706 Visicorder oscillograph was chosen for this important task because of its high sensitivity, its versatility, and its ability to produce traces for immediate analysis without processing. A Honeywell Visicorder can help solve your research problems economically too.

For further information circle 229 on Service Card



NEW DEMONSTRATION UNIT ON THE ROAD

Honeywell's 4" Pneumatic Tel-O-Set demonstration unit has proved so successful that a new unit has been inaugurated, with John Clark 'at the helm'. John, a specialist engineer, has been with Honeywell for more than 7 years and has considerable experience in Honeywell equipment. In his first 'tour' he will be demonstrating the Honeywell 5060 throughout the U.K. and the Continent.

The Tel-O-Set demonstration is given by Ted Amery, the Product Sales Manager. He said, after his recent successful Continental tour "These demonstrations receive considerable interest, and enable us to discuss a manufacturer's particular process recording and control problems in a *practical* manner. They also give us an opportunity to show the advantages of the equipment first hand, with better effect than can be achieved by literature alone".

The demonstrations are available to any manufacturer and are given 'on site'. Arrangements to take advantage of this Honeywell service can be made through any of the Honeywell Branch Offices:

For further information circle 230 on Service Card

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296 Albert Bridge Road, Belfast, N. Ireland. Belfast 558309.

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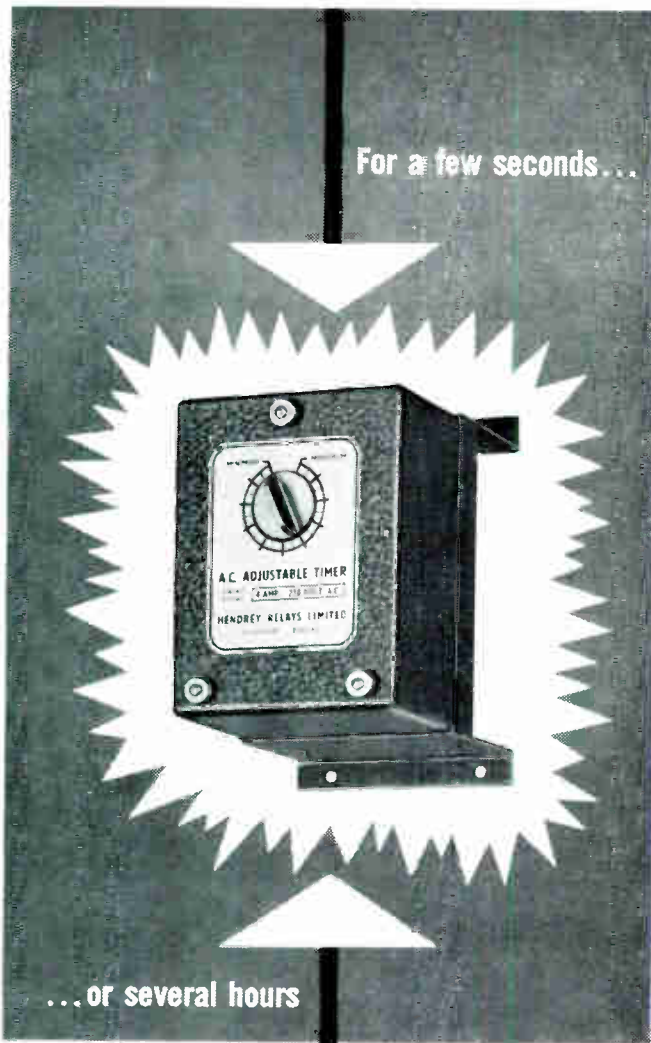
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Incorporates a small self-starting, synchronous motor, which when energised, is arranged to operate a micro-switchette after a pre-determined adjustable time delay has expired. Automatically resets on de-energising. The minimum time delay setting is in all cases 10% of the maximum. Types are available for delays of up to several hours. Adjustment between minimum and maximum settings is by means of indicating knob.

SPECIFICATION

- COIL and MOTOR**
— Wound for 110 V. or 230 V. 50 c.p.s.
Consumption— 8 V.A. approx. total.
- SWITCH**
— Micro switchette
- RATING**
— 4 amps. at 230 V. A.C.
- DELAY**
— The minimum delay setting recommended is approximately 10 seconds.
- DIMENSIONS**
Width— 3" (77 mm)
Height— 4½" (115 mm)
Projection— 4½" (105 mm)
4— 0.152" (3.86 mm) dia. fixing holes.
Weight— 2 lb. (0.907 kg.)



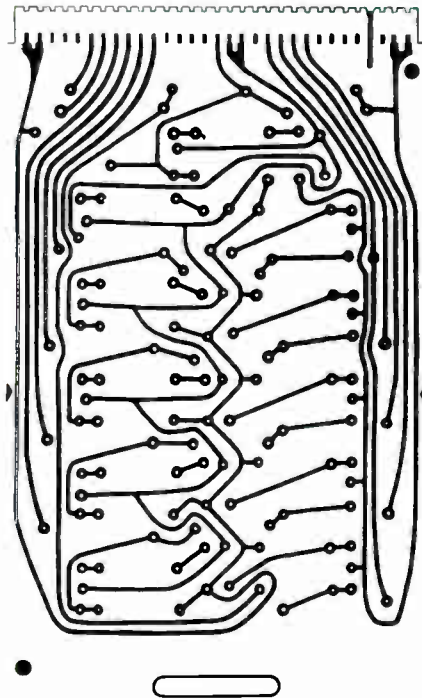
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electrosil electronic components – trend setters for industry

TYPE NUMBER	Power Rating	Ohmic Range	Standard Tolerances
 TR4	$\frac{1}{10}$ W @ 70°C $\frac{1}{8}$ W @ 70°C $\frac{1}{4}$ W @ 70°C	51 – 150K	5% 2% 1%
 TR5	$\frac{1}{8}$ W @ 70°C $\frac{1}{4}$ W @ 70°C $\frac{1}{2}$ W @ 70°C	10 – 470K	5% 2% 1%
 TR6	$\frac{1}{4}$ W @ 70°C $\frac{1}{2}$ W @ 70°C 1W @ 70°C	10 – 1M	5% 2% 1%
 TR8	$\frac{1}{2}$ W @ 70°C 1W @ 70°C 2W @ 70°C	100 – 1.4M	5% 2% 1%

Triple rated metal oxide film resistors

The Electrosil TR range is the most versatile ever available. One resistor may be used at three ratings – semi-precision, high stability and general purpose. Full Qualification Approval has been granted to the TR5 and TR6 at both semi-precision and general purpose ratings and supplies are readily available from bonded stock.

Type P Low Power Insulated Resistors



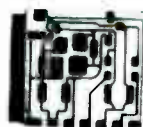
Power Ratings of 3 to 10 watts at 70°C are covered by the new P range of insulated oxide film resistors. The rugged construction leads to reliable performance across the full ohmic range, and prices are very much less than for comparable vitreous enamelled wire resistors.

CYFM glass capacitors



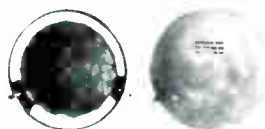
The CYFM range of glass capacitors is of fused monolithic construction in which the capacitive element is completely frozen in glass, with a true glass-to-metal seal at the leads. Values between 0.5 pf and 1,200 pf are covered in two case sizes.

Microcircuits



Electrosil microcircuits consist of resistors and capacitors deposited on the surface of a specially glazed high density alumina substrate. The resistive film is identical to that used in the Electrosil range of metal oxide film resistors and the combination of oxide film molecularly bonded to a glass surface is already well-known for its stability and reliability.

Digital ultrasonic delay lines



Glass digital delay lines, which use a time invariant glass as a delay medium and either quartz or ceramic transducers, represent a new generation of delay lines. They can be operated at frequencies of 2.5 Mc/s to 30 Mc/s or higher, with access time up to 15 times smaller than a high speed magnetostrictive line of comparable storage.

Glass memories

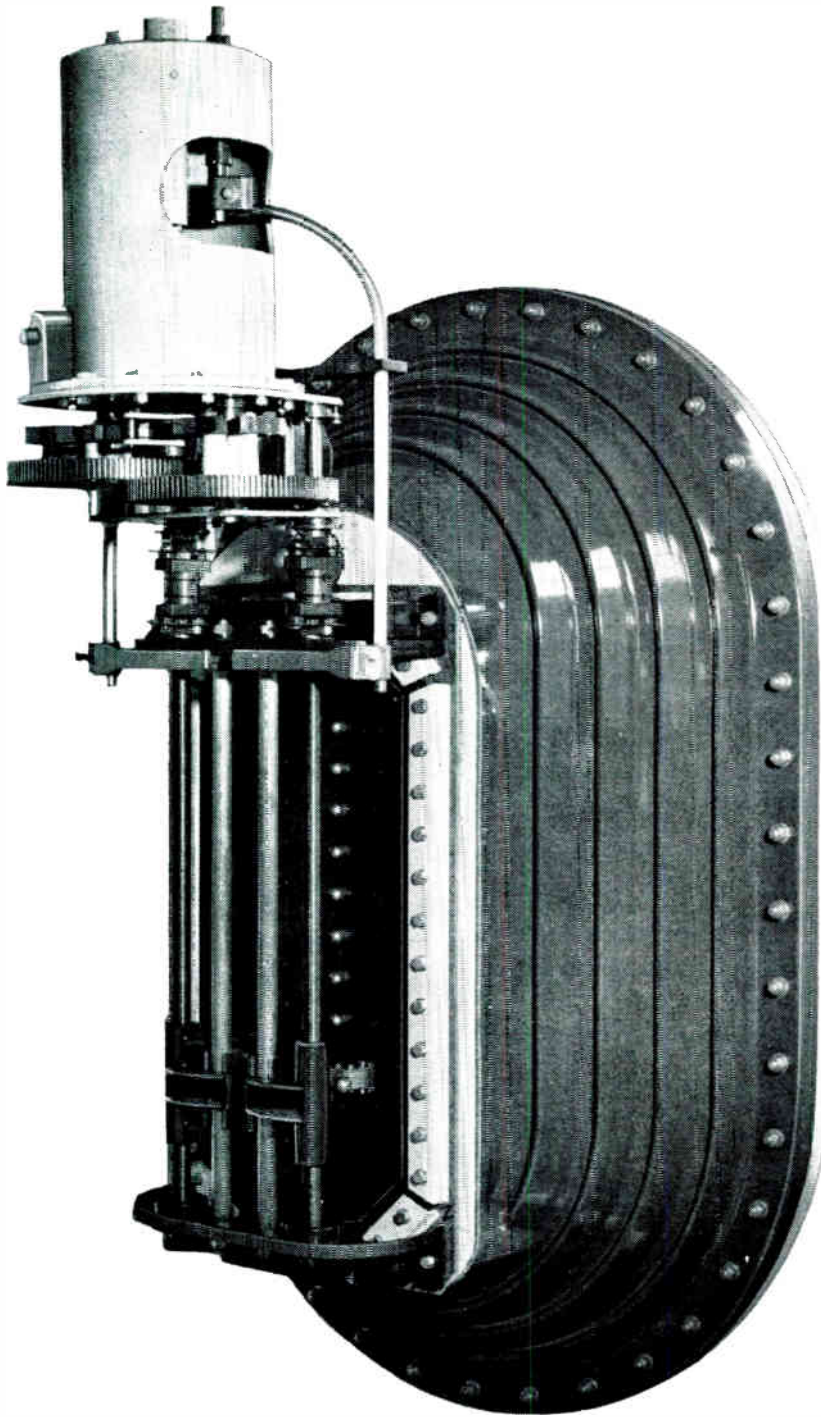
In terms of cost per bit, they are many times less expensive than cores and only slightly more expensive than drums, and can operate at rates up to 100 mb/s.



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ES/A45a



Epoxy resin casting for 132kV

The barrier panel insulation of the Ferranti high speed resistor on-load tap changer is a large Araldite casting. It forms the basic 132kV insulation and also acts as an oil-tight barrier capable of withstanding a vacuum, between the transformer tank and the selector switch. Araldite was chosen because of its excellent electrical properties, resistance to oil, and mechanical strength. An epoxy resin casting is considerably less bulky than an equivalent in other materials. By designing for Araldite, electrical equipment can be reduced in size and weight, while efficiency is increased. The remarkable adhesive properties of Araldite enable metal inserts to be cast in situ. As shrinkage during setting is negligible, an Araldite casting can be made to close limits; castings can be drilled, machined and finished by normal methods.

Further information on Araldite casting resins will be sent gladly on request.

C I B A

Araldite epoxy resins

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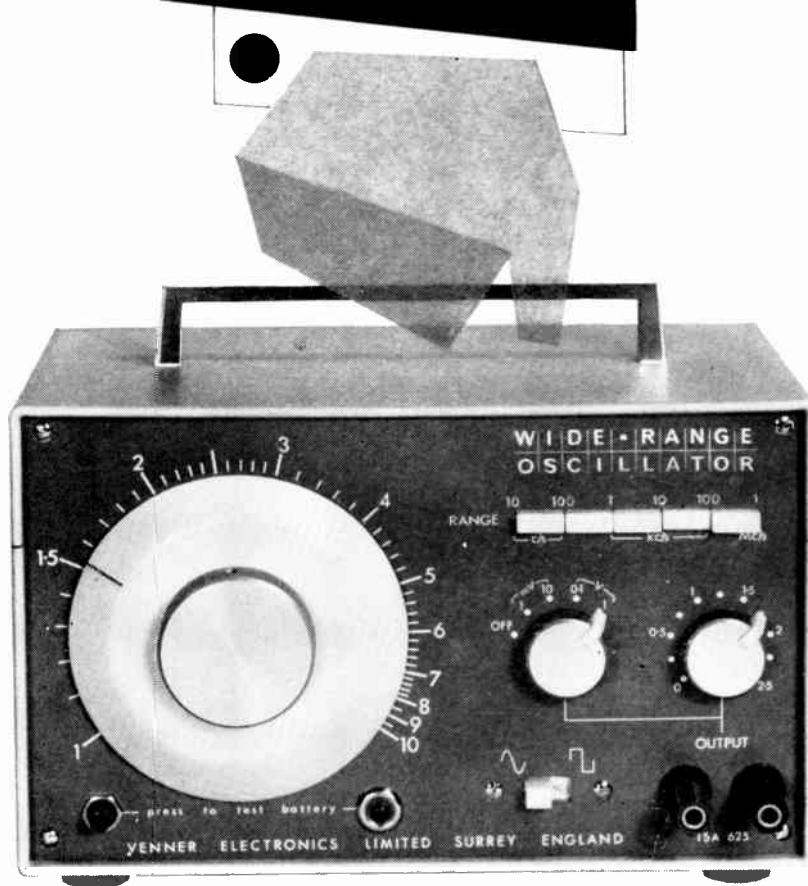


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2H1254 2H1255 2H1256 2H1257 2H1258 2H1259 HT100 HT101	TO-18 Case	<p>A unique range of double-diffused 100 Mc/s switching transistors.</p> <p>BV up to 50V hFE specified max/min values within range 14 - 150</p> <p>$V_{ce(sat)}$ 0.3V $t_d + t_r$ 25nanosec</p>
2N1254-9	TO-5 Case	

2H1254-9 Type Approved CV 7484-9

2N1131 2N1131A 2N1132 2N1132A 2N1132B	TO-5 Case	<p>Medium power general purpose transistors available in either TO-5 or TO-18 case style.</p> <p>Min f_t 60 Mc/s BV up to 60V hFE specified max/min values within range 20 - 200</p> <p>$V_{ce(sat)}$ 1.5V</p>
2N721 2N722	TO-18 Case	

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PLANAR PASSIVATED

2N706 2N706A 2N706B 2N707 2N708 2N753 2N914	TO-18 Case	<p>A preferred range of 300 Mc/s transistors with excellent switching characteristics.</p> <p>BV up to 56V hFE specified max/min values within range 9 - 120</p> <p>$V_{ce(sat)}$ 0.4V</p>
2N717-720A 2N870-1 2N910-2 2N956 HT400-1	TO-18 Case	

2N696-9 2N1613 2N1711 2N1893 2N1889-90	TO-5 Case	<p>70 Mc/s medium power general purpose transistor available in either TO-18 or TO-5 case style.</p> <p>BV up to 120V hFE specified max/min values within range 20 - 100</p> <p>$V_{ce(sat)}$ 1.5V</p>
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M & P HM24

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UNDER THE SEA

Ersin Multicore Solder is made in Europe's largest cored solder factory, and contains only the purest tin and lead plus five cores of extra-active non-corrosive Ersin flux. It is undoubtedly the world's finest and most reliable cored solder. **THERE IS AN ERSIN MULTICORE SOLDER FOR YOUR PURPOSE . . .** whether it be the rapid soldering of miniature components by a production soldering process, or the individual production of large units of equipment such as fully transistorised submersible repeaters. Alloy, diameter of the solder, type and percentage of flux in the cores—less fumes are liberated—less flux residue is left.

For production soldering processes Ersin Multicore Solder with 362P Ersin flux in 60/40 and Savbit No. 1 alloys, and containing an exclusive agent Pentacol, promote the extra rapid spread of the lower percentage of flux in the cores—less fumes are liberated—less flux residue is left.

Multicore Savbit Alloy, to which a precise amount of copper is added prolongs bit life up to ten times, ensures more consistent soldered joints, and eliminates maintenance of soldering iron bits.



Ersin Multicore Solder is shown being used at the Erith factory of Submarine Cables Ltd., in the production of a submersible repeater designed to last for a minimum of 20 years under the sea without attention.

The life and reputation of any piece of electronic equipment can rest entirely on the solder used in assembly, a minute fraction of its cost. That is why the finest, most dependable cored solder is invariably the most economical and best. Ersin Multicore is the most widely used cored solder in the U.K. and is exported to over 50 overseas countries.

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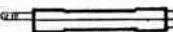



Engineers and technicians are invited to write on their Company's letter heading for the completely revised 6th Edition of the 24-page booklet "MODERN SOLDERS" containing data on melting points, gauges, alloys, etc. Also, reprint of "Industrial Electronics" article "Erosion of Soldering iron bits", by P. Sharples.

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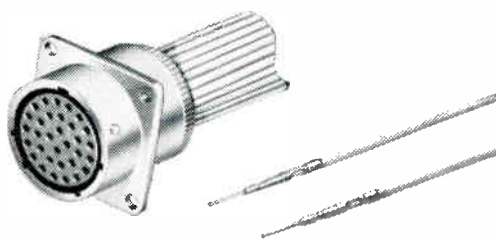
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INDUSTRIAL ELECTRONICS

Comment

We are now so familiar with satellites and their launching that few give any thought to the technicalities involved or the great precision needed to put them on course. Some realization of the precision now obtainable in modern scientific apparatus (mainly by the aid of electronics) may be obtained from the fact that it is now possible to send a stellar telescope up to 80,000 ft by a balloon, point it at a given star, and photograph that star with an exposure time of one hour!

When one thinks about how an object suspended from a balloon swings about this seems quite incredible. It is even more incredible when the telescope weighs 3 tons and has a 36-in. aperture optical system with a photographic resolution of 0.1 second of arc. It can distinguish two objects 30 in. apart at 1,000 miles!

The necessary stability is achieved with the aid of television and servo systems. There are two television systems, a coarse and a fine with much larger fields of view than the photographic system. There are remote control and telemetry systems. Using the coarse television system first, and then the fine, two reference stars are brought into view by remote control, and then an automatic 'lock-on' system is brought into action to keep the telescope pointing in a fixed direction using these stars as reference. This sounds simple enough and, in principle, it is. The surprising thing is the accuracy which can be achieved, 0.02 second of arc.

Known as Stratoscope II, the system has already made two flights. In March 1963 it was used to gather infra-red data on the atmosphere of Mars. In November it was directed at 10 objects, including Jupiter. Late this year the first photographic flight is expected to take place.

The system has been designed and built by the Perkin-Elmer Corporation and is sponsored by the National Science Foundation, the Office of Naval Research, and the National Aeronautics and Space Administration. It is being directed by Professor Martin Schwarzschild of Princetown University Observatory and the object is to gather information about celestial objects without interference from the dust and water vapour of the atmosphere.

Valves and Reliability

The valve is usually considered to be one of the most unreliable parts of electronic equipment and one of the greatest advantages of the transistor is thought to be its much greater reliability. There is, of course, no doubt that the transistor is more robust than the valve in that it will withstand much rougher handling, but in a suitable environment the valve is a very reliable device indeed.

Valves are used in the submerged

repeaters of submarine cables and are expected to have a life of 20 years continuous operation. They are low-power types of special design and are in a supremely quiet environment. It will be a surprise to many, however, to learn that even quite high power valves can have long lives. Two CAT 27 (M-O Valve Co. Ltd.) triodes used in the B.B.C. Overseas Service at the Rampisham station have recently been withdrawn from service after 63,000 hours of operation and many

valves of this type are still in use after an even longer operating time. The valve has a rating of 150 kW and is thus very different indeed from those used in submerged repeaters.

The moral is that valves are not necessarily unreliable, but they certainly will not withstand extremes of vibration and shock so well as the transistor.

Super Ultrasonics

It is reported from the U.S.A. that it is now possible to generate ultrasonic waves with a frequency as high as 9,000 Mc/s. This comes about through a new transducer developed by Westinghouse. This is a film, some 10^{-4} to 10^{-5} inch in thickness, of cadmium sulphide which is grown in vacuum to be as nearly as possible a single crystal structure.

The transducers are being used in the study of the structure of materials like ruby and sapphire. A great advantage of the mode of construction is that the transducer, being a thin film, can be deposited directly on the material under investigation.

Radar and Trains

At first sight it seems very odd that radar should be used to find a train. There would seem to be so many easier ways of doing it! Nevertheless, experiments are being carried out in the Edinburgh area by Ferranti.

A surface-wave transmission line is mounted alongside the track and energized at radio-frequency. The presence of a train provides, in effect, a local discontinuity in the line and energy is consequently reflected at that point. As a result, both the position and speed of the train can be determined.

It seems probable that this alone might not be worth while, but the transmission line, being wideband, can also be used for communication with the train.

Plasma

We are hearing a lot about plasma nowadays especially in connection with the magneto hydrodynamic generation of electricity. It is now proposed that plasma jets should be used for steering satellites.

Those who do not know what a plasma is will get no help from the dictionary. The word is given but is defined as a green variety of quartz, or a colourless coagulable part of blood, lymph or milk! 'Chamber's Technical Dictionary' adds 'the region in a gaseous discharge where there is no resultant charge, the number of positive ions and negative ions being equal, in addition to unionized molecules'. The penultimate word, incidentally, has nothing to do with

unions, it is un-ionized. The 'International Dictionary of Physics and Electronics' has a definition which is too long to quote; it is to the effect that a plasma is an electrically neutral assembly of ions, electrons, neutral atoms and molecules in which the motion of the particles is dominated by electromagnetic interactions.

No dictionary gives any help about the proper form for the plural of plasma. We think it should be the same as the singular, but 'plasmas' is being used. In this state of doubt we have had to be careful to avoid using the plural here!

For steering a satellite a plasma jet is proposed by Westinghouse. It appears that quite small jets with a thrust of less than a pound suffice and that a plasma jet of this kind can be started at less than 100 volts and maintained with a power of under 100 watts. The idea thus seems quite feasible.

Valve Sales

Last month we quoted some export figures for valves, tubes and semiconductors, the total for the second quarter of 1964 being £2,626,723. B.V.A. and V.A.S.C.A. have now issued figures for the total values of their members' sales for the same quarter. These amount to £18,600,000 of which two-thirds is for valves and tubes and one-third for semiconductor devices.

The Birth of Electronics

Talking about valves reminds us that it is just 60 years this month since Sir Ambrose Fleming invented the thermionic diode. The triode amplifier is usually attributed to Lee de Forest and came two years later. These inventions really mark the birth of the electronics industry, although development was very slow indeed at first.

It could be argued that since semiconductors are electronic devices some of the early work on crystals could be taken as putting the birth of electronics even further back. In 1874 Braun discovered that metallic sulphides, galena and copper pyrites passed current more readily in one direction than the other. However, the true crystal detector does not appear to have been invented until 1906, so valves and semi-conducting devices really appeared at much the same time.

In spite of the fact that crystal detectors were widely used and, after about 1930, copper-oxide and selenium power rectifiers became common, they remained mysterious devices until much fundamental work had been done. This culminated in the invention of the transistor in 1948 and this really marked the beginning of the semiconductor age.

The vibration of mechanical parts can be a nuisance as well as affecting the accuracy of machine tools. This article describes apparatus which enables vibration to be detected and analysed.

ALTHOUGH vibration is an essential part of our lives it can also be a nuisance and, in fact, a danger at the wrong time, in the wrong place, at the wrong frequency or amplitude. Although there can be no sound without vibration the converse does not apply.

Sources and Effects of Vibration

Many types of equipment depend on vibration for their proper functioning. Ultrasonic equipment is of this type¹, as are vibrators for compacting cement and foundry sand, shaker conveyors and so on. The vibrations of such equipment are imparted to the surrounding air and provided that the frequency of vibration falls within the audio-frequency range (about 16–16,000 c/s), the ear will become aware of them as sound. All musical instruments depend for their effect on the generation of vibrations in some form or another; violins have their strings, organs their pipes and drums their skins. Vibration of the vocal cords modified by the mouth, results in speech.

For music or speech there must be vibration, but this also takes place in all types of equipment and machinery which have moving parts. In some cases this vibration does not matter, in others it matters quite a lot. There are two basic objections to vibration in machinery; some vibrations can be heard as sound which can become a nuisance and even do damage to the ear depending on amplitude and frequency; almost all vibrations may, in due course, impair the proper functioning of the equipment itself, other nearby plant or even the structure housing the machinery. For these reasons it is necessary to ensure that vibration which is not essential to proper functioning should be reduced to a minimum.

Vibration Detection

To achieve this there must be detection, measurement, analysis and control of vibration. The human sense of hearing can be of some help in combating audible vibrations but it is a doubtful helpmate. The judgment of the ear is subjective, its response to various sounds depending on such factors as fatigue, age, emotional state, health and many others.

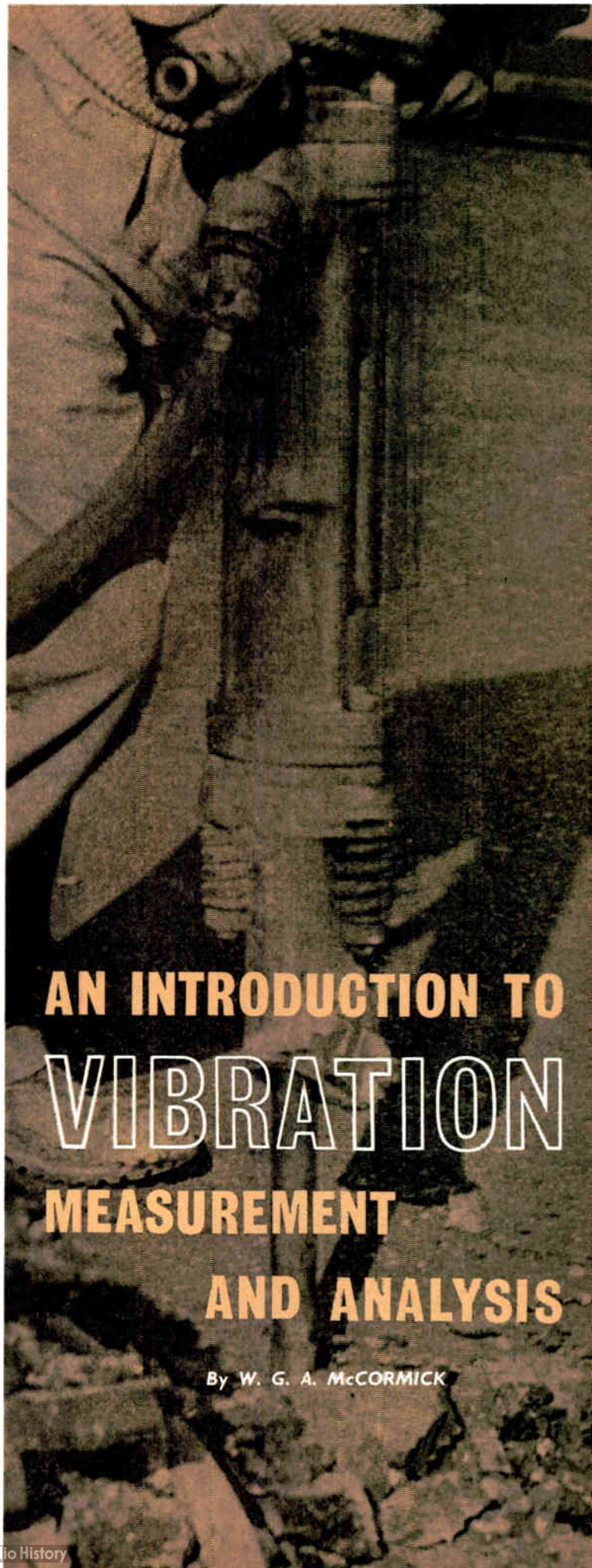
Sound-level meters, which place the measurement of sound on a scientific footing, are a great step forward, but both the ear and the sound-level meter record the sum of all sound present in any location; neither can determine directly how much of the noise present is due to the vibration of any one body in the vicinity.

Vibration Parameters and their Measurement

Vibration-measuring instruments do not suffer from this fault since a probe unit, which is normally part of the instrument, is placed directly in contact with the vibrating body and therefore picks up only the vibration of this particular component: the instrument then converts the vibrations into an electrical signal.

When a sound or vibration has been converted to an electrical signal, by means of a microphone or pick-up unit respectively, this signal takes a general form in both cases since sound and vibration are closely related. Due to this a standard sound-level meter can be used as a vibration meter by replacing the microphone with a suitable

Griffin & George Ltd. (formerly Dawe Instruments Ltd.)



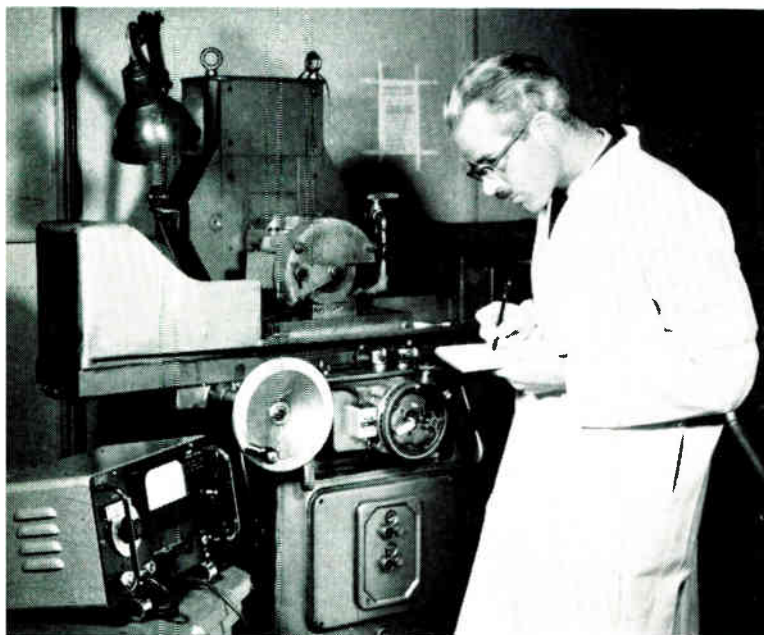


The latest type of vibration meter with accelerometer type pick-up

pick-up adaptor unit. Such a conversion saves a certain initial expenditure where only a restricted number of vibration measurements are required; it is, however, obviously desirable to use an instrument specially designed for the purpose when vibration investigations are to be its main function.

To serve any useful purpose the measurement of vibration must produce the answer in terms of the three common parameters of vibration, amplitude, velocity and acceleration. The subsequent vibration analysis uses one or other of the parameters, depending on the object to be achieved and the type of equipment under investigation. A common pick-up is the inertia-operated crystal type which delivers a voltage proportional to the acceleration of the applied

A Dawe type 1403 vibration meter being used for vibration checks on a Jones & Shipman surface-grinding machine during installation. (Photo by courtesy of Jones & Shipman Ltd.)



motion. For the measurement of velocity or displacement the output of the pick-up unit can be passed through a single or double-integrating circuit respectively. The type of response can be selected by switches in such a manner that the acceleration, velocity and displacement are measured independently and displayed at will.

Other components of the circuit can include an adjustable attenuator and a high-gain amplifier. Insertion of an attenuator before the amplifier stage enables the instrument to cover an extremely wide range by adjustment of an attenuator control. The meter reading then has to be multiplied by a factor, governed by the attenuation, to give the true value of the vibration.

The more modern method of measurement (the Dawe Type 1433), using the standard accelerometer probe, covers parameter ranges of the order of from 3 micro-in. (0.000003 in.) to 300 in. of vibration amplitude, velocities of vibration from 3,000 micro-in. (0.003 in.) to 3,000 in. per second and accelerations of vibration from 3 in. per second per second up to 30,000 in. per second per second. The standard pick-up is capable of withstanding up to 2,000 g peak sine wave cycle or 50,000 g shock. This facility is found most useful when testing for resistance to impact shock. The maximum amplitude of 300 in. is greater than normal conditions require but it could undoubtedly be useful for measurements involved in pure research.

Current research into the effects of rate of change in acceleration, (i.e., rocketry and space research) has disclosed a new parameter 'jerk' (which is expressed in in./sec³). Facilities for measurement of this parameter exist in the instrument illustrated.

The decision as to which parameter to use in a given vibration analysis is largely a matter of experience. When ascertaining the effect of vibration on the strength of a component amplitude is of prime importance.

In a machine shop, on the other hand, vibration of much lower amplitude but of higher acceleration will have far greater effect on surface finish. If, for instance, the effect on the work of a grinding machine is considered, with the machine in a workshop aboard a gently heaving ocean liner, the effect on the work of the extensive bodily movement will be negligible. If, however, the same machine were on a vibrating table the work turned out would be clearly useless.

To ensure optimum quality of work, manufacturers generally recommend that all their machines should be checked during installation for the effects of vibration either transmitted through the mountings, etc., from other machines, or self-generated due to incorrect levelling during installation. The illustration shows the author using the Dawe type 1403A Vibration Meter to carry out such recommended vibration checks on a Jones & Shipman Surface Grinding Machine being installed in a newly re-arranged workshop.

This type of instrument gives direct reading in absolute values of displacement, velocity and acceleration.

A pick-up of the moving-coil type is used in this instance. It gives an output voltage proportional to the velocity of the motion under investigation, thus voltage is fed through attenuators and amplifiers to the meter indicator for velocity measurements. For displacement indication the voltage or signal is first passed through an integrating circuit and for acceleration measurements through a differentiating circuit before amplification.

More searching checks can be made by analysis of the vibration. This can be carried out by plugging an audio-frequency analyser into the socket provided on the control panel of the vibration meter (the signal can also be displayed on a cathode-ray oscilloscope). A typical a.f. analyser is the Dawe type 1461A illustrated which can be

used to measure the frequency and amplitude of components of complex waveforms in the ranges 2.0 to 20,000 cycles per second. This instrument in effect splits up the single overall reading of vibration into its constituents in different frequency ranges. If the characteristic frequencies of the different sources of vibration are known it should then be possible to pin-point the source of the unwanted vibration. The analysis also provides the information on which remedial action can be based.

In rotating machinery the source of vibration is often due to unbalance² of the rotating parts. The vibration meter is used to ascertain the location of the part in question which can then be correctly balanced, eliminating the unwanted vibration.

Although the inherent versatility of the vibration meter is essential where a wide range of vibration analysis is likely to be encountered, a little ingenuity will often enable specific problems to be solved with much more simple equipment. A typical example of such techniques being employed is in the design of jet engines for high-speed aircraft. The manufacturers encountered many problems which have been made more difficult because of the extremely rapid development of this type of power unit. A peculiarity of the jet engines is that although the amplitude of the vibration is much smaller than that of piston-type power units, the forces associated with their vibrations are greater. It therefore became necessary to check the vibration of jet engines as a routine matter in the course of normal production testing. For such routine work it is not generally practicable to use an oscillograph as an indicating instrument. It is far more convenient to use a

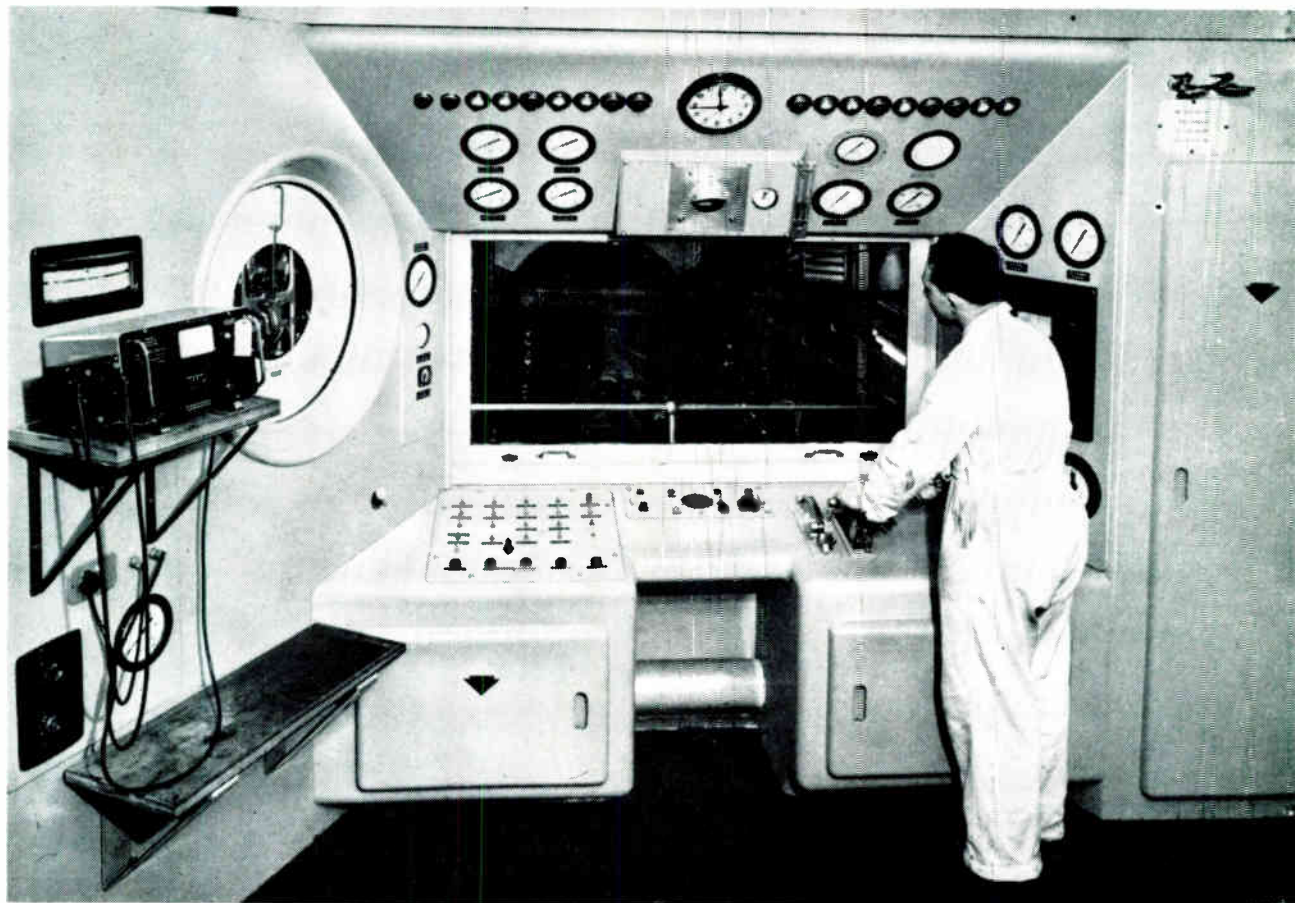


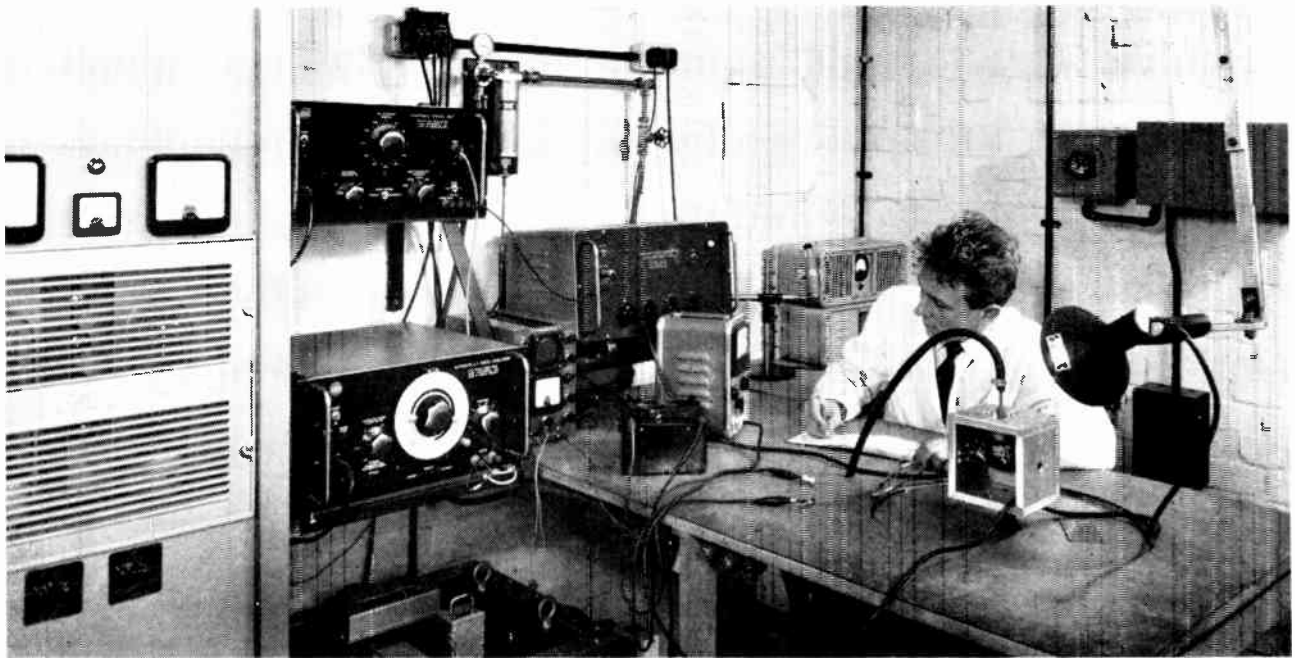
A typical portable a.f. analyser complete with self-contained power supply

meter indicating directly in movement and calibrated in thousandths of an inch.

The research involved to achieve this method of indication resulted in the development of the Dawe type 1416B Rolls Royce Roughness Measuring Set illustrated being used to test Rolls Royce 'Avon' jet engines for vibration.

Rolls-Royce jet engines being tested for vibration. (Photo by courtesy of Rolls-Royce Ltd., Derby)





Resonance search-testing of pressure sensitive aircraft instruments. (Photo by courtesy of R. W. Munro Ltd., London)

This instrument provides direct indication of peak to peak displacement in four full-scale ranges of 3, 10, 30 and 100 thousandths of an inch.

Another example of how components and instruments are checked for effects of vibration is typified by the way R. W. Munro Ltd., of London, ensure that their aircraft instruments are airworthy as far as vibration is concerned. Before a new instrument type is accepted as suitable for service it must pass many stringent tests, one of the most important being a resonance search test.

This test ensures that the performance of the unit is not affected by resonance at an induced vibration within the frequency range to which the unit may be subjected in service. An illustration shows a section of the special vibration laboratory in the Munro Test Department. A vibrator is controlled by a Dawe Automatic Low Frequency Sweep Oscillator which has a range from 5 c/s to 5 kc/s covered by a single sweep of the dial. A built-in motor drives the sweep control to give various sweep rates between desired limits; the direction of sweep can also be arranged to reverse automatically at the limiting frequencies. The output amplitude is held constant.

To enable the effects of induced vibration on the test unit to be observed, a Dawe Variphase Strobe Unit is used to provide an output signal for triggering a stroboscope, the output signal frequency having a constant frequency difference in relation to the input frequency which is derived from the automatic l.f. sweep oscillator. The difference frequency is adjustable from 0 to 1.5 c/s which allows the movement of the vibrating object under test to be frozen³ or examined in uniform slow motion, irrespective of its true rate of vibration. This feature is of particular value in automatic resonance tests employing the automatic sweep facility of the oscillator. Without the Variphase unit frequency changes of the oscillator would have to be followed by manually adjusting the frequency of an independent stroboscope, which would be almost impossible. The phase of the output signal can be varied through 360° allowing any desired point in the vibration cycle to be frozen. The characteristics of the applied

vibration can be monitored by mounting a pick-up on the vibrator in the same rig as the object under test. The output from the pick-up can then be fed to a vibration meter.

This article has only dealt with a superficial study of the nature, effects and analysis of vibration and hinted at the extent to which electronics assist in detection and provision of information for its elimination and/or absorption. Some industrial examples have also been given which it is hoped will suggest to the reader the extent of the problems faced in this field.

References

- ¹ 'Cleaning by Ultrasonics', *Industrial Electronics*, August 1963.
- ² 'Dynamic Balancing', *Industrial Electronics*, February 1963.
- ³ 'Stroboscopes in Industry', *Industrial Electronics*, December 1962.

D C C U S

SGS-Fairchild have announced price reductions for integrated circuits for the commercial and industrial markets. The units are guaranteed over the temperature range 15-55 °C and are available in nine different types which include a buffer stage, a half-shift register, an expander and a flip-flop as well as a variety of gates.

Prices range from 54s to 136s for the various types in lots of 1-24, 43s to 108s 6d in lots of 25-99 and 36s 6d to 91s in 100 lots. Intermediate prices apply for a lot of 100 of mixed types.

The circuits are of the silicon planar epitaxial integrated type and can readily be connected together to form digital equipment.

For further information circle 51 on Service Card

CODED MAGNETIC CHARACTERS

This article describes characters which can be printed in magnetic ink and read by a machine. They are sufficiently like ordinary numbers and letters to be easily recognizable.

By G. E. THORNE*

Print drum of the CMC 7 printer incorporating both standard and CMC 7 characters

THE system of coded magnetic characters devised by Compagnie des Machines Bull and known as CMC 7, has been accepted by the majority of European bankers and is already being used by banks in France and Italy. What follows is a description of the code itself, of the method of reading it and of the equipment designed by Bull for printing, reading and sorting CMC 7 documents as well as for converting punched cards into the form of coded documents.

The Structure of the Code

The CMC 7 code is immediately legible by the human eye. The shape of each character is based on a combination of seven vertical bars, and is recognized by machine according to the allocation of short and long spaces between them. This allocation is based on a code of the binary type which allows for the formation of the complete alphabet, in addition to the digits 0 to 9 and a set of special symbols—a total of 41 characters in all. No other m.i.c.r. (magnetic ink character recognition) system is so completely comprehensive.

Each of the seven bars in a character is 0.145 mm wide, the distance between two bars—'short' or 'long'—being 0.3 mm or 0.5 mm. The magnetic code for numerals uses two long and four short spaces, thus allowing for 15 possible combinations: these are used for the ten digits and five symbols. The positions of the spaces within the characters are shown in Fig. 1, in which 0 is a short space and 1 a long space. The Roman numerals on the right indicate the positions of the five symbols used in conjunction with the numerical code.

An alphabetical character is coded in one of two ways as shown in Fig. 2: by three long and three short spaces, or by one long space and five short ones. As before, long spaces are indicated by 1 and short by 0.

The tolerances for bars and spaces are as follows:

- (a) Bar width: 0.145 ± 0.04 mm.
- (b) Bar height: at least 0.7 mm (normally 1.2 to 3.2 mm).
- (c) Length of spaces *within* a character: 0.30 ± 0.04 mm (short) or 0.50 ± 0.04 mm (long).
- (d) Length of space *between* characters: 0.79 to 2.42 mm (very long).

Layout of Coded Data

If a document coded with CMC 7 characters is to be read or sorted by machine, then the document itself and the position of the characters must conform to certain tolerances. The lower edge of the printing band must be 4.8 mm from the lower edge of the document. The characters must be printed within this band, which is 6.4 mm in depth.

Printed data may be divided into character-groups, which in turn are grouped into blocks (Fig. 3). The beginning of

* De La Rue Bull Machines Ltd.

POSITION OF SPACE FROM LEFT OF SYMBOL						SPECIAL SYMBOL	
1	2	3	4	5	6		
1	1	0	0	0	0	7	
1	0	1	0	0	0	3	
1	0	0	1	0	0	4	
1	0	0	0	1	0	1	
1	0	0	0	0	1	S	I
0	1	1	0	0	0	2	
0	1	0	1	0	0	9	
0	1	0	0	1	0	8	
0	1	0	0	0	1	S	II
0	0	1	1	0	0	0	
0	0	1	0	1	0	6	
0	0	1	0	0	1	S	III
0	0	0	1	1	0	5	
0	0	0	1	0	1	S	IV
0	0	0	0	1	1	S	V

Fig. 1. Numeric characters and special symbols (S)—each with two long spaces (1)

POSITION OF SPACE FROM LEFT OF SYMBOL						SYMBOL
1	2	3	4	5	6	
0	1	0	0	0	0	A
1	0	1	0	1	0	B
0	0	0	1	1	1	C
1	0	0	1	1	0	D
0	0	0	1	0	0	E
0	0	1	0	1	1	F
1	0	0	0	1	1	G
1	0	1	1	0	0	H
0	0	0	0	0	1	I
1	0	1	0	0	1	J
0	1	1	0	1	0	K
0	1	0	0	1	1	L
0	0	1	1	1	0	M

POSITION OF SPACE FROM LEFT OF SYMBOL						SYMBOL
1	2	3	4	5	6	
0	0	1	0	0	0	N
1	0	0	0	0	0	O
0	1	0	1	1	0	P
1	1	1	0	0	0	Q
0	1	1	1	0	0	R
0	1	0	1	0	1	S
0	0	0	0	1	0	T
1	1	0	1	0	0	U
1	1	0	0	0	1	V
1	0	0	1	0	1	W
1	1	0	0	1	0	X
0	1	1	0	0	1	Y
0	0	1	1	0	1	Z

Fig. 2. Alphabetic characters: with one or three long spaces

each block is marked by one of the special symbols. Two adjacent character-groups must be separated by a space of more than 4 mm—an 'extra long' space. The significance of a character-group (e.g., an account number, a branch number) is determined by its position on the document: an account number, for example, might always appear at F in Fig. 3.

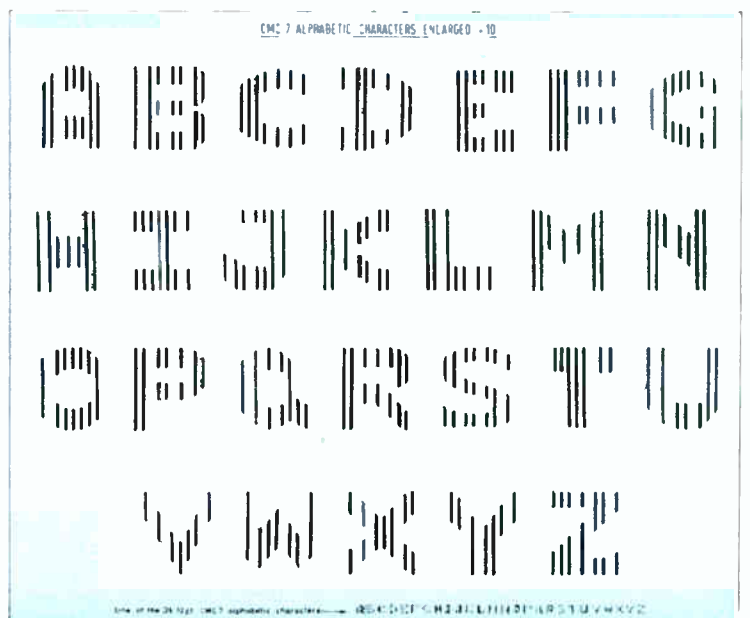
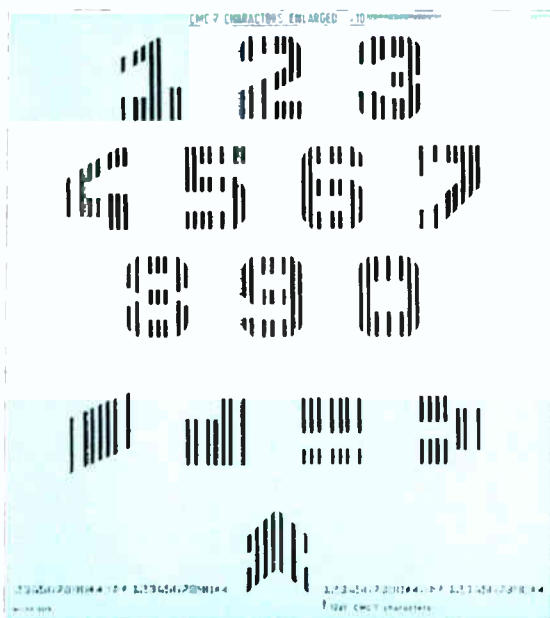
This method of designating blocks of data by means of symbols allows the reader or reader/sorter to distinguish easily between different types of document. During a single machine run it is therefore possible to process documents with data in varying positions and marked by the presence or absence of coded symbols.

Reading the Code

Documents are read from right to left. Each character passes first under a magnetizing head, and at this point the ink in the character is magnetized by a permanent field. The following reading head consists primarily of a magnetic field. As the document passes through its air gap each character read induces its own variations in an electric current, the signal generated by a character being a succession of 14 pulses with alternating signs—positive for a right-hand edge, negative for a left-hand edge.

As each space is recognized it is systematically recorded in one of the six positions of a special register—a long space being represented by the presence of a binary pulse.

The CMC 7 numeral and special characters are shown on the left and the alphabet on the right



a short space by the absence of the pulse. The recognition of a very long space shows that all the spaces within a character have been read and is the signal for clearing the register and transferring its contents to the decoding circuits. But if, at this stage, the necessary total of binary pulses is not present—in the case of a numeral this would be two, since each numeral has two long spaces—the document is rejected and the data already read is erased.

This recognition process operates quite independently of the ink density on each printed bar—provided always that there is the fixed minimum of ink. Nor is recognition affected by the overall shape of the character. It is therefore possible to mutilate documents printed in CMC 7 without affecting their machine readability. For example, characters can be scored through with ink or pencil, or the paper can be creased: provided its height is not decreased below 0.7 mm the bar will still be read.

CMC 7 Magnetic Character Reader

This unit, designed to read data direct to a computer, consists basically of three interconnected components: a reading head, a pre-amplifier and recognition circuits. The method of reading has already been described. The reading head is a single-channel type, and both the pre-amplifier and the recognition circuits are transistorized. The circuits operate on 200 volts $\pm 15\%$, 50 or 60 c/s. Depending on their size, between 350 and 600 documents can be read in one minute. For each character sensed the character register is fed with the following data: the six binary positions of the code (Figs. 1 and 2), two binary positions indicating whether the character read is numeric or alphabetic, and one check position. If a 7 were read the register would therefore be in the state shown in Fig. 4.

The corresponding voltage levels are:

- 1: $V = 0$ to $6 - 0.2$ V, with a possible flow of 10 mA towards negative potentials.
- 0: $V = 10$ V $\pm 20\%$.

These voltages, produced after the last bar sensed has moved 0.7 mm past the reading head, last for 20 microseconds. At 'half-time' (i.e., after only 10 microseconds) another (end-of-character) pulse is generated, lasting for at least 10 microseconds. In this case the pulse level is from 0 to -0.4 V for a 1 and -5 V $\pm 20\%$ for a 0. The current may be as high as 20 mA.

One of several built-in safety checks is the division of the recognition circuits into two tracks. One is used during the normal reading process; the other is sensitive only to useful signals and, whenever interference is caused by magnetic particles or ink blots, rejects all signals below a predetermined level.

210111 SICKNESS LV327586

6 5 6 5B9480 5B2600

R.EPPS ESQ. ZERO TWO
17 WATKIN RD. ZERO ZERO
CATFIELD ZERO THREE
NORFOLK

11237308811109 002 00 03

A demonstration form showing printing in normal and coded characters

CMC 7 Electronic Printer

This is the only machine so far designed to print magnetic characters at high speed. Operating at 300 lines a minute, it can be connected to a computer system, such as the Bull Gamma 30, for printing out the results of processing.

The 120 print positions can be allocated either to the full range of CMC 7 characters; or to CMC 7 numeric characters and symbols plus standard alphanumeric characters and special signs. A 120-position ferrite-core buffer store holds each line for printing. As each line is transferred to the printer the buffer is cleared to receive the next line of processed results from the computer.

The buffer is also used for a print check. As each character is printed the corresponding buffer position is filled by a special code. At the end of the printing cycle the buffer is systematically scanned and if a blank position is found, a signal is emitted and the programme is blocked.

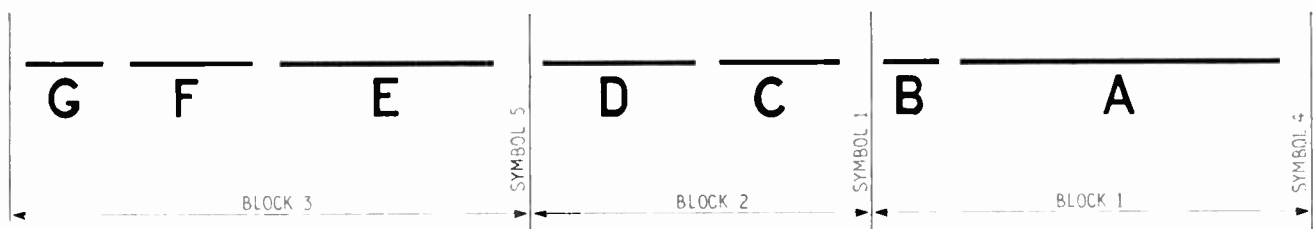
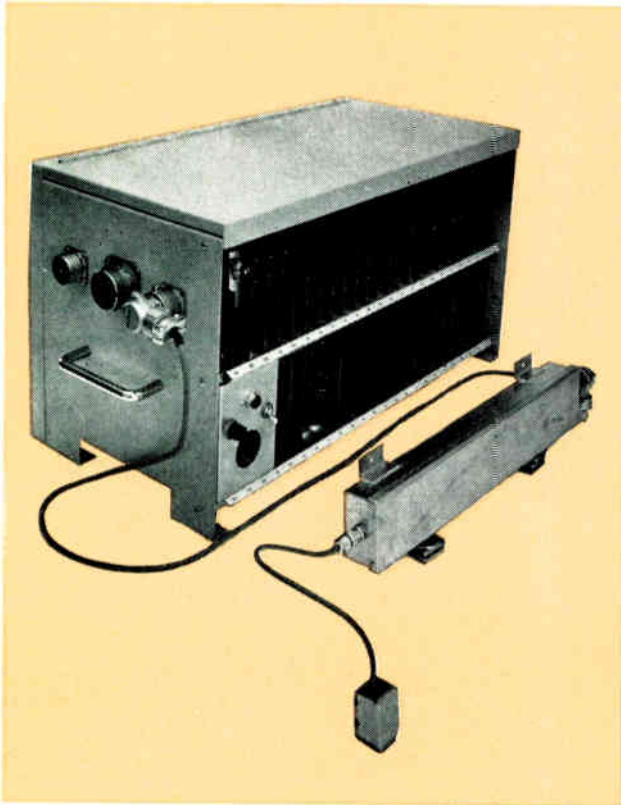


Fig. 3. Printed magnetic character line divided into character-groups and blocks

Fig. 4. (Right) Full code for the numeral 7

110000	0	1	0
7	ABSENT (ALPHABETIC CODE)	PRESENT (NUMERIC CODE)	CHARACTER CORRECT



The CMC 7 reader — the reading head, pre-amplifier and recognition circuits

CMC 7 Reader/Sorter

Unlike the CMC 7 printer, this reader/sorter operates either autonomously or as an input for a computer: the changeover is effected by a single switch.

The character recognition circuits are similar to those of the CMC 7 reader, but the reader/sorter will accept documents of several different formats simultaneously. A special control panel is used for selecting the document fields to be read or for selecting the positions within a field on which a sort is to be carried out.

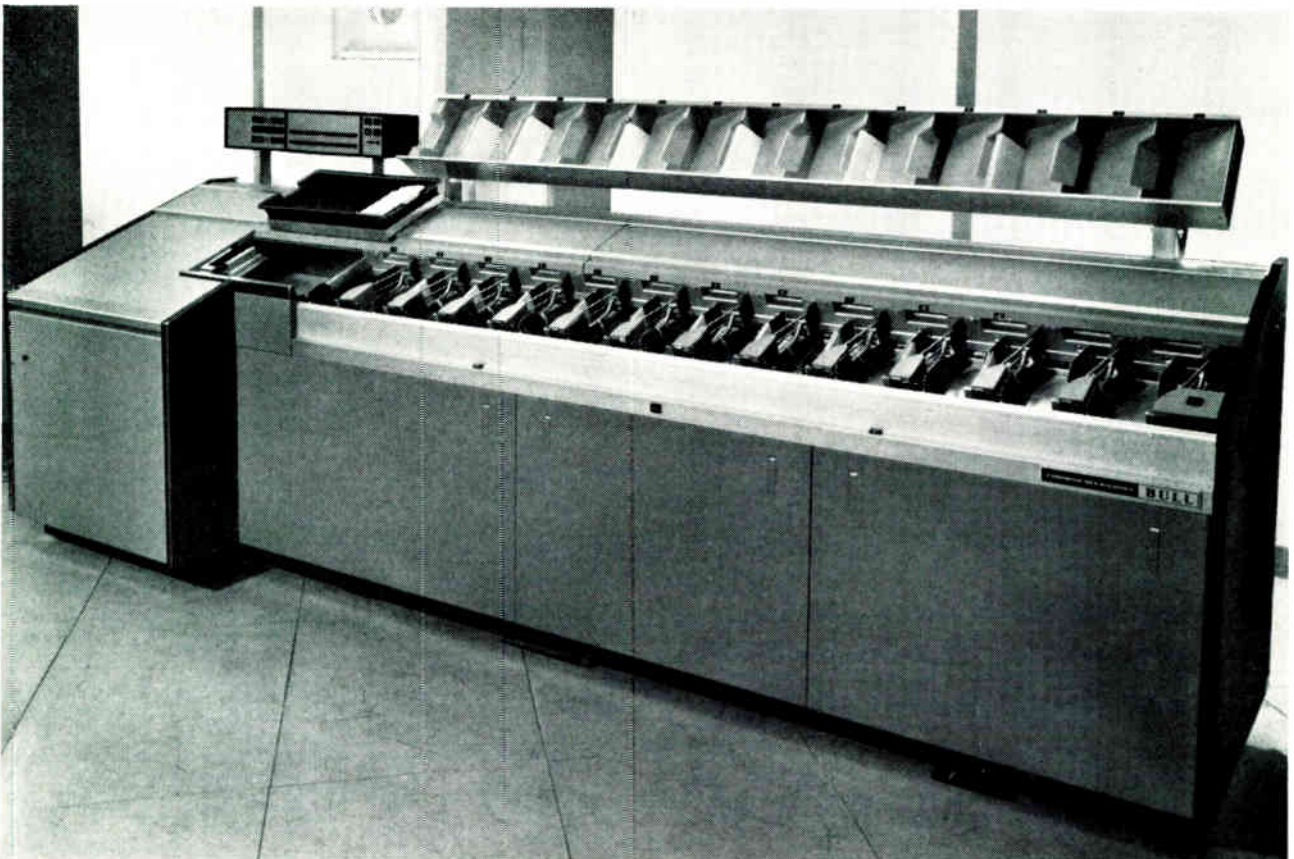
LD I Document Reader

By linking this unit, which handles up to 300 CMC 7 documents a minute, to a Gamma 10 computer with a CMC 7 print cylinder a complete 'closed-circuit' system is produced. As an example, documents such as bills can be printed with CMC 7 characters by machine, despatched to customers or subscribers for payment and, on return read back into the computer for record and analysis.

Printing CMC 7

The CMC 7 code owes its success to several elements. It is simple to print by flatbed or rotary letterpress, or by lithography. It can be easily recognized both by machine and by the human eye. Printing and paper tolerances are wide. CMC 7 documents can be printed, circulated to the public and finally processed—without transferring their data into any other form of store, such as punched cards. And CMC 7 is not prone to error: 12,000,000 cheques have been read by the Credit Lyonnais in Paris without a single error being found.

The CMC 7 reader/sorter



In order to control thyristors in power-frequency circuits a reliable firing method is to provide gate current for the complete conduction period required from the thyristor. Standard single- and three-phase circuits with this type of control are described with applications.

THE simplest thyristor (s.c.r.) firing circuits provide one (or two) gate current pulse per cycle of the supply. The pulse has a duration longer than the switch-on time of the thyristor. This is shown in Fig. 1(a).

Control is obtained by shifting the phase of the pulse with respect to the supply voltage. This type of circuit functions satisfactorily on controlled a.c. or d.c. resistive loads, but difficulties can arise with a.c. or d.c. inductive loads and d.c. back-e.m.f. loads such as batteries, capacitors or motors.

On inductive loads, circuit inductance can prevent the thyristor from reaching its holding current before the gate pulse ends, and then the thyristor never switches on. This fault can also occur in firing circuits which provide a train of pulses controlled by phase variation of the leading edge of the pulse train as shown in Fig. 1(b).

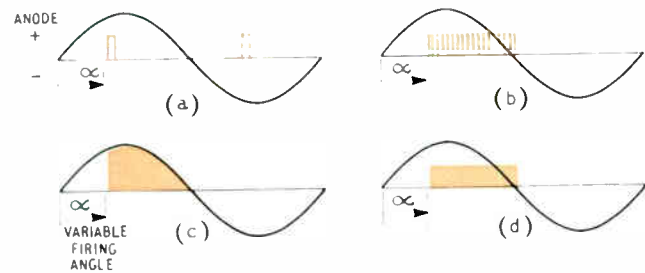
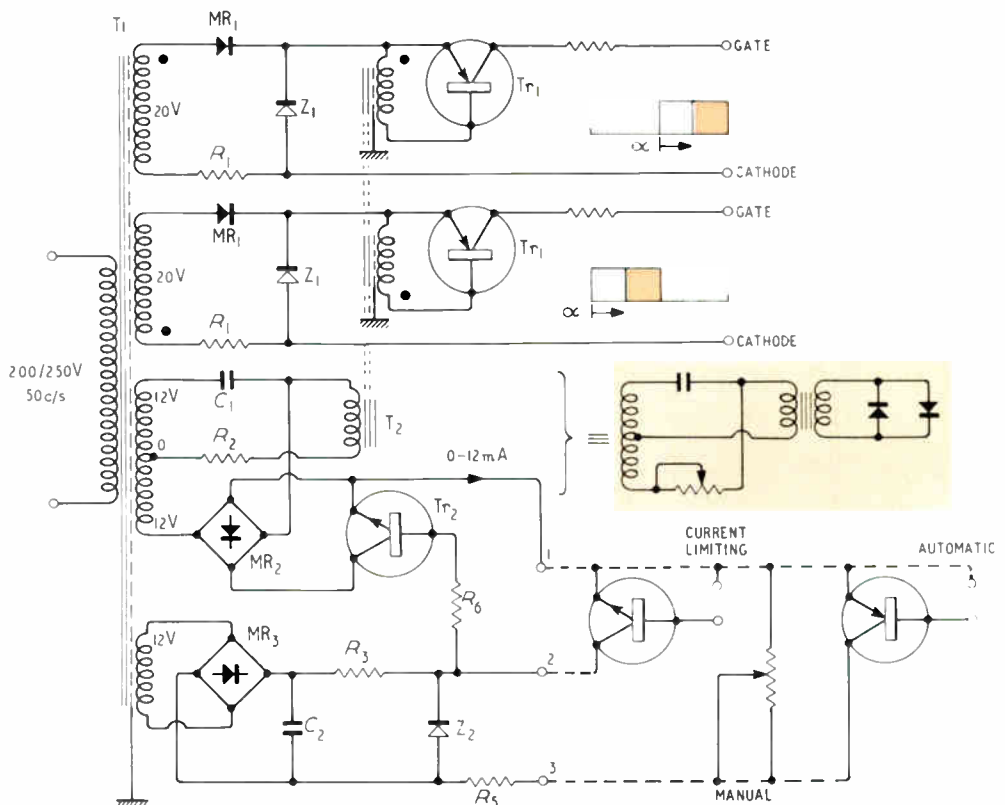


Fig. 1. (Above) The firing angle α of a thyristor can be controlled by a short pulse (a) or by a train of short pulses (b). A part sinusoidal pulse (c) is better and a half-cycle square pulse (d) is better still

Fig. 2. (Right) Single-phase circuit for generating square gate pulses of variable phase



A THYRISTOR FIRING CIRCUIT FOR A.C. POWER APPLICATIONS

By E. R. Orr, Graduate I.E.E.*

On d.c. back-e.m.f. loads the single pulse circuit may not fire the thyristor because circuit e.m.f.s when the pulse occurs may reverse bias the thyristor so that it will not switch on; it cannot conduct later when the anode polarity is correct because the firing pulse has then ceased.

Half sine-wave or half-cycle square-wave gate signals (shown in Fig. 1(c) and (d)) with variable-phase leading edges overcome these difficulties. The square-wave signal is preferable, since if the sine-wave is to give sufficient gate

* Standard Telephones & Cables Ltd.

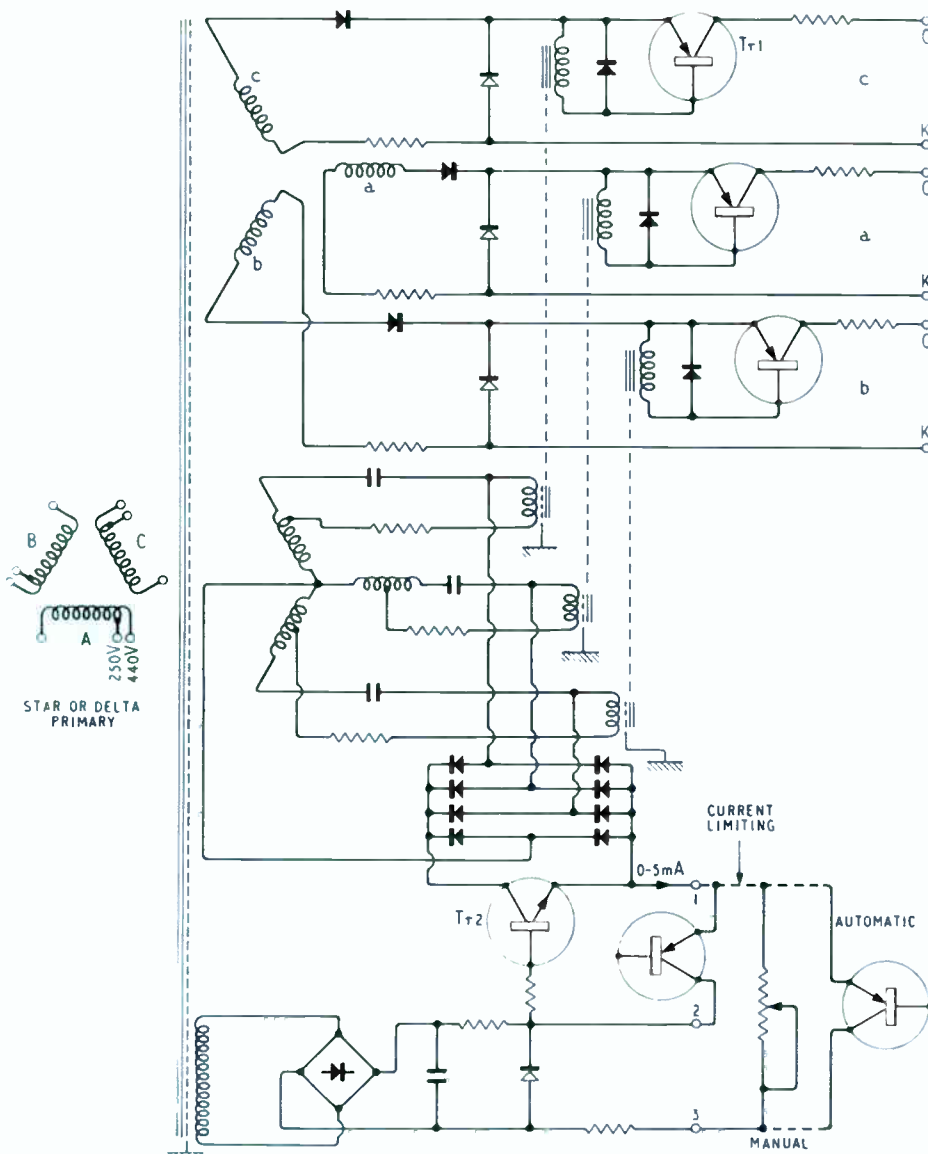


Fig. 3. Three-phase circuit. This is virtually Fig. 2 in triplicate but with a single phasing circuit

firing current at near maximum and minimum firing angles, excessive gate power dissipation can occur. The circuit described in this article provides the variable-phase leading-edge square-wave gate signals by transistors switched from a variable-phase circuit and supplied by a fixed-phase square wave.

Circuit Description

The circuit* for a single-phase supply is shown in Fig. 2. The capacitor C_1 , bridge MR_2 , and transistor Tr_2 form a conventional RC phase-shift circuit, for MR_2 and Tr_2 are equivalent to a variable resistor. The load on the phase-shifter consists of a resistor R_2 and the emitter-base diodes of transistors Tr_1 on the secondaries of transformer T_2 . Varying transistor Tr_2 from off to on will give nearly 180° phase shift, and transistors Tr_1 will be switched on for a half-cycle in antiphase to each other, and variable in phase with respect to the square waves which appear across zener diodes Z_1 . With transistor Tr_2 on, transistor Tr_1 is switched in phase with the voltage across zener diode Z_1 , and a full half-cycle of gate current fires the thyristors. With transistor Tr_2 off transistor Tr_1 is switched on nearly

in antiphase to the voltage across zener diode Z_1 and the thyristor firing angle approaches 180° .

The stabilized voltage at zener diode Z_1 is used to supply base current to transistor Tr_2 , and a variable resistor or transistor connected across terminals 1 and 3 provides smooth control of thyristor output voltage.

Earthed screens on the transformers allow the input terminals 1, 2 and 3 to be connected to earth or line potential.

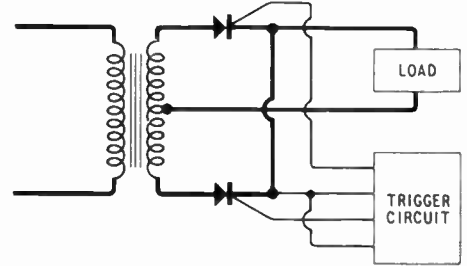
With a three-phase supply the circuit takes the form shown in Fig. 3. Essentially this comprises three single-phase circuits, star connected, with a common controlling transistor Tr_2 . Three gate signals 120° apart are of variable-phase leading edge for nearly 180° , as in the single-phase circuit. The primary of the main transformer can be star- or delta-connected to give a 30° phase shift to correct the phasing for the common main power circuit connections.

Applications

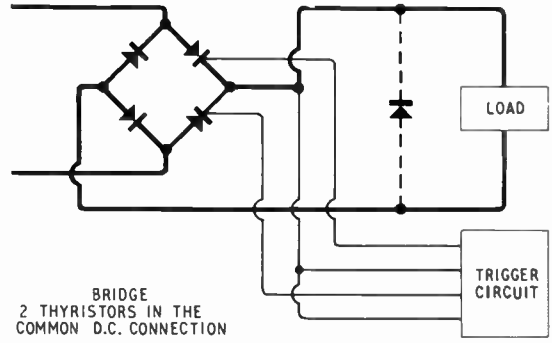
The firing circuits described can be used in the thyristor connections shown in Fig 4. The load voltage waveform is dependent on the circuit connection, firing angle, and nature of the load. Fig. 5 shows the load voltage waveform

* British Patent Nos. 947,476 and 947,477; Standard Telephones & Cables Ltd.

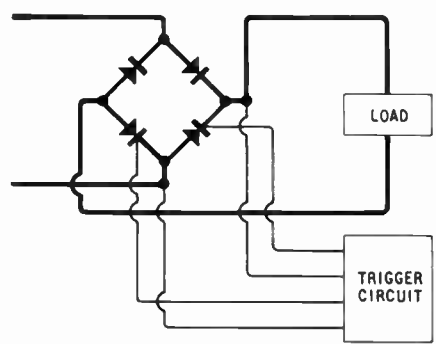
SINGLE-PHASE



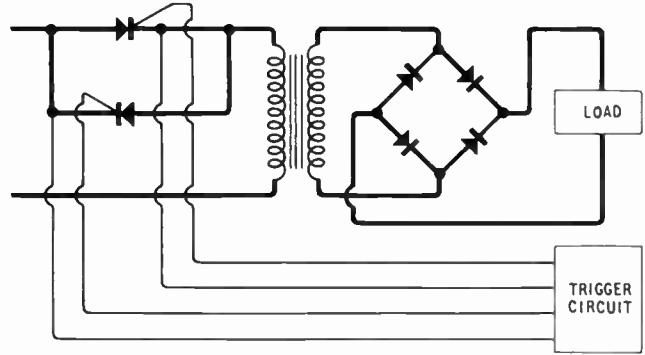
(a) FULL-WAVE CENTRE TAP



(b) BRIDGE 2 THYRISTORS IN THE COMMON D.C. CONNECTION

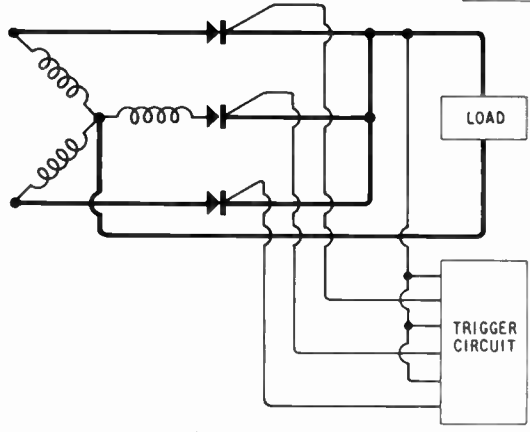


(c) BRIDGE - 2 THYRISTORS IN THE COMMON A.C. CONNECTION

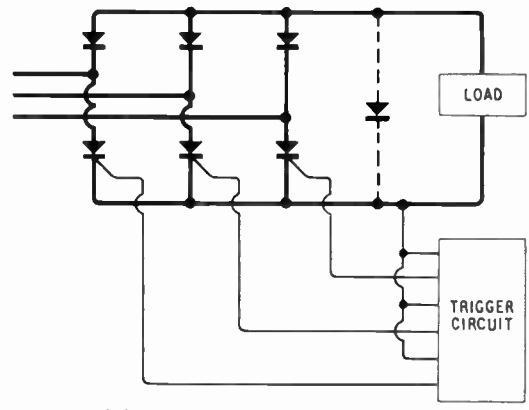


(d) A.C. CONTROL

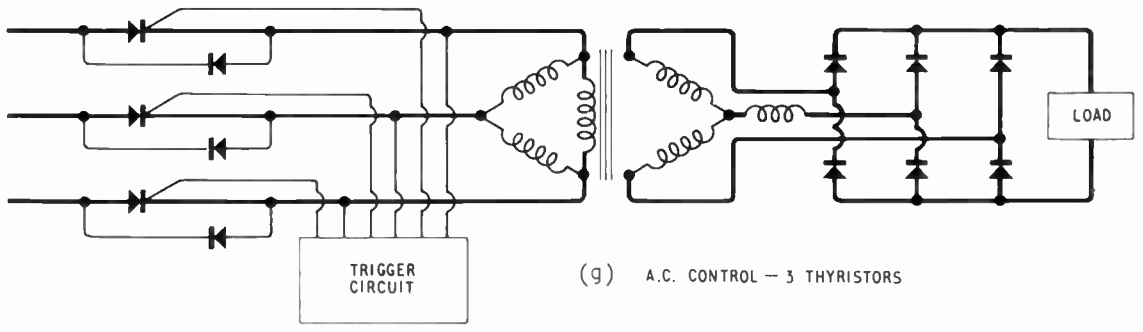
THREE-PHASE



(e) HALF-WAVE



(f) BRIDGE - 3 THYRISTORS



(g) A.C. CONTROL - 3 THYRISTORS

Fig. 4. Various thyristor circuits using the trigger circuits of Figs. 2 and 3

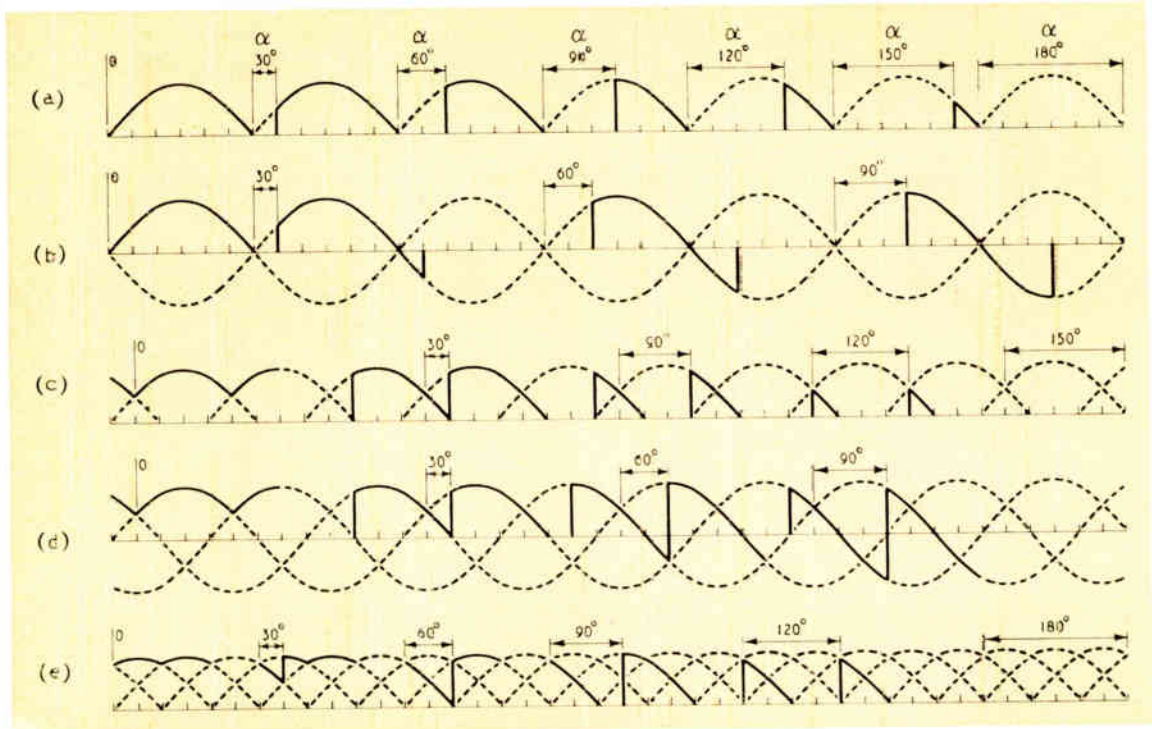


Fig. 5. Output voltage waveforms for the circuits of Fig. 4 for resistive and infinite inductance loads

variation with firing angle for the circuit connections of Fig. 4 for resistive and infinite inductive loads. With infinite inductance, the load current is smooth d.c. and this condition is approached in practice where a large amount of choke smoothing is used. By integration of the waveforms in Fig. 5, the control characteristics of Fig. 6 are obtained. This gives the mean load voltage variation with firing angle for the waveforms of Fig. 5, and the circuits of Fig. 4. Table 1 shows which waveform and control characteristic belongs to which circuit connection.

Firing angle control is from 15° to 165° in the single- and three-phase firing circuits, and control of output voltage with the correct phasing is from 96% to $\leq 4\%$ of the output voltage obtained if non-controlled rectifiers were used.

Commutating (by-pass) diodes shown in broken lines in Fig. 4 (b) and (f) are essential for the satisfactory operation of these two circuits, where there is sufficient load inductance to maintain a continuous load current. If the diode is omitted, the inductive discharge current will flow through the thyristors, and control will be lost, since the continuous current through one thyristor will prevent it from reaching the blocking state.

Circuit Response

The speed of response of the circuit can be seen in Fig. 7. The upper trace shows the thyristor gate-current waveform, and the lower trace the voltage across control terminals 1 and 3 of Figs. 2 and 3. Initially with terminals 1 and 3 open, the firing angle is at its maximum. A short-circuit

Fig. 6. Control characteristics showing mean output voltage against firing angle

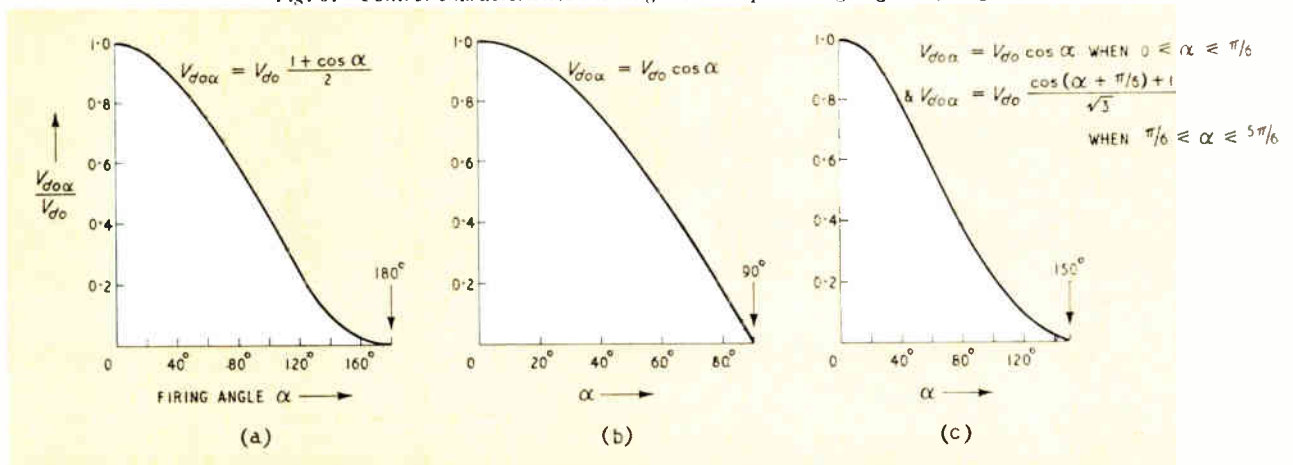


TABLE I

SINGLE-PHASE	Circuit Diagram	Output Voltage Waveforms		Mean Output Voltage & Firing Angle	
		Resistive Load	Infinite Inductive Load	Resistive Load	Infinite Inductive Load
Full-wave centre tap	Fig. 4 (a)	Fig. 5 (a)	Fig. 5 (b)	Fig. 6 (a)	Fig. 6 (b)
Bridge—2 Thyristors in the common d.c. connection	.. (b)	.. (a)	.. (a)	.. (a)	.. (a)
Bridge—2 Thyristors in the common a.c. connection	.. (c)	.. (a)	.. (a)	.. (a)	.. (a)
A.c. control ... ..	.. (d)	.. (a)	.. (a)	.. (a)	.. (a)
THREE-PHASE					
Half-wave ... ..	.. (e)	.. (c)	.. (d)	.. (c)	.. (b)
Bridge—3 thyristors ... ..	.. (f)	.. (e)	.. (e)	.. (a)	.. (a)
A.c. control—3 thyristors ... ..	.. (g)	.. (e)	.. (e)	.. (a)	.. (a)

suddenly applied to the control terminals advances the firing angle after a delay of about 2 milliseconds. On removing the short-circuit the firing angle retards to its maximum in the next half-cycle of gate current; this is the earliest that the conducting thyristor can respond.

Typical Applications

Typical circuit applications are in automatic battery chargers, constant-voltage power supplies with over-current limiting, and high-voltage or heavy-current controlled power

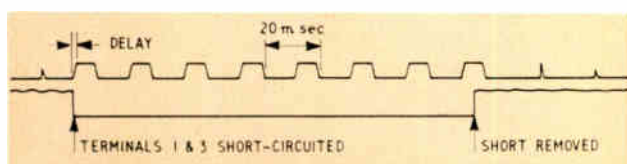


Fig. 7. Transient response of circuit

supplies using a.c. control on the supply side of step-up or -down transformers.

An example of a battery charger application is a 247-volt charger giving float charge to within $\pm 2\frac{1}{2}\%$ on voltage over the current range 0 to 50 amperes and mains change of $\pm 6\%$. Boost charge gives 50 amperes $\pm 2\frac{1}{2}\%$ with a battery voltage change of $\pm 25\%$. This circuit consists of a three-phase bridge as in Fig 4(f), with LC smoothing, a potential divider across the output and a low voltage sensing bridge controlling a transistor across terminals 1 and 3 of the trigger unit. Constant current is controlled from a sensing circuit supplied from a current transformer in an a.c. supply lead. For more critical applications output voltage can be controlled to within $\pm \frac{1}{2}\%$ by using more sensitive voltage sensing circuits.

Acknowledgments

The author acknowledges the permission of Standard Telephones & Cables Ltd. to publish this article.

Axial-Flow Fan Design Charts

SO many interrelated variables are involved in fan design that computation is laborious and the optimum design may be missed because of the limited number of attempts which can be made by hand calculation. To assist the designer, charts for choosing the best hub and tip diameters to meet a given head and flow duty with maximum efficiency have been produced by the National Engineering Laboratory, East Kilbride, Glasgow. The charts are for ducted axial-flow fans of 'free vortex' design with a stator down-stream of the rotor. They cover a range of specific speeds from 2,500 to 10,000.

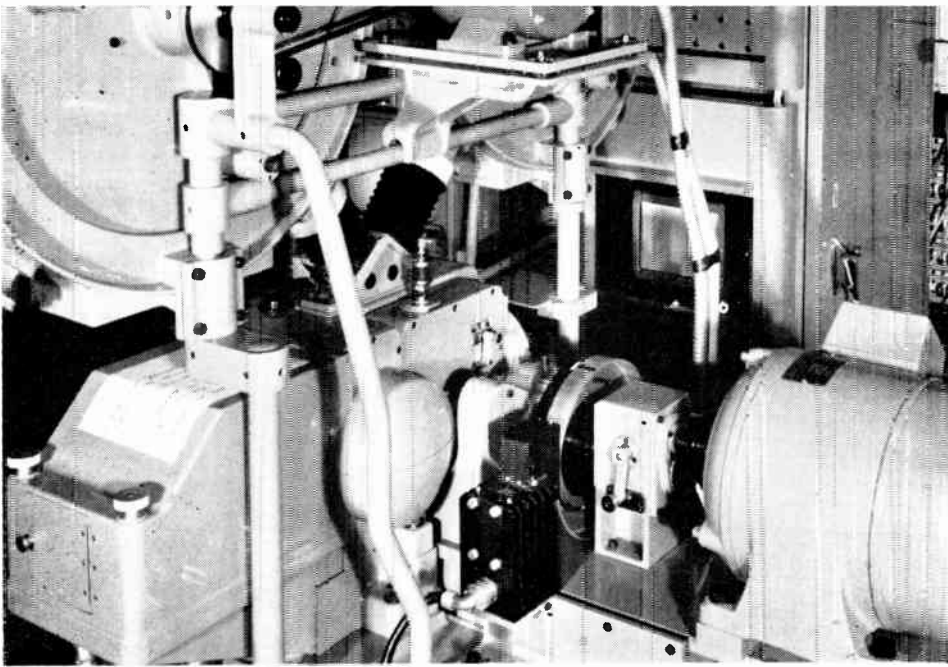
A computer was used to scan available blading data and calculate total fan efficiencies. These were plotted on the basis of head and flow coefficients. Limitations imposed by maximum permissible stress in the blade material, speed, and aerodynamic loading of rotor and stator are incorporated on the charts. The limiting direct stress on the blade is given for a circular pin fixing, but the values can be adjusted for other types of fixing. Fan total efficiency was calculated assuming a tip clearance of less than 1 per

cent of the blade height and a diffuser efficiency of 80 per cent; a method is given for correcting the fan efficiency value of other conditions.

The variations of specific diameter, blade bending and direct stress with specific loading are given for an 85 per cent total efficiency over the range of specific speeds. Curves showing the variation of specific diameter with hub-to-tip ratio are also given which, when used in conjunction with the specific-diameter/specific-loading curves, enable the hub-to-tip ratio to be read directly.

The investigation is being extended so that the computer can be used to obtain optimum values of blade camber, setting angle and solidity at each section, and to transform the geometric ratios into blade co-ordinates suitable for production using either manually or numerically controlled machine tools.

Further information is given in: NEL Report No. 145 (The design of axial-flow fans by computer, Part 1. Basic frame sizes, by D. J. Myles and J. T. R. Watson), obtainable from the Laboratory.



Accurate phase-lock is achieved by a photo-electric detector head (centre foreground) focused on to the periphery of the camera flywheel. Four black slots on the flywheel each generate a pulse which is compared with the television field pulse to give an error signal

L.D.E.P. HAVE recently been awarded contracts by the B.B.C. for supplying six sets of static-inverter drives for 35-mm telerecording equipment.

The drive provides controlled power to a wound-rotor a.c. machine which drives a telerecording film camera at a speed which is accurately phase-locked to the television field sync signal. This signal may be nominally 50 c/s or 60 c/s and the accuracy of phase-locking required corresponds to $\pm 25 \mu\text{sec}$.

The drive motor is wound with a two-phase rotor and three-phase stator. The rotor windings are separate and the stator windings are star-connected. A two-phase square-wave variable-frequency inverter supplies power to the rotor of the machine, which starts up from rest as an induction motor, having three $100\text{-}\Omega$ resistors star-connected to the stator.

When the motor has speeded up sufficiently, the stator resistances are reduced to 25Ω each. As the shaft speed increases, the stator connections are shorted together, and when the required speed is reached one stator terminal is disconnected from the other two. D.C. is then applied, thus converting the machine into a synchronous motor for subsequent running.

To achieve an accurate phase lock, a shaft-phase pick-up

transducer is used. A train of pulses at the television field rate is generated by a photo-electric detector head unit which is focused on to the periphery of a reflective disc in which are engraved four black slots, each of which generates a pulse.

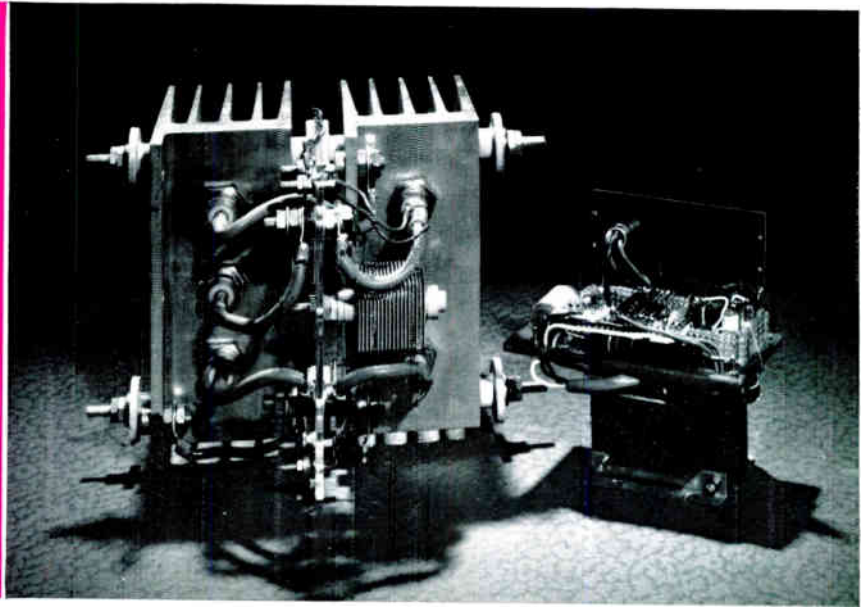
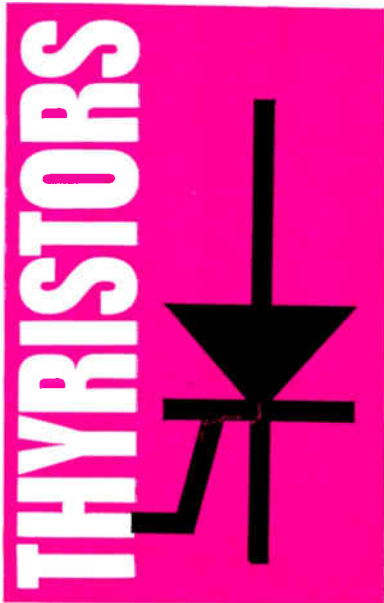
Since the disc is supported by the camera flywheel, which is driven by the motor via a 2:1 reduction gear, and the motor itself is rotated at exactly half the 50-c/s synchronous speed, a pulse is generated for comparison with each television field pulse. These pulses are subsequently compared with the television field sync pulses by means of phase-sensitive rectifiers to produce an error signal which controls the frequency of the inverter.

Two rectifiers are used, one covering a narrow range of phase error and the other a broader range to assist the system to pull in from large errors. For errors of more than 1 c/s a phase-rate detection system is brought into operation: this produces an error signal which reduces the phase error to within the range of the phase-sensitive rectifiers.

The two-phase inverter consists of two single-phase units each delivering power to the motor via an output transformer. The switching actions are performed by thyristors.



An operator using a test card to set up telerecording equipment



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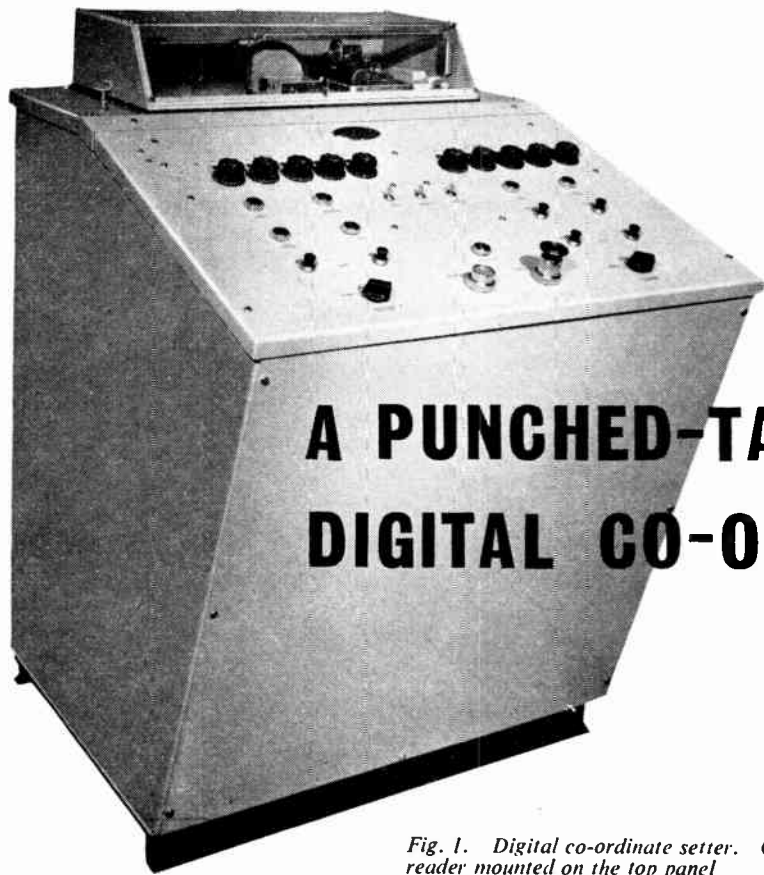
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World Radio History

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A PUNCHED-TAPE CONTROLLED DIGITAL CO-ORDINATE SETTER

By G. T. OHLSEN, B.Sc.*

Fig. 1. Digital co-ordinate setter. General view of control console showing the punched-tape reader mounted on the top panel

This article describes an automatic machine-tool control system designed for general machine-shop work. It is a relatively simple system which is designed for reliability and ease of operation and accepts any one of a variety of standard codes for the punched tape, including all British Standard data-processing codes and the British and American machine-tool codes.

THE recent machine-tool exhibitions at Milan and London have shown to how great an extent interest in automatic co-ordinate positioning and continuous milling has grown in the interval since the Brussels exhibition, with something like 60 machines fitted with co-ordinate setting equipment and 13 with continuous control in Milan, and rather more continuous controls on show at Olympia. This, however, is not altogether surprising; what is surprising is that an appreciation of the savings and benefits which automatic control of this form can confer has not come sooner.

Much criticism has been levelled at the suppliers of such control equipment, on the grounds of complexity, cost and the lack of some form of standard for the input information, usually magnetic tape or punched tape. But then, of course, the problems to be solved in controlling machine tools in this manner *are* complex and the fact remains that, even at present-day capital costs, these machines *are* economic.

Nevertheless, a great deal is being done in an attempt to meet these criticisms. The industry has co-operated closely in the development of standard codes for punched tape, not only for machine-tool control purposes but also for use in computer data-processing installations. These codes have now been published as British Standards and attempts are at present being made to achieve international standards with the additional object of making the machine-tool codes compatible with those used for data processing. This will greatly simplify the position of the user who operates several different punched-tape-controlled machines. It will also help those who, in addition, need to prepare punched tape for data-processing purposes.

* Associated Electrical Industries Ltd.

While this is a much-needed rationalization of the position, its full effects will not be apparent for some few years and with this in mind, together with the questions of minimizing complexity and cost, the author's Company has developed a punched-tape controlled co-ordinate setting control system which goes a very long way to meet these objectives.

A basic standard has been aimed at, to which a variety of additional features can be added to suit the needs of the particular application. In addition to the usual considerations of reliability and cost, prime objectives have been ease of maintenance and the almost total elimination of setting-up procedures.

The standard equipment provides automatic position control in two axes together with means for controlling the machining operation. Two modes of operation are possible, either completely automatic under control from the tape or semi-automatic with operator-control of the sequence of events. In the former case a workpiece may be completely machined without operator intervention; in the latter he must set up the required co-ordinates on two sets of selector switches. These switches can be seen on the sloping top panel of the control console shown in Fig. 1 and the tape reader is seen, housed under a dust-tight transparent cover, at the top of the console and to the rear.

The smallest position increment which can be demanded is 0.001 in. and the normal range of the equipment is 98 in. although this can readily be extended to 980 in. The positioning control is based on the use of a two-speed drive, employing a squirrel-cage induction motor and chain drive to a gear box incorporating magnetic clutch speed selection; this box is shown in Fig. 3. Although normally

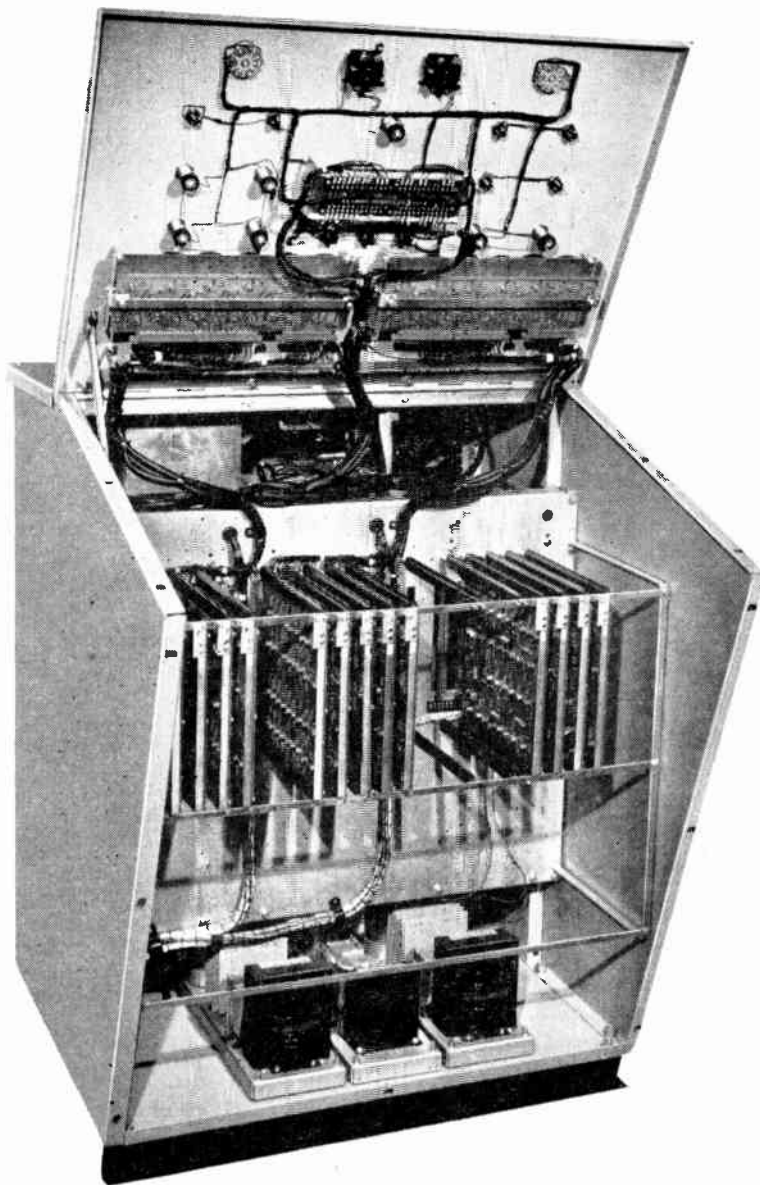


Fig. 2. View of control console with front cover removed and control panel raised

supplied with a $\frac{1}{2}$ -h.p. driving motor, the box has a comfortable 1-h.p. rating and has been designed to take a motor of this rating when required. The standard traverse speeds are 120 in./min and 2.5 in./min and the positioning cycle is so arranged that the final approach to the required position is always from the same direction, in order to overcome backlash problems. It is not a difficult matter to accommodate alternative traverse speeds where these are desirable.

Gear and Data Boxes

The gear box has been designed so that its output shaft can be directly coupled to a 4 t.p.i. shaft or leadscrew. On many small machines therefore, the box can be mounted directly at the end of the leadscrew, thus avoiding the embarrassment of having to find space for additional gearing; on large machines only a small ratio will be required. Mounted at the rear of the gear box, see Fig. 3, is the data box which measures the machine displacements. With this arrangement, which is adequate for the majority of

applications, the positioning system relies ultimately on the accuracy of the machine screw or rack and overall positioning accuracies of ± 0.002 in. or better and repeatabilities of ± 0.0002 in. are obtainable. However, in cases where the machine screw would not be sufficiently accurate, a small gear box is available on which the data box can be separately mounted and driven by means of an instrument rack. Inherently, the data box is capable of an accuracy of ± 0.0003 in. but the equipment is not intended for accuracies of jig borer standard since the overall figure quoted earlier is adequate for the majority of general machine-shop work.

The data box employs a commutator-type digitizer with a special form of pick-off device which eliminates brush-gear. Output signals from the box are in binary-coded decimal form and are compared directly with the input demand from the tape when under automatic control or from the selector switches when under manual control.

Transistors are used throughout the control circuits; the only relays or contactors being those controlling the low-voltage d.c. supplies and the motors. These circuits have been designed to be operative under worst-possible tolerance accumulation conditions and are entirely on/off in nature. They are therefore extremely reliable and, should checking be necessary, no more than a voltmeter is required.

The construction of the control circuits is shown in Fig. 2. Plug-in printed-circuit boards are used, employing sockets of known reliability. Each board has a coding plate attached to ensure that it cannot be inserted in the wrong position. The first five boards from the left-hand end control positioning in the X-axis; of these boards the left-hand pair are identical. The next five boards control the Y-axis and, position for position, are identical to the X-axis boards. The remaining four boards control the overall sequence.

For testing purposes, any board may be withdrawn and mounted in a test interconnector giving access to both sides of the board while allowing the equipment to remain operational. In the event of a board becoming faulty, a replacement can be plugged in, without any setting-up being required, except for one board which requires one simple adjustment.

The Tape Reader

In order to keep complexity down to a minimum, a block tape reader is used. This avoids the need for complex and costly information-storage circuits since all the data for one operation (that is, the required co-ordinates plus any special instructions) is read simultaneously in one block instead of reading one digit or instruction at a time, as is more usual. The reader will accept standard 5- or 8-track punched tape and a wide choice of codes is available, including all the British Standard data-processing codes and the British and American machine-tool codes. This means that in many cases existing tape preparation equipment can be used.

Except when very short lengths of tape are in use, the tape is formed into an endless loop by splicing with proprietary adhesive tape and then placed in a 'tumble box'

with a nominal capacity of 40 ft, which is sufficient for approximately 300 operations. Tape is drawn from the tumble box and fed through the reader by friction drive, giving an exceptionally long tape life. Although the maximum block size which can be accommodated is 23 characters, the usual length would be about 12 characters, giving 2×5 digits for the co-ordinate data and 2 further characters for auxiliary functions.

Once the tape has been loaded into the reader, automatic operation is initiated by an 'Auto Start' button which causes the tape reader to select the first block and the machine to position to the co-ordinates punched in that block, both axes being positioned simultaneously. Completion of positioning is signalled by an indicator lamp for each axis. These lamps are energized at the same time as the brakes, mounted on the gear box output shafts, are applied. A signal is then given for the commencement of the machining operation and while this is taking place, the tape is positioned to read the next block (this operation taking approximately $\frac{1}{4}$ second).

The basic equipment includes the necessary control circuits for three commonly required auxiliary functions. The first of these is 'Programme Up Stop'. When the code corresponding to this function is read from the tape the spindle of the machine is stopped, just clear of the work-piece, on its retract stroke. This eliminates the needless loss of time otherwise incurred if the spindle were retracted to its fully withdrawn position on all occasions. The second function is a preset 'Dwell', which can be coded to occur at the end of the in-feed, so permitting a full revolution of the tool to be completed before commencing the retract stroke. This facility is essential for cleaning-up or counterboring operations. The remaining function is that of 'Stop for Tool Change'. When this code is sensed in a block, the machine is stopped after positioning to the co-ordinates in that block and an indicator lamp lit. The machining operation will be carried out, after completion of the tool change, when the operator presses the 'Auto Start' button.

In manual operation, independent buttons are provided for positioning the two axes. This permits the operator to reposition in both axes simultaneously or in any desired sequence by appropriate use of the buttons, which are placed so that they can be operated together by the two fingers of one hand.

The datum position of each axis can be displaced to any point in the traverse by a simple procedure carried out entirely from the control console, thus enabling the work-piece to be set down on the machine table in the most

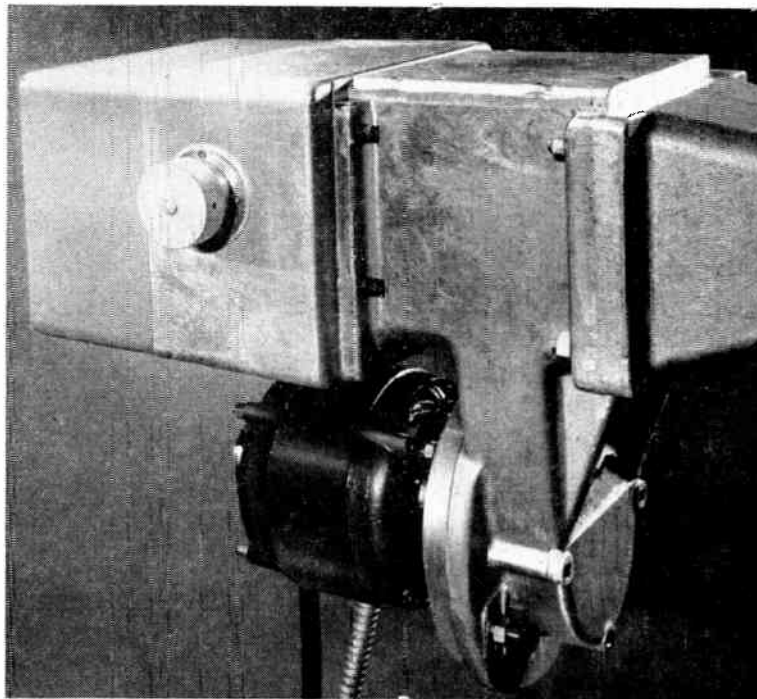


Fig. 3. Standard $\frac{1}{2}$ -h.p. drive unit with data box mounted at rear

convenient position without the need to use an accurate reference on the table.

While the standard equipment is arranged for independent drives to the two axes, a simple modification permits the use of a common drive and sequential positioning. Various additional features are available, such as a visual display of the block number to indicate the operation in progress and a facility to enable a tape to be run through without performing the machining operations.

Space has been left in the console for housing these additional facilities, including control of a third axis.

The equipment is therefore versatile and every effort has been made to keep complexity to a minimum while maintaining a high degree of reliability.

Acknowledgment

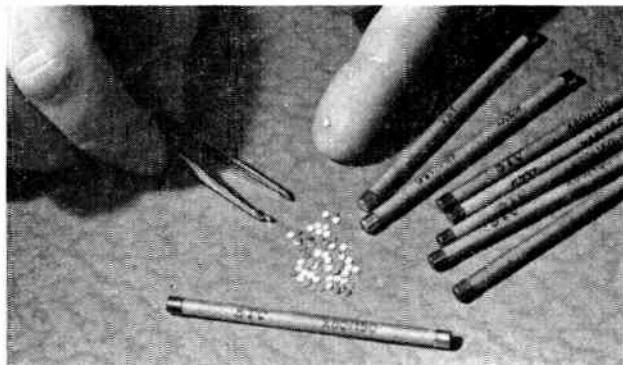
The author wishes to thank the Executive of the A.E.I. Electronic Apparatus Division, Leicester, and the Board of the A.E.I. Company for permission to publish this paper.

Selenium Rectifiers for Television Sets

A miniature selenium rectifier, made up of 150 2-mm diameter discs stacked inside a 3-in. long tube, has taken the place of the 16-kV picture tube rectifier valve in 17 brands of British television receiver. Three of these rectifiers (type X80/150) are used in normal black-and-white sets; for battery-operated, small-screen sets, only two are needed.

The rectifier, made by STC, has succeeded in bringing miniature selenium units back into television e.h.t. circuits and is claimed to represent a significant step forward in the development and assembly of selenium plates of very small area. Apart from its establishment in current television receiver production, the X80/150 has also been chosen for prototype fully-transistorized sets now under development.

For further information circle 52 on Service Card



BUSINESS EFFICIENCY EXHIBITION 1964



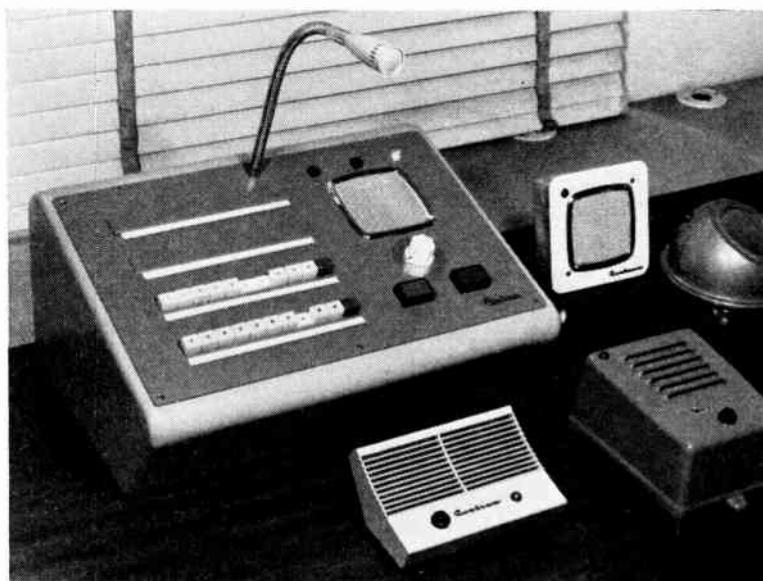
LAST year, business equipment to the value of over £124 million was sold by British manufacturers, with exports at the record level of nearly £51 million. Now, for the first time, business machines worth more than £1 million are being exported each week, showing that Britain is maintaining her position as the world's second largest supplier. The 1964 Business Efficiency Exhibition, held at Olympia during 5th-14th October, provided a comprehensive review of this rapidly expanding industry.

Most of the new exhibits represented a logical development of previous models and, as far as electronics was concerned, the techniques generally employed have been known and used in other industries for some time. The only real surprise was a microminiaturized computer (see p. 520), with a maximum storage capacity of 16,384 24-bit words, housed in a console the size and shape of a standard office desk. While the cost of the micro-circuit modules is considerably greater than that of the equivalent conventional components, this is balanced by substantially lower assembly costs. The manufacturers claim that the overall production cost of such a computer will, in fact, be lower than that of an equivalent 'conventional' unit.

In a few years' time, electronics may well be providing the business equipment industry with its principal source of income. The following pages of photographs, taken at the B.E.E., illustrate some of the ways in which electronic devices are already helping to increase business efficiency.

INTERCOM CONTROL SYSTEM—Shown for the first time by *Centrum Electronics* was a transistorized intercom control system for use with one or more master controls and up to 120 sub-stations. Designed for installations where it is unnecessary for sub-stations to intercommunicate, the system is particularly suitable for production control networks where multiple processes or production units are involved. Three standard systems are available, catering for 10-40 lines, 15-60 lines, and 45-120 lines. If incoming calls are received while the master control is engaged, a visual signal remains illuminated until dealt with

For further information circle 53 on Service Card



PORTABLE DICTATING MACHINE—Edison showed the 'V.P. Voicewriter', a compact portable dictating machine, employing permanent micro-groove recording on double-sided discs, which will accommodate approximately 30 average-length business letters.

Features include pushbutton indexing, scanning and normal play-back as well as a short 'quick review' play-back controlled from the microphone.

The 'V.P.' is available in both dictating and transcribing models, or as a combination of the two. Optional extras include a conference microphone, a desk loudspeaker for group listening, and a telephone recorder

For further information circle 54 on Service Card

Ultra Electronics showed the Ultronic 1000, a new development designed specifically for the preparation of data in punched paper-tape form for use by computer systems. Fully transistorized, it incorporates error-prevention devices, combined with standard parity checks and full verification facilities, to ensure a high standard of accuracy. The model shown consists of an electric typewriter with paper-tape/edge-punched card reader and a punch operating in English Electric KDF9 code

For further information circle 55 on Service Card





MICROMINIATURIZED COMPUTER—The Marconi pre-MYRIAD computer is the result of several years' advanced work in microminiature components and ultra-high-speed silicon logic circuitry; the design minimizes inter-module connections and the subsequent inter-stage delays, to ensure that the intrinsic high speed of the elements is fully utilized. This machine is the prototype of MYRIAD, a real-time version of a new generation of computers for commercial, scientific and industrial work. The basic storage capacity is 4,096 24-bit words, and this may be increased by additional blocks of 4,096 words up to a total of 16,384 words. The instruction speed, including store access, is 2.5 μ sec for single orders such as 'add', 'subtract' and 'fetch', and 11 μ sec for 'multiply'. A multi-level priority interrupt system allows individual peripheral items to request and receive the computer's attention. In the demonstration, pre-MYRIAD dealt with the yields of selected shares of three industrial groups; it held in its store the history of prices, dividends and yields for each share over a period of three years. As each new price was presented to it on the keyboard of the control console, the computer calculated the yield and indicated the revised data on a tabular display, together with comparable information about other shares in the group. At the same time it showed the updated historical yield performance for the share on a graphical display unit

◀ For further information circle 56 on Service Card

UNIVAC 1050 COMPUTER—Demonstrated for the first time in this country was the latest development in the Univac range of computers, the 1050 series. Priced in the range from £40,000 to £400,000, the 1050 may be built to individual requirements from any permutation of a family of units. These include two speeds of central processor, two speeds of card or paper tape readers, punches and output printers, magnetic tape units, random access drums and communications peripherals.

Applications range from simple routine batch data processing to on-line processing using communications networks with remote stations. The 1050 is related to the 1107-8 series of computers by shared assembly systems as well as by the provision of Cobol and Fortran IV compilers in both series. In addition to these compilers and the Pal basic assembler, the 1050 software library contains a report generator, co-ordinator for twin-programme execution, sort generator and programme 'debugging' aids

◀ For further information circle 57 on Service Card



STERLING INVOICING MACHINE—The Friden 5010 'Electronic Computer' is a fully-transistorized machine which will automatically type and calculate sterling invoices, and can be operated by any competent touch typist. Typing errors are easily corrected, and an automatic input check and other programmable safety devices eliminate the possibility of errors in invoicing.

The 5010 is controlled through a bank of programme keys located in front of the typewriter keyboard, and a programme panel (which, in the photograph, has just been removed by the operator). The processing unit will add, subtract, calculate and make logical decisions; average multiplication time is 450 msec and the average time for addition or subtraction is 20 msec. The computer memory consists of 12 magnetic core stores of 12 digits each: three stores are used for calculation purposes and the remaining nine can be selected as cross-footers or accumulators, or can hold constant factors, the date, consecutive numbers, etc.

◀ For further information circle 58 on Service Card



PROTECTION FOR MAGNETIC TAPES—On show for the first time was the Remington 'Data Safe', which affords complete protection for magnetic tapes against the ravages of both fire and steam. The unit, which takes a total of 78 reels in its three drawers, is designed specifically for day-to-day use, not merely to house records normally kept away from the computer room.

Because magnetic tapes are far more vulnerable to damage by heat and steam than paper, the Data Safe has, in addition to effective fire insulation, a special inner wall to protect the contents against steam. Mylar tapes, even when housed in their original plastic containers, are completely safeguarded.

◀ For further information circle 59 on Service Card

BE '64

ELECTRONIC CALCULATOR—Anita Mk. 9 is the latest version of a well-tried electronic desk calculator which was first marketed by Sumlock Comptometer nearly three years ago. The size remains the same as for other models and the price is £425.

In addition to high speed, simplicity of operation and silence, this 12-digit machine features programmed fully-automatic decimal pointing for multiplication, division and combinations of the two. It also provides for instant checking of multiplication and recall of the product which has been checked. Any result may be processed further (e.g., raising to a power or multiplication followed by division), without intermediate resetting operations.

▶ For further information circle 60 on Service Card



PRIVATE ELECTRONIC TELEPHONE EXCHANGES—Quick-access plug-in units are a feature of this Pye 50-line electronic telephone exchange. The latest techniques have been employed to produce a series of fully-automatic private systems providing facilities for 25, 50, 75 and 100 subscribers. It is impossible for conversation to be overheard and no third party can interrupt, thus affording complete privacy.

With no mechanical moving parts, these exchanges are completely silent in operation and are unaffected by humidity, dust and vibration. Consequently, the equipment can be installed in offices or other working areas without special accommodation. Reliability is claimed to be extremely high.

▶ For further information circle 61 on Service Card

EQUIPMENT REVIEW

1. High-Voltage Ignitrons

National Electronics Inc. have introduced a range of high-voltage switching ignitrons which are now available in the U.K. through Walmore Electronics. These are rated at 20 kV peak anode voltage and have peak current ratings of 100,000 A. Ignitrons of this performance are needed in several important new fields of work where large capacitor banks have to be discharged.

Examples of the applications where this technique is being used are: explosive and magnetic forming, magnetic lenses for particle accelerators, arc discharge in wind tunnels, and fusion research.—*Walmore Electronics Ltd., 11-15 Betterton Street, Drury Lane, London, W.C.2.*

For further information circle 1 on Service Card

2. Electronic Delay Timer

Solid State Controls have recently introduced a sealed, plug-in electronic delay timer, the PT/900, which is available at a cost of 59s.

The PT/900 is capable of continuous duty for a life in excess of 20 million operations or 4 years, and has a repetitive accuracy better than 2%. It is robust, unaffected by humidity and vibration, and maintains its timing accuracy in ambient temperatures of -20°C to $+60^{\circ}\text{C}$.

Timing periods may be internally set at the factory, or may be adjusted by means of an external resistor over the range 0.1 sec to 4 min. The output circuit is suitable for operating a relay and the unit re-sets instantaneously and is provided with the standard international octal plug.—*Solid State Controls Ltd., 30/40 Dalling Road, London, W.6.*

For further information circle 2 on Service Card

3. Ultrasonic Flaw Detector

Ultrasonoscope announce the introduction of the fully-transistorized mark V ultrasonic flaw detector.

The switched frequencies are 5, 2.5 and 1.25 Mc/s and the gain is con-

trolled with a calibrated attenuator. The fastest time-base speed is $2\ \mu\text{sec}$ and this means that $\frac{1}{4}$ in. of steel may be expanded across the full 5-in. screen. The timebase has a continuously variable delay and the maximum range in steel is 20 ft. The p.r.f. is variable from 50 to 1,000 c/s to facilitate the elimination of ghost echoes. Scatter from the structure of a metal can be 'grass-cut' with a reject control with switched steps. Either a rectified or an unrectified display may be selected.

The most important controls are on

the front panel and the remainder are grouped in order of use along one side. The re-chargeable batteries have a life of 7 hr, and the mark V can also be operated on a normal mains supply by using a mains pack in the battery compartment. The overall dimensions are $9\frac{1}{2} \times 7 \times 21\frac{1}{2}$ in. and the weight is 28 lb (including batteries).

—*Ultrasonoscope Co. (London) Ltd., Sudbourne Road, Brixton Hill, London, S.W.2.*

For further information circle 3 on Service Card

4. Semi-Rigid Coaxial Cable

Now available from Sealectro are several styles of semi-rigid sub-miniature coaxial cable intended for use with their range of semi-rigid coaxial connectors.

These cables have a solid-copper extruded shield and are mostly of 50- Ω impedance, dimensionally equivalent to the RG style 188/U and 196/U, but other specifications are available, e.g. aluminium shields instead of copper.

The solid shield is readily formable and remains coaxial even when pre-



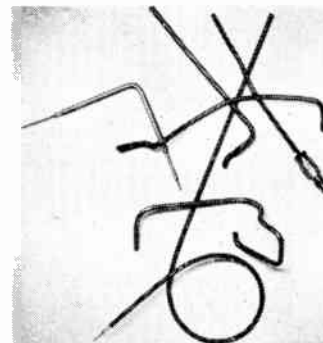
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formed into intricate shapes; it is claimed to provide better screening, and freedom from the vibration noise which can occur with a braided shield. Pre-formed tubing, Bourdon and pointer tubing is also available.—*Sealectro Ltd., Hershham Trading Estate, Walton-on-Thames, Surrey.*

For further information circle 4 on Service Card

5. Switch Sets

Jenkins Fidgeon have introduced a range of switch sets for use with punched-card machines.

Each set comprises 3, 5, 8 or 10 switches working independently of each other, and each has a middle, rest and action position. Different machine functions can be made dependent on each switch without changing the cable connections. Several switch sets can be included in any position on one switchboard.

Complete ranges of type, holes, figure groups and control positions can be selected without the need for selector apparatus. Switch sets can be included on all cross-flex switchboards. They can also be used on

machines not normally equipped with switches. The switch flex is normally introduced into the switch from below.—*Jenkins Fidgeon Ltd., Linley Road, Talke, Staffs.*

For further information circle 5 on Service Card

6. Top Hat Rectifiers

International Rectifier announces an extension to its range of 'top hat' silicon rectifiers. Rated at 1.1 A average, at 40 °C ambient, they are available in voltages from 400 to 1,000 p.i.v.

Designated type numbers SD 94S to SD 910S, these diffused power diodes feature high surge-current capacity. Minimum rated 10-msec peak transient voltage withstand is at least 40% above the rated p.i.v. The glass-to-metal seal top-hat outline conforms to VASCA SO-16 and JEDEC D.O.3 outlines. This range of diodes supersedes the alloyed types SD 98, SD 98A, SD 910 and SD 910A, which are now discontinued.—*International Rectifier Co. (Great Britain), Hurst Green, Oxted, Surrey.*

For further information circle 6 on Service Card

7. Packaged Air Monitor

To avoid the need for expert commissioning services, the M.O.M. air monitor has been developed in a packaged form, sent out with the optical systems factory balanced so that all that is necessary is to install the sensing system in a ventilating chamber or corridor, and to connect up to the control unit. Five different models are available to cover both low and high sensitivity, with or without indicators and alarms to suit varying requirements.

The instrument is stabilized optically, electrically and mechanically. In consequence a very fine control setting can be achieved, which will not require re-adjustment over a 12-month period. It can therefore be used to monitor an increase of dust particles in an air conditioned room or, in the case of the less sensitive models, to control auxiliary fans in a ventilating system.—*Photoelectronics (M.O.M.) Holdings Ltd., Oldfields Trading Estate, Oldfields Road, Sutton, Surrey.*

For further information circle 7 on Service Card

8. Battery-Operated Recorder

The latest addition to the range of recording and laboratory instruments offered by Smiths is a version of their multi-range 'Multiscrypt' recorder, the 'Multiscrypt' B. This model is completely portable with a 3-speed chart mechanism driven by a speed-controlled d.c. motor capable of running continuously for 80–100 hr on a size 8 battery. Power consumption of the drive is approximately 6 mA.

The instrument can be offered in a wooden carrying case with a built-in arrangement for storing 3–5 m of recorded chart information, equivalent to 6–8 days recording at a speed of 20 mm/hr.

A scale expansion (voltage) accessory is also available, permitting the top 25% of the 100, 110, 127, 220, 330 and 500-V nominal ranges to be expanded over the full width of the chart. The price of the 'Multiscrypt' B is £70.—*Smiths Industrial Division, Kelvin House, Wembley Park Drive, Wembley, Middlesex.*

For further information circle 8 on Service Card

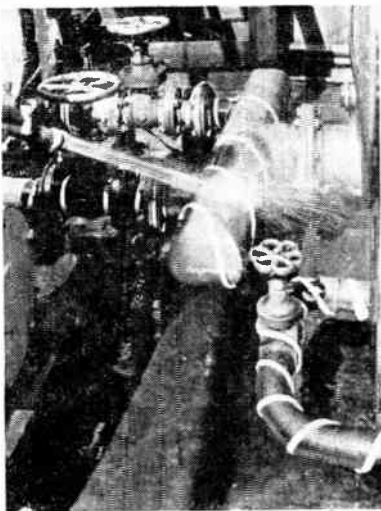
9. Solid-State Preamplifiers

Solid-state preamplifiers of the ATI series, covering 2 to 1,000 Mc/s, are now available with an integral power supply. This series provides octave coverage in the v.h.f. and u.h.f. ranges with guaranteed noise figures of 4 dB in the 100 to 400 Mc/s region and 6 to 8 dB in the 500 to 1,000 Mc/s range.

The laboratory enclosure for these



**EQUIPMENT
REVIEW**



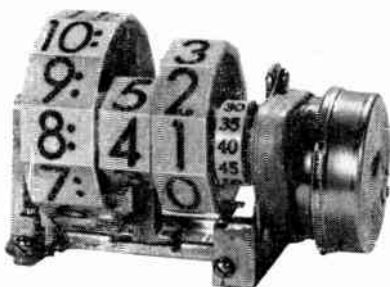
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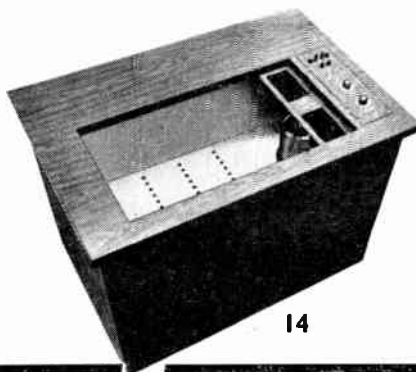
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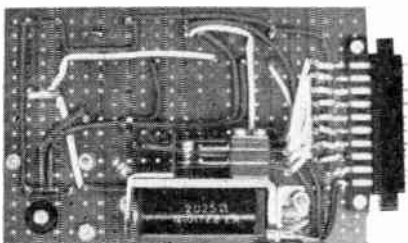
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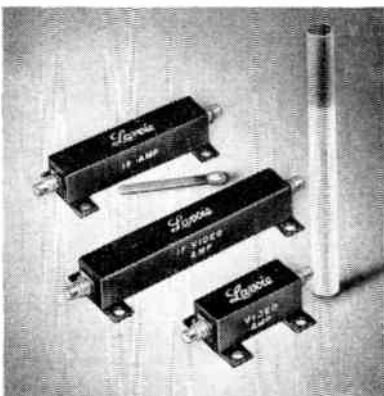
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units includes a front-panel switch and pilot light and a fused power supply that operates from 105 to 125 V a.c. An alternative weather-proof enclosure, suitable for remote mast mounting in tropical or marine environments, also includes an integral power supply that operates from 105 to 125 V a.c., 50-400 c/s. Any combination of preamplifiers and power supplies in the ATI line can be housed in these enclosures.—*Applied Technology Inc., 3410 Hillview Avenue, Stanford Industrial Park, Palo Alto, California, U.S.A.*

For further information circle 9 on Service Card

10. Component Bridge

K.L.B. have introduced a versatile component bridge intended for use in the service department and test bay.

The bridge, the M.300, has four capacitance ranges from 10 pF to 1,000 μ F, four resistance ranges from 0.05 Ω to 100 M Ω , and facilities for capacitor leakage tests with an adjustable test voltage up to 500 V d.c.

Ratio tests in the ranges of 0.05 : 1 and 20 : 1 can be carried out between any two capacitors, inductors or resistors. This test is intended for use when components have to be adjusted against a standard. The price of the M.300 is £22 5s.—*K.L.B. Electric Ltd., 335 Whitehorse Road, Croydon, Surrey.*

For further information circle 10 on Service Card

11. Waterproof Pipe Heater

The Electrothermal range of flexible pipe heaters has been extended by the addition of the HP4 series which is fitted with waterproof terminations.

This heating cable, which is flat and approximately $\frac{1}{4}$ in. wide, has a 'cold lead' sealed into the heater at one end only. It is designed to operate in conjunction with a thermostat to provide surface temperatures up to 85 $^{\circ}$ C from a mains voltage of 100/125 or 200/250 V.

The heater can be traced or spiralled around the pipe and is rated at 7 W/ft. Five standard lengths are available: 6.25, 12.5, 25, 50 and 100 ft. The photograph shows a waterproof pipe heater being washed down.—*Electrothermal Engineering Ltd., 270 Neville Road, London, E.7.*

For further information circle 11 on Service Card

12. Electromagnetic Counter

B. & F. Carter & Co. have announced a simple, robust, general-purpose electromagnetic counter unit for

both laboratory and industrial applications.

The unit is available with up to six figures, $\frac{3}{8}$ -in. high, and with or without knurled-wheel reset. Maximum speed of the instrument covers most applications and the design incorporates an invertible feature which permits easy conversion from base to panel mounting or vice-versa. The illustration shows the counter suitable for panel mounting.

The moving parts are reduced to a minimum to ensure a long working life and lubrication is not necessary. The voltage range is from 12 to 440 V.—*B. & F. Carter & Co. Ltd., Albion Works, Bolton, Lancs.*

For further information circle 12 on Service Card

13. Digital Clocks

Spectrum Electronics have introduced the 'Tymeter' range of 12 and 24-hr digital clocks, which register time on three drums—marked in minutes, tens of minutes and hours, with seconds indicated on a 1 r.p.m. calibrated wheel.

These units are arranged for easy mounting in existing equipment and are also available as complete clocks. The 12-hr clocks have characters $\frac{5}{8}$ in. high, and the 24-hr units feature $\frac{7}{8}$ in. characters. They are driven by self-starting synchronous motors and are suitable for operation from 50 or 60-c/s, 110 or 230-V supplies.—*Spectrum Electronics Ltd., Deneway House, Potters Bar, Middlesex.*

For further information circle 13 on Service Card

14. Constant Temperature Oil Bath

The Singer Company, Metrics Division, has announced a range of low-cost constant-temperature oil baths for use primarily in the calibration of standard resistors, where the precise maintenance of a fixed temperature over a long period of time is essential, or in the determination of resistor temperature coefficients where testing must be accomplished at several fixed stable temperatures.

The type 9730 series unit utilizes a solid-state temperature controller and temperature control is guaranteed ± 0.05 °C. A thermistor network detects ± 0.01 °C variations in control. Temperature gradients in the bath are guaranteed to be less than ± 0.01 °C.

The unit has overall dimensions of 43 × 31 × 36 in. high and weighs approximately 350 lb. The stainless steel insulated tank 34 × 17 × 13 in. deep is mounted in a Formica covered cabinet that has a 14-in. table space slanted toward the bath. Other fea-

tures include a motor-driven impeller for optimum oil circulation, and solid-state switching. Two models are available: type 97305 with single fixed temperature setting, and type 9730M with multiple temperature settings from 20 to 40 °C.—*The Singer Company, Metrics Division, 915 Pembroke Street, Bridgeport, Connecticut, U.S.A.*

For further information circle 14 on Service Card

15. Voltage-Sensing Relays

Now available from Newton Derby are type TVS voltage-sensing relays, designed to provide a means of switching at an accurate pre-determined voltage level, for example, in under- and over-voltage protection circuits.

The range covers sensing voltages between 10 and 220 V d.c., sensitivity being $\pm 1\%$ and differential, 1%. The speed of response is 10–15 msec, but where it is required to prevent tripping by overloads under transient conditions, a time delay from a few msec up to 2 min can be provided.

These units are fitted with 10-pin plugs and can be readily incorporated in control cubicles. Each is fitted with two normally-closed and one normally-open heavy-duty contacts.—*Newton Brothers (Derby) Ltd., Alfreton Road, Derby.*

For further information circle 15 on Service Card

16. Portable Humidity Meter

Wayne Kerr have introduced the first instrument in the 'Midge' range of special-purpose miniature bridges, the MB100 humidity meter. This self-contained unit requires no setting-up or calibration and operates in conjunction with a low-cost transducer to provide direct readings of relative humidities from 20 to 100%, in two ranges. Sealed packages can be so designed that each includes a transducer element with leads to a connector on the outer case, enabling the condition of equipment stored or shipped under humid conditions to be checked instantly without any unpacking.

Overall measurement accuracy, including the transducer, is 5%. Transducers will withstand temperature variations between -40 and $+100$ °C and their performance is unimpaired by prolonged storage or use under extreme conditions of relative humidity. Essentially the measurement circuit is a transformer ratio-arm bridge operating at 2 kc/s and balanced electronically by a high-gain feedback amplifier. Source, detector and battery are all housed in the case ($4\frac{3}{4} \times 2\frac{3}{4} \times 6\frac{1}{2}$ in.) and an output of

0–100 μ A is available for recorders, etc.—*The Wayne Kerr Laboratories Ltd., Sycamore Grove, New Malden, Surrey.*

For further information circle 16 on Service Card

17. Microminiature Amplifiers

Lavoie Laboratories has developed a range of microminiature i.f. video, and combination i.f. detector and video amplifiers, which are available in the U.K. from Bemex Instruments.

Silicon semiconductors, as well as ceramic and tantalum capacitors, are used exclusively, and these units meet all applicable requirements of MIL-E-5400 and MIL-E-16400. The i.f. amplifier frequency range is 10–200 Mc/s. and maximum gain stability is ± 3 dB. Video amplifier voltage gain is up to 90 dB with frequency response from 50 kc/s to 10 Mc/s.—*Bemex Instruments Ltd., 54 Victoria Road, Surbiton, Surrey.*

For further information circle 17 on Service Card

18. Low-Cost Intercom System

Extending their range of low-cost intercoms, D.J.P. Telephones have introduced a 10-way system which they are offering at £105 complete.

The system comprises ten 10-button telephones, 100 yd of cable and a power supply unit. Initially a few telephones can be installed and added to as required. It is claimed that good performance may be obtained over distances of 1,000 yd or more.

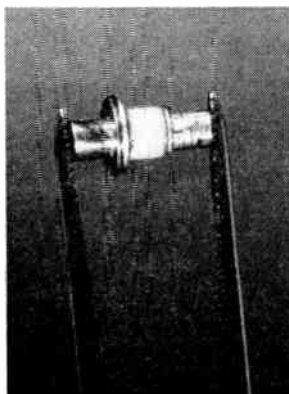
Using the same handsets as the G.P.O. 706 telephone and styled in two-tone grey to match, the equipment is designed for ease of installation and reliability. A 3-year free maintenance guarantee is included.—*D.J.P. Telephones Ltd., 156 Camden High Street, London, N.W.1.*

For further information circle 18 on Service Card

19. Gallium Arsenide Varactor Diodes

Two designs of gallium arsenide varactor diodes, now available from Sylvania, are suitable for harmonic generation and parametric amplification at microwave frequencies.

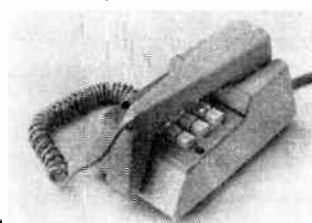
The diffused junction mesa type D5047 (illustrated), designed for resistance to extreme environments, features a bonded contact hermetically weld-sealed in a miniature ceramic package, and can be cooled to liquid helium temperature for very low noise applications. Cut-off frequency at 6 V ranges from 150 Gc/s for type D5047 to 300 Gc/s for type D5047C. Power dissipation is 300 mW. The diodes have been used successfully in



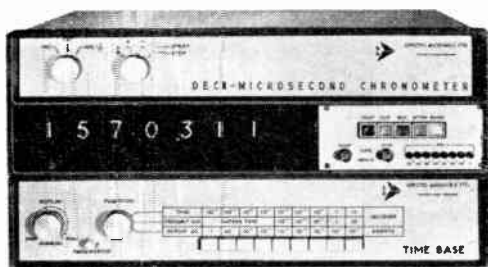
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harmonic generators up to 35 Gc/s; at this frequency efficiencies of 30% with 80 mW output power were attained.

Point contact types are designed to operate from 10 to 50 Gc/s in harmonic multiplier and parametric amplifier applications. Operation at these high frequencies is made possible by low package capacitance (0.09 pF) and cut-off frequencies up to 200 Gc/s (D4957B). Low junction capacitances reduce pump power requirements, making it possible to use solid-state sources. The D4957 series may be cooled to liquid nitrogen temperatures. Power dissipation is 100 mW. —*Sylvania International, 21 rue du Rhone, Geneva, Switzerland.*

For further information circle 19 on Service Card

20. Digital Voltmeter

The DM2005 digital voltmeter recently announced by Digital Measurements has an accuracy of 0.0125% f.s.d. $\pm 0.02\%$ of reading and a sensitivity of 10 μ V. It has evolved from the designs used in the DM2001 and DM2020 series of voltmeters.

This instrument has a scale of 7,999, giving a resolution of 1 part in 8,000, and six ranges covering from 0 to

2 kV. The input impedance is greater than 25,000 M Ω on the two lowest ranges and 10 M Ω on the higher ranges. The input can be isolated from earth to reject common-mode voltages present at the signal source.

The DM2005 incorporates the wide range of facilities featured in the earlier instruments. These include external scaling to give readings in lb/in.², °C, etc., from voltage analogue inputs; full accuracy maximum and minimum operating modes; and decade outputs in any one of six codes to drive printers, punches, etc. — *Digital Measurements Ltd., Salisbury Grove, Mytchett, Aldershot, Hants.*

For further information circle 20 on Service Card

21. Time Base

A universal time-measuring instrument, for the accurate measurement of frequency, period, time and pulse width, has been developed by Spectro Avionics.

The instrument combines two standard units, the deci-microsecond chronometer type 222 and the timebase unit type 233. The accuracy of these combined instruments is ± 2 parts in 10⁷ long term; ± 1 part in 10⁸ short term. The timebase uses silicon tran-

sistors, printed-circuit techniques and is of modular construction. It can be rack mounted or used independently on the bench. The size of the timebase is 17 $\frac{3}{4}$ \times 3 $\frac{1}{2}$ \times 14 $\frac{1}{2}$ in.; when mounted with the deci-microsecond chronometer the combined height is 8 $\frac{3}{4}$ in.

The brief specification of the combined instruments is as follows: time measurement, 0.1 μ sec to 10⁸ sec; pulse-width measurement, 0.1 μ sec to 1 sec; frequency 30 c/s to 20 Mc/s; period, 1 event to 10⁸ event, minimum period 0.05 μ sec. Marketed exclusively by *Livingston Laboratories Ltd., 31 Camden Road, London, N.W.1.*

For further information circle 21 on Service Card

22. Lightweight Push-Button Intercom

An office internal telephone with a handset weighing less than half that of the normal telephone is being introduced by STC.

Named the Deltaline Interphone, the system can have up to 15 extensions any of which can be called by a push-button. A pleasant 'warbling' tone replaces the usual bell and is produced by an electronic unit within the telephone.

High quality speech reproduction is given by a 4-oz handset of unique design. This reduction in weight is achieved by the use of lightweight materials and a concealed 'speaking tube' connected to the microphone; the microphone and earphone are in one piece, close to the ear.

Deltaline systems are being offered with either 10-button or 15-button telephone instruments. The systems can be purchased outright or rented.—*STC Private Communication Equipment Division, Standard Telephones and Cables Ltd., Footscray, Kent.*

For further information circle 22 on Service Card

23. 32-Pole Programming Switch

The Actan Division of Sealectro announces the availability of a 32-pole, double-throw contact arrangement, programming switch offering as many as 16 programming drum positions. The new switch, designated as AP-L32-D16, measures only 4 $\frac{7}{8}$ in. long by 2 $\frac{3}{8}$ in. wide and 1 $\frac{3}{8}$ in. high, and features contacts mounted in two rows on both sides of the programming drum.

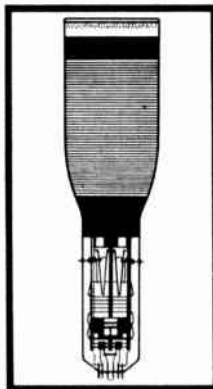
The switch can be programmed in either of two ways: (1) Programming the drum in the usual manner will actuate each row of contacts, with a lag of 180°. Different programming functions can be achieved with the same programme on the drum by

(Continued on page 527)

M-O V PLACE DOUBLE GUN TUBES IN NEW PERSPECTIVE



Fired with inspiration, M-O V advance to a new compact construction method for dual trace tubes. The result? Brilliant! Down comes pattern distortion (closer tolerance reduced from 2½% to 1%). Up goes sensitivity and scan amplitudes. Auxiliary electrodes provide for retrace blanking at gun potential, independent astigmatism adjustment and trace superimposition.



Typical operation	1000 H	1000 J	1300 H	1300 J	1800 H
Screen dia	10 cm	10 cm	13 cm	13 cm	17.5 cm
Va4	4 kV	4 kV	6 kV	6 kV	4 kV
Va3	1 kV	1 kV	1 kV	1 kV	1.5 kV
Minimum useful scan (each gun)	60 x 80 mm.	40 x 80 mm.	60 x 100 mm.	40 x 100 mm.	100 x 150 mm.
Area of common scan	40 x 80 mm.	20 x 80 mm.	40 x 100 mm.	20 x 100 mm.	80 x 150 mm.
Sx	18 V/cm	18 V/cm	18 V/cm	18 V/cm	16 V/cm
Sy	6.5 V/cm	4.5 V/cm	6.5 V/cm	4.5 V/cm	6 V/cm

All with aluminised screen

Our technical information centre is ready to help with your application problems. Write for full data sheets on these and other M-O V products, or telephone RIVerside 3431. Telex 23435.

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INSTRUMENT AMPLIFIER T5102

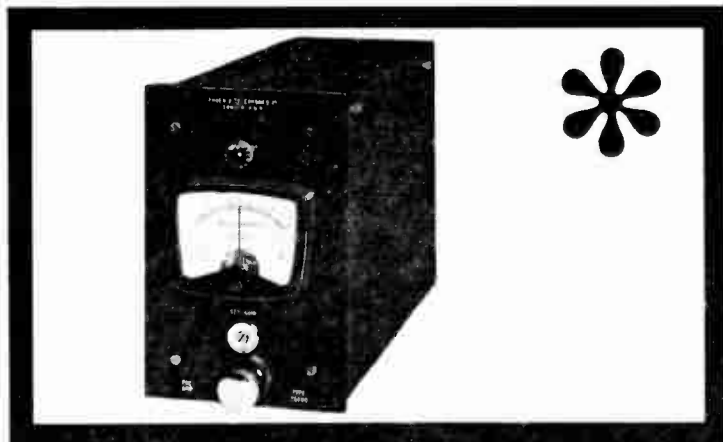
DESIGNED FOR USE ON INSTRUMENTATION, AUTOMATIC AND PROCESS CONTROL. FEATURES INCLUDE:—

- D.C. AMPLIFICATION
- DIFFERENTIAL OR SUMMATION APPLICATIONS, i.e., two electrically isolated inputs are provided (More on application)
- SUBSTANTIALLY LINEAR
- LONG TERM ZERO DRIFT
- UNAFFECTED BY MAINS VARIATION
- NO MOVING PARTS OR THERMIONIC COMPONENTS
- LONG UNSERVICED LIFE EXPECTANCY
- PRICE £45.0.0 List as illustrated

THE CORREX T 5102 magnetic amplifier is eminently suitable for operation from low impedance, low e.m.f. sources such as strain gauges, photo emissive devices, load cells, thermocouples, resistance bulbs, tacho generators, radiation pyrometers, etc., as pre-amplifiers to indicating and recording instruments or for use as an intermediate stage between the transducers and transducer systems in a host of automatic and process control schemes.

The amplifier can be used on summation or differential applications since two electrically isolated input circuits are provided. The sum or difference of the input signals being detected in the core as the net effective control flux. Extra control windings can be supplied non standard on request.

CORREX



MODULAR EQUIPMENT FOR STEPLESS PROPORTIONAL CONTROL OF VOLTAGE, SPEED, POWER, HEAT, LIGHT, ETC.

This range is readily available as individual units or as packaged systems designed to enable you to construct control schemes using the CORREX modular "add on" system.

Included, for use with and in this range are:—

- PROPORTIONAL CONTROLLERS
- MAGNETIC INSTRUMENT AMPLIFIERS
- MAGNETIC AMPLIFIER DRIVER STAGES
- TRIP AMPLIFIERS (MAGNETIC)
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Other specialised control equipment for all purposes.



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changes in the wiring arrangements. (2) A stop to limit the drum rotation to 180° can be provided for a second programming method. In this case, eight programmes on the drum will actuate one row of contacts while a second set of eight programmes on the drum will actuate the other contact row.

Actan programming switches feature a mechanical life in excess of 100 million operations. Contact resistance is 0.055 Ω maximum. Self-cleaning lift-off contacts are rated at 2 A at 24 V d.c. or 115 V a.c.—*Sealectro Ltd., Hersham Trading Estate, Walton-on-Thames, Surrey.*

For further information circle 23 on Service Card

24. Autographic Recorder

Avery are now offering an autographic recorder for use in conjunction with certain of their tensile and compression testing machines.

Known as type 7608, the recorder is self-contained and requires only an electric power supply and cables to transmit the input signals. Its primary use is for plotting load extension diagrams in which the load ordinate is derived from a transducer fitted to a dial-type load-indicating system and the extension ordinate from a suitable strain follower.

The recorder is designed for use with Avery testing machines having a CCG, CCJ or CCN type indicator system, although it can also be used with DCG, DCJ and DCN type indicators, by-passing the recording unit already fitted.—*W. & T. Avery Ltd., Soho Foundry, Birmingham 40.*

For further information circle 24 on Service Card

25. LDEP 'Stardrives' Extended

Lancashire Dynamo Electronic Products has extended its range of 'Star-drive' thyristor-controlled adjustable speed drives up to 150 h.p. They are now manufactured in nine power ratings ranging from ¼ h.p. to 150 h.p. Static controllers are used throughout the range, employing thyristor and semiconductor components.

A control station is available for all models and incorporates stop/start or stop/forward/reverse pushbuttons, a supply indicator and finger-tip speed setting control, which provides a stepless control over a speed range of 20:1. On the ¼ to 2 h.p. ratings the control station is mounted on the cubicle itself, but can be provided in separate form on the ¼ to 2 h.p. units. All models above 2 h.p. have separate control stations.

Good regulation of the set speed is

maintained in the presence of fluctuations of load and supply voltage. Current-limiting circuits are included to safeguard both control unit and driven plant from damage by excessive torque. Optional features include reversing, dynamic braking, inching, tachospeed indication, ammeter and acceleration controls.—*Lancashire Dynamo Electronic Products, Rugeley, Staffs.*

For further information circle 25 on Service Card

26. Electronic Waveguide Switch

A fully-electronic waveguide switch with a power handling capacity of 2 W, covering the frequency range 7.75 to 8.5 Gc/s, is now available from Marconi. The attenuation of the switch is 50 dB, and it has been designed for use with microwave communications equipment where it will provide improvements in reliability, speed, space saving and efficiency over previous mechanical switching methods.

The switch is in waveguide size No. 15 and consists of a length of specially-fabricated waveguide containing a ferrite insert, with a coil wound round the outer body of the waveguide to produce a longitudinal

magnetic field. When the coil is energized, the attenuation rises quickly to the stated figure. The switching time can be achieved in less than 1 msec by a small transistorized switching circuit.—*The Marconi Co. Ltd., Chelmsford, Essex.*

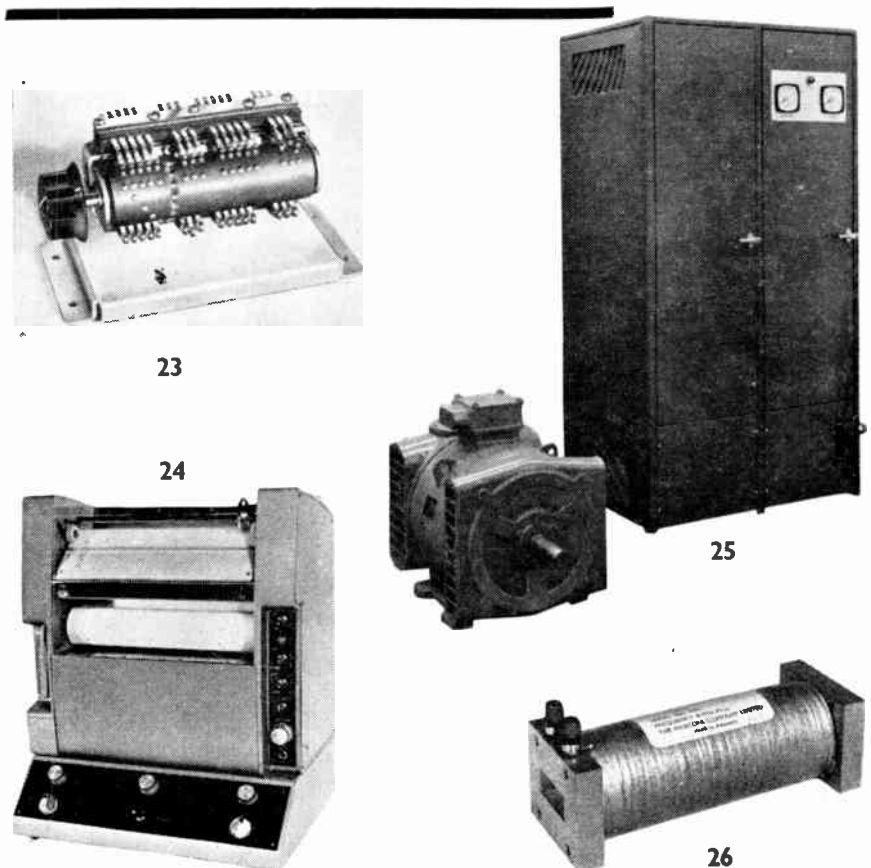
For further information circle 26 on Service Card

27. Signals Personnel Trainer

Aero Electronics have announced the Scoba Com-Tutor T/20-3, a training device for signals personnel. It is capable of training from ab initio through to operational standard in morse (both sound and light) and in r.t. procedure, quickly and inexpensively. There is no need for skilled instructors, and pupils can be trained under conditions which simulate their eventual operating environment.

Twenty training positions are provided, each with headset, microphone and morse key. Any trainee can transmit speech or morse via the class headsets or through the loudspeaker incorporated in the trainer, each key producing its own distinctive note. For visual training the key can be switched to operate a light.

A magnetic tape deck is incorporated to allow any form of recorded intelli-



EQUIPMENT REVIEW

gence or noise to be introduced. The combination of background signal, trainees' exercises, plus the instructor's ability to control the relative volumes and to over-talk, results in a comprehensive and adaptable training device. A valuable feature is the ability to record the trainees' r.t. or morse exercises for subsequent play-back and evaluation. The manufacturers have facilities available for the preparation of tapes to match customers' needs.—*Aero Electronics Ltd., Gatwick House, Horley, Surrey.*

For further information circle 27 on Service Card

28. Packaged Transistor Circuits

Newmarket are now in quantity production with the PC5+ Mark II audio amplifier.

The unit is a 3-W, 12-V, 3-ohm modular-constructed transistor amplifier with integral heat sink. The 3-W rating is an r.m.s. one. The amplifier has a very low quiescent current (only 10 mA), which makes it ideal for dry battery operation.

In the PC5+ Mark II, a connection has been added to provide a decoupled supply voltage for a separate pre-

amplifier. The unit has also been improved by the use of riveted construction for greater robustness.

To avoid difficulties for users who designed Mark I into their equipment, the overall size, mounting facilities and electrical characteristics have not been significantly modified in the Mark II.—*Newmarket Transistors Ltd., Packaged Circuit Division, Newmarket, Suffolk.*

For further information circle 28 on Service Card

29. Test Waveform Generator

Designed for testing automatic control systems, the latest instrument from Feedback Ltd. provides all of the common driving functions including sine, square and triangular waveforms.

The instrument, type TWG300, covers a frequency range from 0.001 to 1,000 c/s and has a scale accuracy better than $\pm 5\%$. It has resettable initial starting conditions from either peak positive or negative potentials. The output at 20 mA/80 V peak-to-peak is sufficient to drive most electro-pneumatic or electro-hydraulic converters.—*Feedback Ltd., Crowborough, Sussex.*

For further information circle 29 on Service Card

30. Time-Delay Unit

Diamond H Controls have announced a compact industrial time-delay unit incorporating their standard BW relay. Basically, the circuit is an RC network which discharges into a cold-cathode tube amplifier, full use being made of printed-circuit techniques.

Time delays, available from 250 msec to 15 min in overlapping ranges, are normally supplied preset to customers' requirements. However, a potentiometer is fitted enabling adjustments to be made in service. Alternatively terminals can be fitted for external potentiometer connections.

Standard units are available for 110/240 V a.c. with single-pole double-throw switching rated at 25 A 250 V a.c. — *Diamond H. Controls Ltd., Gunnersbury Avenue, London, W.4.*

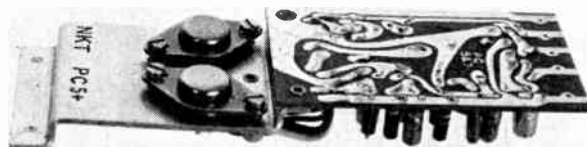
For further information circle 30 on Service Card

31. Climatic Cabinet

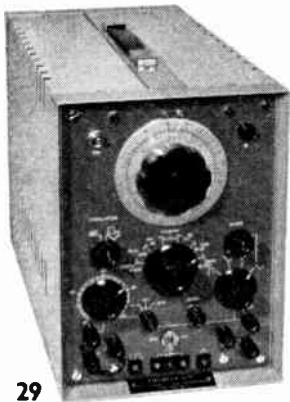
The Weyco Division of Fisons Scientific Apparatus have recently added to their range of environmental test equipment a climatic cabinet intended primarily to meet the needs of the packaging, pharmaceutical, plant and chemical industries.



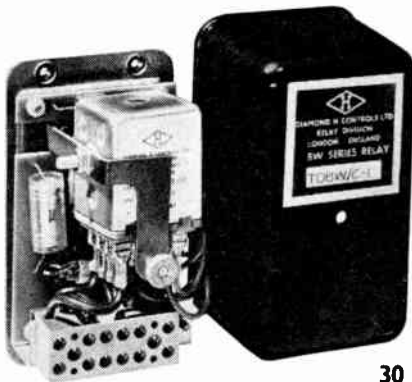
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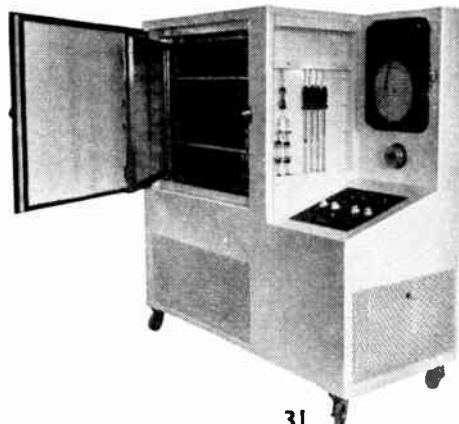
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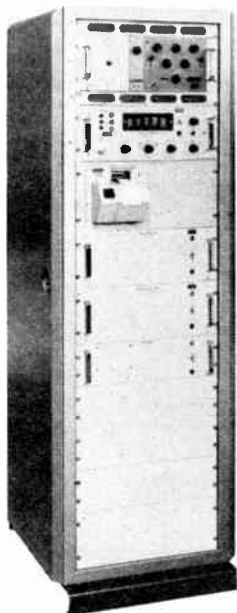
This cabinet, known as the CM/49, has the following main features: temperature range from -25 to $+150$ °C controlled to ± 1 °C; humidity range, 12% to maximum controlled to $\pm 1\%$ R.H.; capacity of working chamber, 9.4 cu ft.

All controls are mounted at the front of the cabinet for ease of operation and access to all electrical components is gained by lifting the hinged control panel. A twin-pen recorder, to give continuous recording of temperature and humidity, is fitted as standard. — *Weyco Division, Fisons Scientific Apparatus Ltd., Loughborough, Leics.*

For further information circle 31 on Service Card

32. Automatic Inspection Equipment

Automatic inspection equipment designed by Digital Measurements in conjunction with Ether Langham Thompson enables 500 production testing operations which previously took 4 days to be completed in less than 3 hours. The equipment measures resistance and conductance in the range $10\text{ m}\Omega$ to $1,000\text{ M}\Omega$, to a maximum accuracy of 0.2%.



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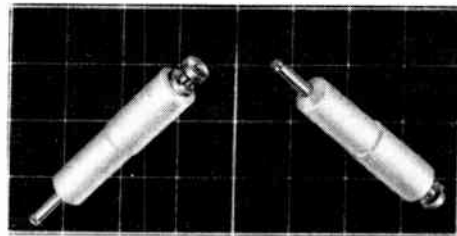
The automatic inspector consists of a digital data logging and off-limit alarm system used in conjunction with a programme unit and a card reader. A punched card determines the test to be made, selects the correct resistance or conductance range and provides information on the high and low production limit for the test. The digital logging equipment is scaled to give direct readings in units of resistance or conductance, as selected. The measurement, the test number, the range in use, etc., are printed out in decimal form by a paper strip printer to provide a permanent test record. If the measurement is outside the production limit, the print-out is in red. — *Digital Measurements Ltd., Salisbury Grove, Mytchett, Aldershot, Hants.*

For further information circle 32 on Service Card

33. Terminal for High Pressures

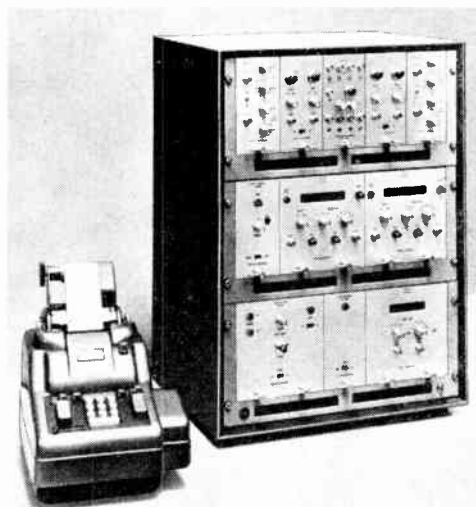
A miniature feed-through terminal, designated as FT-2000-L1 and designed for high-pressure applications, is available from Seaelectro.

The unit has a virgin Teflon bushing and silver plated brass lug. It is claimed that the unit has been sub-



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jected to tests in which oil exerted pressure against the shoulder of the bushing, and that a 36-hr test maintaining 3,000 p.s.i. revealed no oil leaks or deformation of the bushing. A second test conducted for 60 hr under 1,500 p.s.i. was also successful.

The FT-2000-L1 is designed for 'Press-Fit' installation into a prepared chassis hole. Insertion is made quickly with a B13-6 insertion tool. The unit measures 1.115 in. in overall length with a bushing length of 0.775 in. Units are available in all ten E.I.A. colours. — *Seaelectro Ltd., Hersham Trading Estate, Walton-on-Thames, Surrey.*

For further information circle 33 on Service Card

34. Fast/Slow Coincidence Systems

Nuclear Enterprises has designed a range of fast/slow coincidence systems for nuclear physics experiments around the NE 5704 coincidence unit, NE 5256 amplifier and other units of its Edinburgh series of transistorized modular instruments.

The four fast inputs to the NE 5704 may be used to select those events which bear a definite coincident or anti-coincident time relationship to one another. The range of resolving times is variable from 10 to 50 nsec, and the resolving time is determined by a plug-in delay-cable board. Two of the fast channels are preceded by cross-over pick-off circuits which take advantage of the accurate timing of the bipolar-pulse baseline crossover obtained from the NE 5256 amplifier operated in the double delay-line mode.

The slow coincidence channels may be used for imposing energy conditions on the experiment by means of NE 5153 single-channel pulse-height analysers or for gating the circuit by logic pulses from ancillary equipment. These spectrometers are usually built to the specific requirements of customers. The photograph shows a typical system. — *Nuclear Enterprises (G.B.) Ltd., Sighthill, Edinburgh, Scotland.*

For further information circle 34 on Service Card

35. Improved Synchros

Departing from the conventional smooth slip ring with a blade-type brush, Moore, Reed & Co. are now producing synchros in which a circular-section brush is located in a grooved slip ring. This design provides four contact points per winding. Applied vibrations have much less effect on this design and vibration tests between 5 and 2,000 c/s at acceleration figures well in excess of those quoted in

EQUIPMENT REVIEW

MIL-S-20708A, have been carried out with no signs of brush bounce.

The most striking effect of this design has shown up in the ability of the synchros to meet severe temperature/pressure/humidity cycling. Slipping assemblies which show signs of contact resistance and open circuit during such tests cause complete breakdown of servo control systems, but the grooved assemblies functioned perfectly throughout the tests.—*Moore, Reed & Co. Ltd., Woodman Works, Durnsford Road, London, S.W.19.*

For further information circle 35 on Service Card

36. Automatic Capacitance Bridge

A fully-automatic capacitance bridge, which selects range, achieves balance, and presents the measured value in digital in-line form, has been announced by General Radio.

The type 1680-A automatic capacitance bridge, including built-in transistor oscillator (120, 400, and 1,000 c/s) as well as bridge and detector circuits, measures parallel capacitance from 0.01 pF to 100 μ F at 400 and

1,000 c/s, and from 100 pF to 1,000 μ F at 120 c/s. Basic accuracy is $\pm 0.1\%$ of reading. The bridge also measures dissipation factor from 0.0001 to 1.0 and parallel conductance from 0.1 nanomho to 1.0 mho.

Measurement results (capacitance and loss) are shown, complete with decimal point and units, on an in-line Numerik digital readout display. The same information is also supplied in binary-coded decimal form for use by printers and other data-handling equipment. The entire balance takes about 0.5 sec.—*General Radio Company (U.K.) Ltd., Marlow Road, Bournemouth, Bucks.*

For further information circle 36 on Service Card

37. Motor Speed Controllers

The Industrial Control Division of W. H. Sanders have recently applied for a provisional patent on the control circuit of two fractional horse power motor-speed controllers, types FHP15A and FHP50A.

These are semiconductor devices giving a full-wave output from a 240-V 50-c/s input. The simplicity of their

design enables them to be used for applications where the cost of any previous electronic speed controller would be prohibitive. A feature of their design is their small size.

The controller supplies the field and armature of a d.c. shunt-wound motor on a full-wave basis. Control is effected by means of a feedback loop which maintains the armature voltage at a value proportional to a stabilized reference voltage.

The FHP15A is rated for motors taking 1.5 A total current and is suitable for controlling motors in Dyeline printing machines, air-conditioning plant, fan control, etc. The FHP50A will control motors taking up to 5 A, typical applications being small machine tools, packaging machinery, conveyors, etc. The field-winding supply from both controllers is 220 V d.c. and the armature supply is controllable over the range 10 to 180 V d.c.

Single unit prices for the controllers are FHP15A £15 and FHP50A £18, complete with case.—*W. H. Sanders (Electronics) Ltd., Stevenage, Herts.*

For further information circle 37 on Service Card

38. Miniature No-Bounce Switch

Guaranteed no-bounce closure is one of the unique features of a range of miniature switches now being manufactured in this country by the Erg Industrial Corp., under licence from Vitramon Inc.

The no-bounce characteristic will be of particular interest to manufacturers of digital equipment, since a square pulse can be obtained from the push-button version of the switch without using a multivibrator.

This switch also offers a noise level of $< 1 \mu$ V and is therefore suitable for switching the low-level potentials associated with process-control thermocouples. Contacts can be initiated by linear motion, manual pushbutton, or cam rotation.

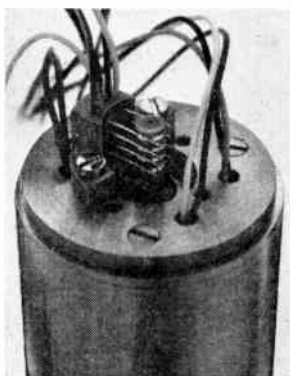
The closure motion and differential (being the motion required for repeated complete closing and opening of the contacts) is less than 0.0005 in. and the actuation pressure is < 30 gm. The switch is a single-pole type and is rated at 28 V d.c. (0.25 A); closed-contact resistance is 0.050 Ω max. at 10 mA.—*Erg Industrial Corporation Ltd., Luton Road, Dunstable, Beds.*

For further information circle 38 on Service Card

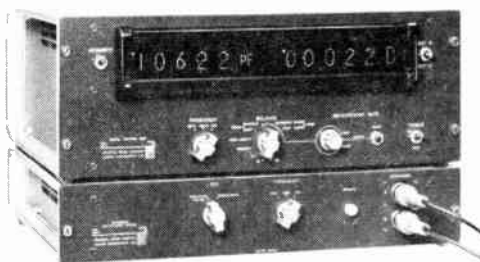
39. Hall Effect Kit

Available from Livingston Laboratories and manufactured by F. W. Bell Inc., of Columbus, Ohio, is the type 700 Hall Effect kit priced at £12 10s

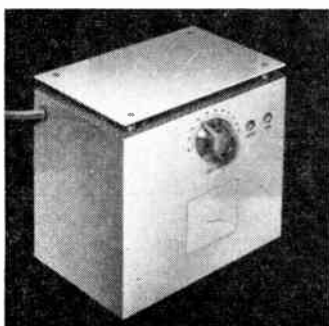
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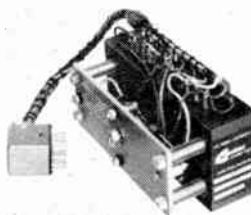
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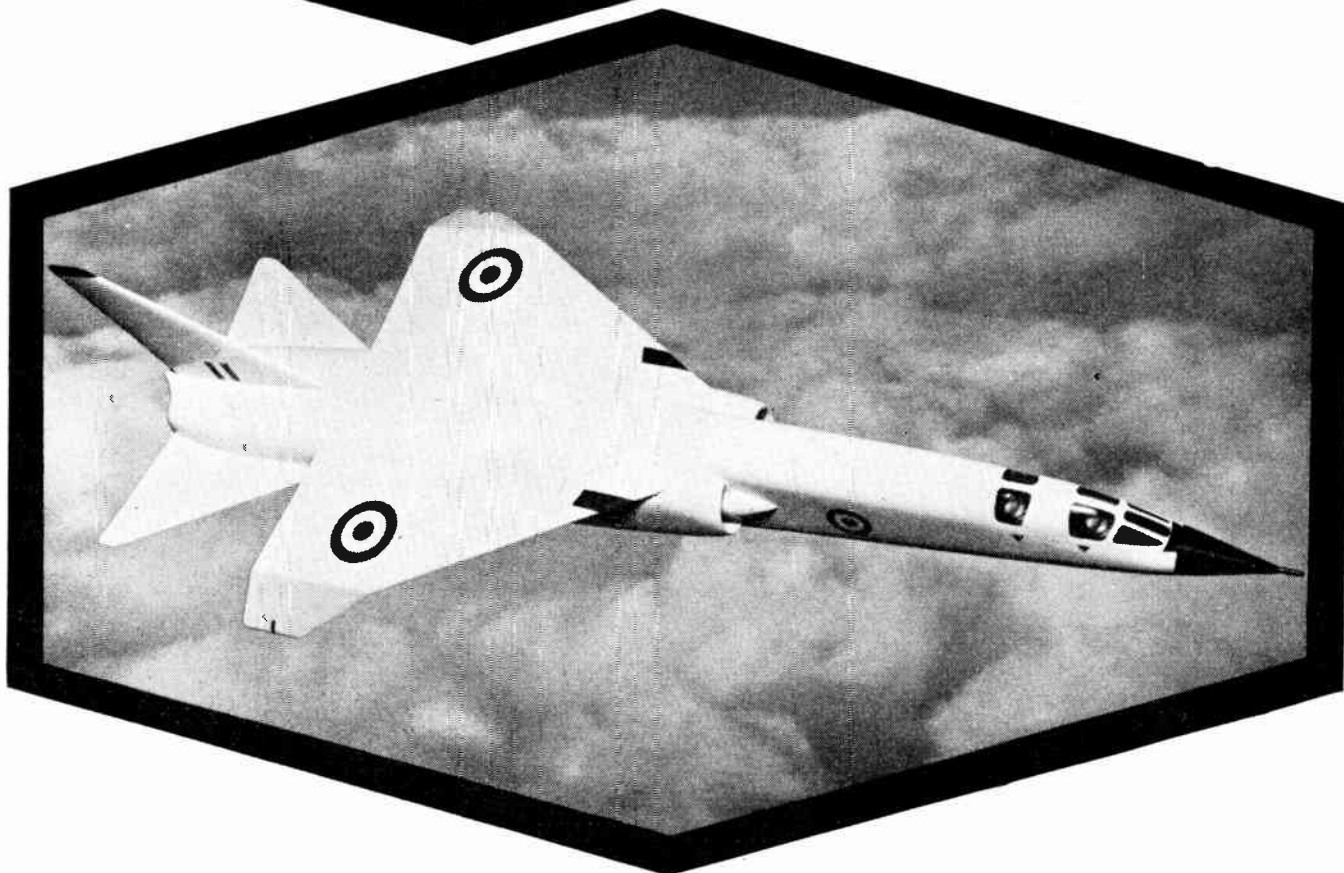
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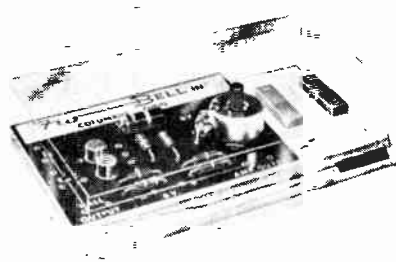
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wcw2

including duty. This consists of a semiconductor Hall element with a transistorized amplifier and permanent magnets.

When used with two 6-V batteries or power supplies the kit can be used to perform elementary experiments and demonstrations of the Hall Effect, the measurement of flux density, field gradients, ferromagnetic studies, etc. It is primarily intended for use in schools, technical colleges and development laboratories which are considering the use of this measuring technique. —*Livingston Laboratories Ltd., 31 Camden Road, London, N.W.1.*

For further information circle 39 on Service Card



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40. Fail-Safe Coaxial Switch

Sage Laboratories of Massachusetts, have produced model SAN521E fail-safe two-position coaxial switch which has a 2,000,000-cycle life.

It provides a maximum v.s.w.r. of 1.3 from d.c. to 4.2 Gc/s and is designed for remote operation from a 28-V d.c. source. (Other drive voltages, both d.c. and a.c., can be accommodated.) The mechanism is spring-returned when d.c. power is removed. Switch time is less than 10 msec.

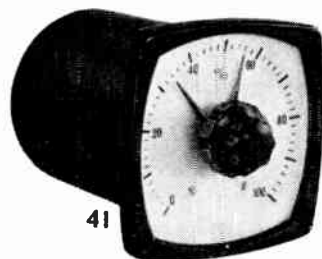
Production lots of these switches have been life-tested over 2,000,000 cycles, and have demonstrated a mean time between failures of more than 1,000 hours. It withstands the water immersion, shock, and vibration requirements of MIL-S-25879A, and operates over an ambient temperature range of -62°C to $+95^{\circ}\text{C}$. It is available with type N, C, TNC, or BNC connectors. Available in the U.K. through *Roberts Electronics Ltd., 17 Hermitage Road, Hitchin, Herts.*

For further information circle 40 on Service Card

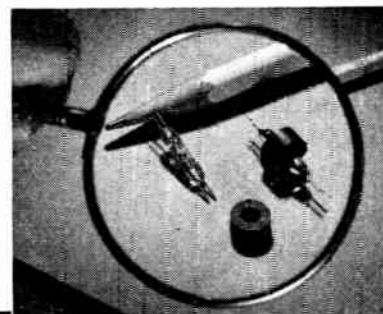
41. Solid-State Controller

Kent Precision Electronics have developed a solid-state calibrated control instrument, operating from a.c. or d.c. inputs, intended to replace the conventional 'contact meter' type of controller in applications such as sensitive power control, under/over current or voltage trip or alarm, servo position or speed control, temperature control, etc.

The instrument consists basically of a transistorized low-drift d.c. amplifier which acts as a balance detector between a controlled reference voltage and the input parameter. The output of this amplifier operates a trigger circuit which in turn controls a thyristor output circuit to switch the load, with either proportional or on/off control. When the controlled power is above the maximum available thyristor ratings or where isolated switching is



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required, a low power thyristor circuit is used to operate an electromagnetic relay or contactor.

The linear scale is calibrated in terms of the parameter to be controlled, with single or dual setting pointers, and these $3\frac{1}{2}$ -in. panel-mounting instruments normally contain standard relays rated at 250 V, 5 A a.c., with alternative ratings available as required. Thyristor outputs with rating of up to 600 V and 100 A are available on request. Operation is from an auxiliary mains supply via an isolation transformer, with regulation for variations of $\pm 20\%$. The temperature coefficient is within 0.05% per $^{\circ}\text{C}$ for all ranges and the instrument is suitable for operation in ambient temperatures of up to 85°C . —*Kent Precision Electronics Ltd., Vale Road, Tonbridge, Kent.*

For further information circle 41 on Service Card

42. Sealed Miniature Switch

Now available in the U.K. from STC is the 'Herkon' H25 miniature ball-armature switch. Maximum contact rating is 75 V, 0.5 A d.c. and flashover voltage is 200 V.

Only 4 mm in diameter and 15 mm long, these glass-encapsulated switches are filled with inert gas and contain a metal ball actuated by a miniature permanent ring magnet used around the outside of the small glass envelope. The two pairs of contacts at opposite

ends of the envelope may be wired to provide alternately operated 'make' contacts, or to function as a one change-over 'break-before-make' contact.

Herkon H25 switches are designed for operation by push keys, and the main applications are in control engineering. They are especially suitable for industrial control systems in hazardous areas of chemical and petroleum manufacture. Apart from safety considerations, these ball-contact switches provide reliable long-life contacts for push-switches on control consoles located in corrosive or humid atmospheres. —*STC Electro-mechanical Division, West Road, Harlow, Essex.*

For further information circle 42 on Service Card

43. Vibration System

Derritron Electronic Vibrators have announced a vibration system consisting of a 30-kVA power amplifier, designed for both random and sine testing, a 6,000-lb thrust vibrator and control equipment.

The amplifier has a maximum continuous anode dissipation of 50 kW, and has a full-power frequency range of 15 c/s to 5 kc/s; full current is available down to 5 c/s. Vapour-cooled valves are employed, and hum and noise is at least 70 dB below full output.

The thrust vibrator (type number

EQUIPMENT REVIEW

VP.600) employs a drive-coil cooling system which provides an extremely stiff table and coil assembly. Distilled-water cooling is normally employed, although for certain extreme climatic chamber conditions, oil cooling could be used. Brief specification for this vibrator is 6,000 lb vector thrust, frequency range approximately 5 c/s to 3 kc/s (usable up to 5 kc/s), with a first major disturbing resonance at 2.5 kc/s. The low table weight of 70 lb allows an unloaded table acceleration of over 85 g.

The illustration shows the vibrator and amplifier, with a standard sine control console. However, all types of vibrator control systems, including fully-automatic random equalization consoles, can be supplied.—*Derritron Electronic Vibrators Ltd., 24 Upper Brook Street, Mayfair, London, W.1.*

For further information circle 43 on Service Card

44. Digital Display C.R.T.

A cathode-ray tube which is particularly suited to the display of digital information under high ambient-lighting conditions is now available from The M-O Valve Co.

This is their type 700E which has a small rectangular face with a display area of 45 mm × 24 mm.

Although high current may be drawn from the cathode, little of this current

flows to the focus electrode or the deflector plates; this enables a large number of tubes to be operated from common focus and deflection supplies. The information is displayed by intensity modulation of the electron beam.

A typical operating e.h.t. of 2 kV results in a Y sensitivity of 94.5 V/cm and an X sensitivity of 43.5 V/cm.—*The M-O Valve Co. Ltd., Brook Green Works, London, W.6.*

For further information circle 44 on Service Card

45. Electronic Stroboscope

Electronic Applications are marketing a portable electronic stroboscope called the 'Flash-Tac', which costs £29. This instrument uses a xenon flash tube and provides flash repetition rates of 100–15,000 per min.

The flashing rate is read directly from a calibrated scale to an accuracy of better than ±3 per cent. A transistorized pulse generator develops a pulse rate that is linearly proportional to the movement of the flashing rate control potentiometer. Silicon transistors, high-stability capacitors and resistors, and wire-wound pre-set potentiometers are used in the frequency-determining circuits to give long-term accuracy of scale indication.

Mains powered (200–250 V, 50 c/s), the 'Flash-Tac' weighs 7½ lb and

measures 10 × 8 × 7 in. overall. Power consumption is 25 W.—*Electronic Applications Ltd., Endeavour House, North Circular Road, London, N.W.2.*

For further information circle 45 on Service Card

46. Inductive Displacement Transducers

Associated Engineering have announced two subminiature inductive displacement transducers which have been developed for displacement and vibration measurements in extreme environmental situations.

The transducers may be used with carrier frequencies up to 300 kc/s, so permitting the detection of vibration or displacement of any metallic material at frequencies from d.c. to 60 kc/s. The two transducers have a working range of 0.01 in., will withstand ambient temperatures up to 150 °C with no appreciable change in sensitivity and when suitably mounted can be subjected to accelerations up to 2,000 g without malfunction.

The largest transducer measures 0.430 in. by 0.250 in. diameter and weighs 0.7 gm. The small transducer measures 0.400 in. by 0.160 in. diameter, and weighs 0.5 gm. The transducers can be supplied with a threaded mounting ring as shown on the left in the photograph. Otherwise, they are supplied as shown centre and right.



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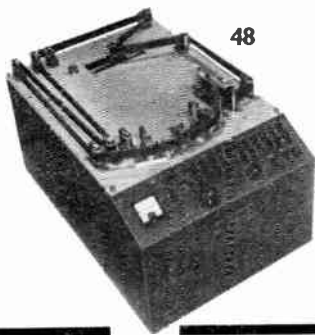
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when they may be mounted by clamping or by the use of a suitable cement or epoxy resin.—*Associated Engineering Ltd., Group Research and Development, Cawston, Rugby, Warwickshire.*

For further information circle 46 on Service Card

47. High-Speed Paper Tape Reader

A high-speed spooling tape reader, developed and manufactured by A.E.I., has successfully completed a 40-hour reliability trial observed by the Technical Support Unit of H.M. Treasury. Known as the CRP1, it is claimed to be one of the fastest of its kind.

During the trial the machine operated at a speed of 1,000 characters/sec and read 733 reels of paper tape carrying over 100 million characters. The error rate was 1 in 3.41×10^7 characters and overall efficiency was 99%. Specifications relating to loss of data by irrecoverable tape damage, which required ten passes per tape to be made, were fulfilled during the trial.

Although designed for use with the A.E.I. 1010 computer, the CRP1 may be used with any other computer or simply for high-speed tape reading,

without modification. The reader will stop on any character and accelerate to full speed within two characters. It is completely self-contained, with all power supplies and amplifiers fully transistorized. For ease of setting up there is a visual character-location indicator. Finger-tip adjustment of the tape allows the reader to be easily set for any tape up to 1 in. in width.—*A.E.I. Electronics Group, New Parks, Leicester.*

For further information circle 47 on Service Card

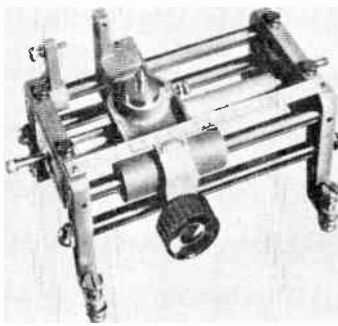
48. Delay Loop Recorder

This equipment, type 61B, has been developed by Gresham Lion Electronics for the recording and playback of audio signals or transients on a continuous loop of magnetic tape.

Three different lengths of loop may be used, 150 in., 112 in. or 75 in. and, in the standard machine, two tape speeds are available, $7\frac{1}{2}$ in./sec and $3\frac{1}{2}$ in./sec.

Other tape speeds and delay times may be obtained by a simple change of capstan motor and the number of idler pulleys.

Fourteen channels on 1-in. tape are



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available, each with a transistorized plug-in record amplifier and playback amplifier, a switchable meter being provided to monitor record and playback levels.

A switch, cutting out the erase and recording circuits, enables a complete loop of recorded signal to be 'frozen' on the tape.

'Record', 'playback' and 'erase' magnetic heads are completely interchangeable without mechanical re-adjustment.—*Gresham Lion Electronics Ltd., Twickenham Road, Hanworth, Middlesex.*

For further information circle 48 on Service Card

49. Coaxial Slotted Line

Covering the frequency range of 2 to 18 Gc/s, the Omni Spectra 'Astroline' model 20010 coaxial slotted line provides the means for accurate measurement of v.s.w.r. and phase on miniature microwave components. Residual v.s.w.r. is 1.05 maximum from 2 to 8 Gc/s, 1.1 maximum from 8 to 18 Gc/s.

The slotted section is a miniature air-dielectric line with integral OSM connectors (one plug and one jack) mounted permanently on the carriages. The probe travel is 10 cm. This slotted line is usable at frequencies up to 26.0 Gc/s.—*Ad. Auriema Ltd., Impectron House, 125 Gunnersbury Lane, London, W.3.*

For further information circle 49 on Service Card

50. Fast Rise Time PM Tubes

First of a new range of fast photo-multiplier tubes, suitable for use in applications where a short rise time and high peak currents are required, is announced by E.M.I. Electronics. The high-field focused dynode system of the type 9594B tube employs antimony caesium secondary-emitting material to give maximum stability and minimum gain shift.

A rise time of $2\frac{1}{2}$ nsec is achieved by the use of an end-window with a concave inner surface on which the semi-transparent photocathode is deposited, in conjunction with focus and deflector electrodes. The fourteen-stage dynode structure gives an overall electron gain in excess of 100,000,000. Photosensitivity is $70 \mu\text{A/lm}$. The flat external surface of the end-window facilitates coupling of scintillating crystals.

Variations of the basic type now in development include a tri-alkali cathode version for applications demanding an extended red response, and another with a quartz window for improved ultra-violet sensitivity.—*E.M.I. Electronics Ltd., Hayes, Middlesex.*

For further information circle 50 on Service Card

A review is given of the effect of minor metallic constituents on tin-lead and similar alloys used as soft solder for electrical joints, with reference to the possibility of modifying solders for special purposes by additions of such metals.

THE EFFECT OF MINOR CONSTITUENTS OF SOFT SOLDER

By B. M. ALLEN and W. RUBIN, Ph.D.*

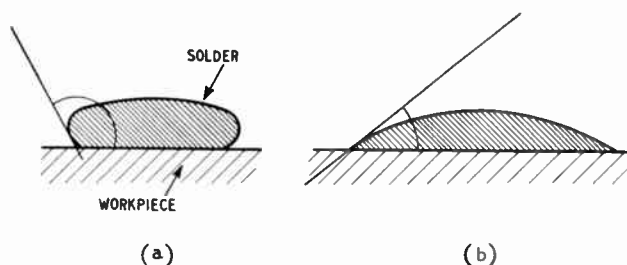
SOFT solders may be arbitrarily defined as those alloys used for metal joining, which melt in the range 130–330 °C. Practically all the useful alloys in this range consist of tin and lead, but they may contain small amounts of other metals which modify particular properties. In electrical equipment, and particularly in communications equipment, the main purpose of the solder is to make and maintain good electrical contact; mechanical strength is only important in so far as it affects the electrical soundness of the joint. The solder joints may be made individually using flux-cored solder and a soldering iron whether conventional wiring or printed circuitry is employed, though in the case of printed circuits it is common practice to make all joints simultaneously by dipping in a solder bath. Each method has its advantages: though in general the effect of impurities is the same in either case, there are certain additional restrictions (to be described later) on the composition of solder baths.

Table 1 shows typical analyses of tin, lead and of a good-quality commercial 60/40 tin/lead solder made from them, in comparison with the composition limits demanded by British Standard and American Federal Specifications. Between them these two specifications cover the only elements likely to be met with as impurities in solder, and it is clear that good-quality solder is not only well within the specification limits but does not become appreciably contaminated during manufacture from the virgin metals. However, impurities may still be picked up by the solder from the workpieces while the joint is being made. To understand the effect of such impurities we first consider how a pure tin/lead solder forms a joint.

Tin and Lead in Joint Formation

Solder is, of course, mainly used for permanent low-amperage connections designed to carry signals rather than power: unlike other joining systems, such as switches, plugs or screw terminals, there are no forces of shear or pressure to ensure good contact. Therefore, to be sure that there is no high resistance in the joint or rectifying effect due to oxide films, the solder must alloy with the metal parts to be joined. When this happens the contact angle of the

Fig. 1. Poor wetting produces a large contact angle (a) while good wetting gives a small contact angle (b)



* Multicore Solders Ltd. A condensed version of an address to the Hungarian Telecommunications Association delivered in Budapest on 25th March 1963.

Table 1

	Tin	Lead	Copper	Silver	Zinc	Cadmium	Aluminium*	Indium	Arsenic	Antimony	Bismuth	Iron
Tin	% 99.32	% 0.075	% 0.023	% 0.002	% nil	% nil	% nil	% 0.004	% 0.021	% 0.033	% 0.020	% 0.003
Lead	0.017	99.98	0.0003	0.0003	nil	nil	nil	nil	nil	nil	0.002	0.0001
60/40	59.45	40.48	0.02	0.0004	nil	nil	nil	0.007	0.005	0.03	0.001	0.001
B.S.219* ...	59-60	balance	0.177	—	nil	nil	nil	—	0.05	0.5	—	0.02
QQ-S-571* ...	59.5-61.5	balance	0.08	—	0.005	—	0.005	—	—	0.2-0.5	0.25	0.02

* Figures quoted are maximum unless a range is stated.

Table 2

<i>Eutectics</i>	<i>Monotectic or Two-liquid Systems</i>
Tin-Zinc	Tin-Aluminium
Tin-Cadmium	Tin-Silicon
Tin-Mercury	Tin-Germanium
Tin-Gallium	Tin-Chromium
Tin-Indium	
Tin-Thallium	
Tin-Lead	
Tin-Bismuth	

molten solder on the solid metal will fall and the solder is said to have 'wetted' the metal. This effect is very easily seen when making the joint and is the operator's only guide to good workmanship. It is illustrated in Fig. 1. The effect is also the basis of all methods of testing solderability, whether these methods are designed to test the flux, the solder or the metal to be joined.

The value of tin in making joints is due to its ability to alloy with a very large number of metals. A few of these alloys are eutectics between two solid solutions, as listed in the first column of Table 2. All other binary alloys of tin are intermetallic compounds with the exception of a few metals (second column of Table 2) which form either monotectic or two-liquid systems. These few metals are almost unsolderable. Figs 2, 3 and 4 illustrate the three types of equilibrium diagram.

When making a soldered joint, in the absence of an intervening film of oxide, the extent of reaction between the tin and the workpiece depends on the slope of the liquidus line at the tin-rich end of the equilibrium diagram, since at a given temperature a low slope permits a greater degree of alloying before the mixture goes semi-solid. Rate of reaction is increased by rising temperature but, in most cases, is so great that the practical limiting factor in joint formation is the rate of oxide removal by the flux.

If the reaction goes too far, the quantity of liquid tin available decreases and the liquid layer splits up into a number of droplets. This effect is called 'de-wetting'; it is suppressed by using a tin/lead alloy instead of pure tin. Very few metals have appreciable solubility in lead or form intermetallic compounds with it, and so the lead moderates the action of tin by diluting it. Since lead forms a eutectic with tin, it also permits the use of a lower operating temperature and, of course, the alloy is stronger than pure tin.

De-wetting by excessive alloying can continue in the solid state. It is often found, for example, that tinned copper wire carrying only a very thin layer of tin becomes virtually unsolderable after a few months' storage due to complete conversion of the tin coating to Cu_6Sn_5 compound. The effect can be considerably retarded by using copper wire with a thicker coating of tin, and completely suppressed by using copper wire coated with a tin/lead alloy.

Effect of Impurities on Soft Solders

Fluidity

Zinc, aluminium and cadmium, when present in tin/lead solders, oxidize rapidly when the solder is melted. Their oxides form a very tenacious skin on the molten solder, in effect raising the surface tension of the latter to a very high value and seriously impairing its mobility. For this reason it has been agreed that more than 0.005% of these elements may not be present. The tin/zinc solders obviously contain much more zinc, but they are for use on

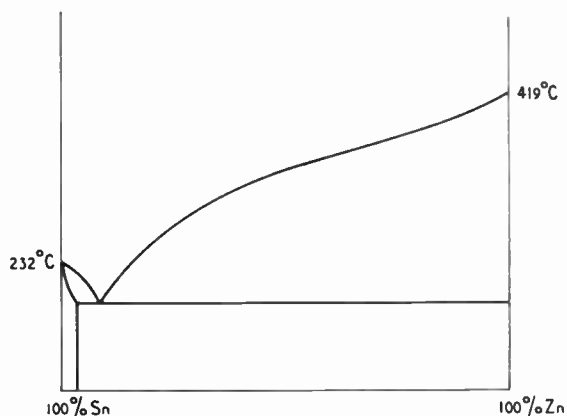


Fig. 2. Equilibrium diagram for tin-zinc Ref. 1; eutectic

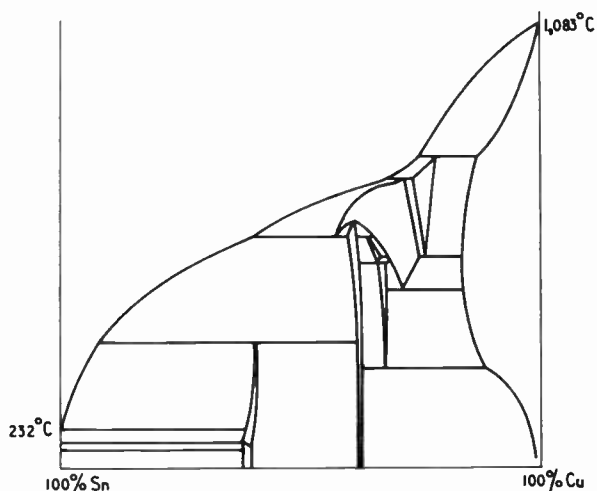
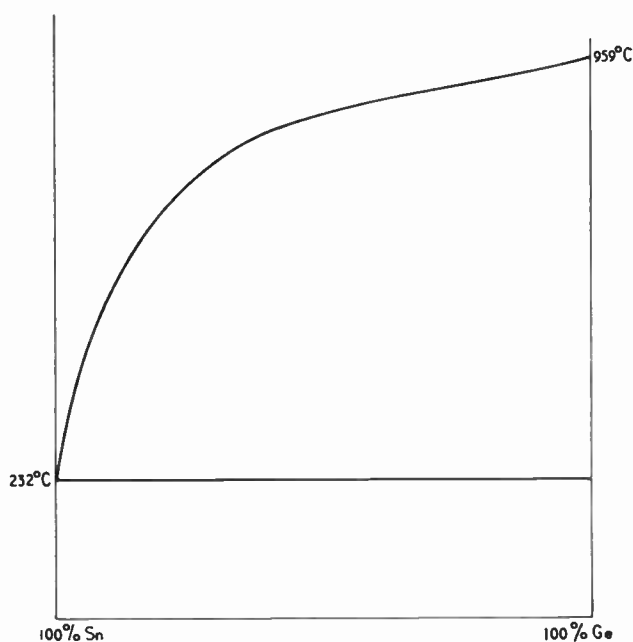


Fig. 3. Equilibrium diagram for tin-copper Ref. 1; intermetallic compound

Fig. 4. Equilibrium diagram for tin-germanium Ref. 1; monotectic



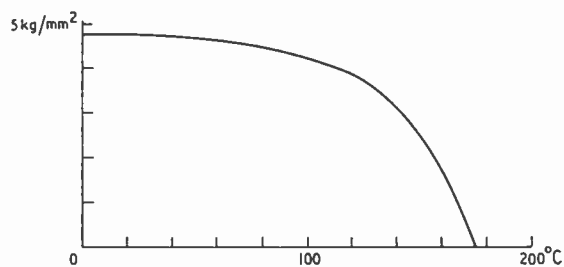


Fig. 5. Variation of tensile strength with temperature 50/50 tin/lead Ref. 4

aluminium and require special fluxes. The low-melting tin/lead/cadmium eutectic containing 17% cadmium is used as a solder, but at its normal soldering temperature (200 °C) the cadmium does not oxidize very rapidly.

Hot-Shortness

The strength of soft solders falls with increasing temperatures as shown in Fig. 5, reaching zero at 10–20 °C below the solidus temperature. This failure below the solidus is probably due to the presence of low-melting eutectics formed by the precipitation of such impurities as zinc, cadmium, mercury, indium, gallium, thallium or bismuth at grain boundaries. In general, no limits can be given for these impurities, though B.S. 219 quotes a maximum of 0.7% lead in the 95/5 tin/antimony solder. The effect is very marked at tin contents around 15%, where the strength may fall to zero as much as 40 °C below the solidus. McKeown & Fox² were unable to identify the impurities responsible but their search was not exhaustive.

Clearly, a margin of 50 °C should be allowed between maximum service temperature and solidus temperature.

Grain Size

Claims have been made that additions of arsenic, sulphur or tellurium will reduce the grain size of solders. Though much used for this purpose in the preparation of high-lead alloys, the effect has not been clearly demonstrated in the range of compositions used for solders; in any case, the grain size in a soldered joint will depend far more on the cooling conditions than on any other factor.

Intermetallic Compounds

Whether picked up from the joint members or present in the original solder, many intermetallic compounds in small quantity improve the strength and creep resistance of solders. In this respect the needle-shaped crystals of the tin/copper or tin/silver compounds are far more effective than the cube-shaped crystals of tin antimonide. They do not seriously reduce the fluidity of molten solder, but may make the solid solder a little more brittle. The latter effect is only serious when considerable quantities of compound are present. Suggested limits in the final joint are: copper 2%; iron 0.2%; silver 5%. The antimony content of the solder should not exceed 0.5% owing to the rapidity of its attack on zinc or brass.

Brittleness at Low Temperatures

In theory, tin changes from the metallic (white) to the crystalline (grey) form when cooled below 13 °C; the crystalline form has lower density, so that the tin would expand and the joint crumble. In practice, the rate of transformation is at a maximum at -40 °C. It seems certain that tin only undergoes the change, even at this

temperature, if inoculated or 'seeded' with grey tin or a material of similar structure such as diamond, germanium, silicon, zinc antimonide, mercury telluride or silver iodide. Work at the Tin Research Institute³ shows that the change is suppressed by the addition of elements soluble in tin. Lead is moderately effective, about 50% being required, but the most effective elements are antimony and bismuth, 0.3 to 0.5% of these being appropriate concentrations to suppress the change in inoculated tin. In uninoculated tin no additions are required.

Solder Baths

For printed circuitry, these generally have a tin content in the range 60–65%, balance lead. Zinc, aluminium and cadmium must be limited to 0.005%. Metals forming intermetallic compounds must also be restricted to the composition which would cause precipitation of the compound at the operating temperature of the bath. For a bath of 60% tin, 40% lead operating at 250 °C, the limits are: iron 0.1%; copper 0.5%; silver 3.0%; antimony 4.0%.

Soft Solders Modified by Additions

It was mentioned above that additions of antimony may be made to inhibit the low-temperature transformation of tin. This addition is in fact required by the American specification QQ-S-571. It should not be assumed, however, that this solder would be safe for use on brass, as it is conceivable that should the antimony react completely with the zinc, the resulting zinc antimonide might actually initiate the transformation.

Solution of copper or silver during soldering can be inhibited by prior addition of the appropriate metal to the solder in quantities depending on the soldering temperature envisaged. There is, for instance, a solder known commercially as Savbit 1* containing 50% tin, 1.5% copper, balance lead, which is suitable for soldering temperatures of about 280 °C, and which inhibits solution of copper from soldering-iron bits, fine wires or printed circuits. Another formulation, containing 62% tin, 2% silver, balance lead, is widely used for soldering silvered ceramics at temperatures around 230 °C.

Acknowledgments

Our thanks are due to Mr. Tibor Szücs, of the editorial staff of *Finommechanika*, and to Híradástechnikai Tudományos Egyesület for permission to print this abridged version of the lecture originally published (in Hungarian) in *Finommechanika*, 1963, No. 6, pp. 183-191.

References

- ¹ Smithells, 'Metals Reference Book'. (Butterworth, 1962.)
- ² McKeown and Fox, 'Hot Shortness in Soft Solders', B.N.F.M.R.A., 1944.
- ³ Hedges, 'Tin and its Alloys'. (Edward Arnold, 1960.)
- ⁴ McKeown, 'Properties of Soft Solders', B.N.F.M.R.A., 1948.

* Produced by Multicore Solders Ltd.

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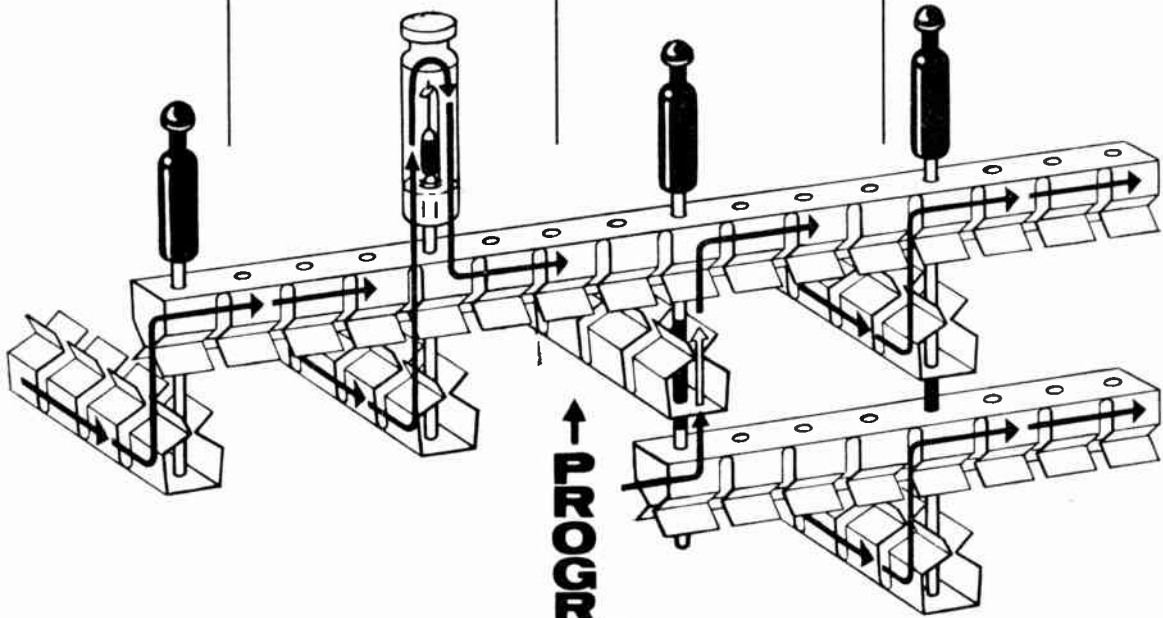
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Three-deck Seaelectroboard doubles the number of points without increasing panel area. Here we show a skip-pin connecting the top and bottom decks whilst missing the centre. Any deck may be isolated or all joined by means of the correct pin, and, of course, components can be introduced.

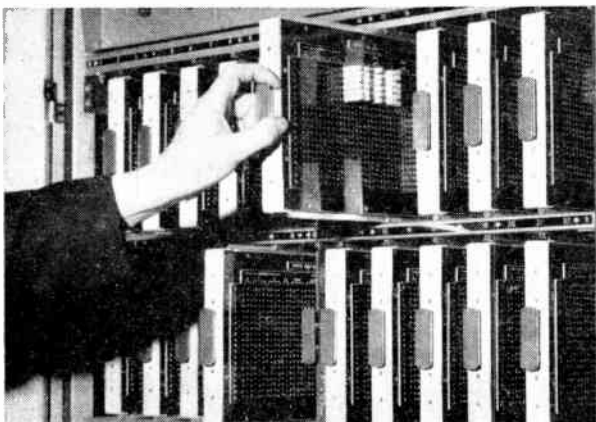
FOUR-DECK WITH SKIP-PIN

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SIMPLE TRANSISTOR CIRCUITS FOR INDUSTRIAL USE

By F. BAMFORTH, A.M.I.E.E.*

This article, which is the first of a short series, describes some basic transistor circuits which are widely used in various combinations to construct quite elaborate apparatus.

THIS short series of articles is intended to show how useful, practical and inexpensive electronic apparatus can be made from a number of simple basic transistor circuits.

The articles will describe simple switching circuits and these will begin with the basic circuits described in simple terms, followed by the development of practical circuits with component values given and the combination of these practical circuits to perform particular functions. Possible applications of these circuits will also be given.

Inexpensive silicon n-p-n transistors and silicon junction diodes will be used in all cases, thus ensuring reliability in the completed equipment. The practical circuits given can be built with confidence by the comparative newcomer to transistor circuitry and no difficulty should be experienced in obtaining satisfactory results.

Simple Switching Circuits

In all cases the transistors will be used as saturated switches. In this mode of operation, the transistor is either non-conducting (OFF) or conducting heavily (ON); the switching between these states is so rapid that it is a negligible proportion of the whole period. In the ON condition, component values will be chosen so that the transistor is saturated;

i.e., base current is so large that any increase of this produces negligible increase of collector current. The advantage of saturated switching circuits is that two clearly defined voltage levels exist at the collector of the transistor in the OFF and ON states. This is shown later in the discussion of the inverter circuit. Additionally, the collector dissipation of saturated circuits is low, since in the OFF state the collector current is almost zero, while in the ON state the collector voltage is almost zero.

While it is not intended that these articles should be an introduction to computer circuits, nevertheless, some circuits which are used in computers are discussed here since they can be very useful in simple industrial applications. The inverter, bistable and NAND gate come into this category of circuits.

Basic Circuits

Inverter

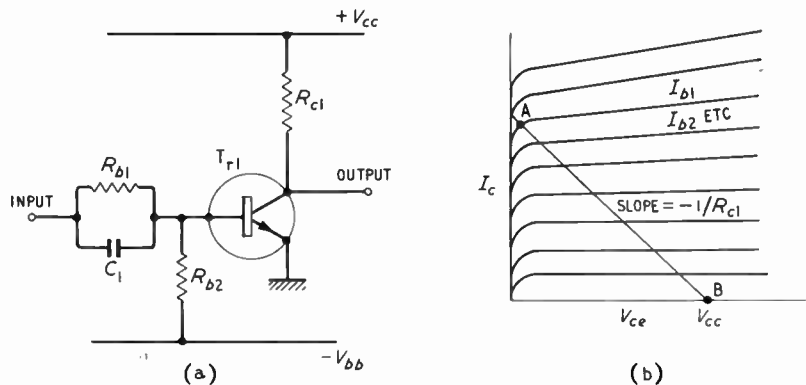
The inverter circuit is shown in Fig. 1 (a), and the operating points indicated on the transistor collector characteristics in Fig. 1 (b).

In the ON condition [point A in Fig. 1(b)], the collector voltage is almost zero, corresponding to a large positive base current and saturated collector current. In the OFF condition (point B), the collector voltage is equal to the supply voltage V_{cc} , while the collector current is only that due to leakage (which may be neglected for silicon transistors) and corresponds to a slightly negative base current.

The following should make clear the method of operation of the inverter.

* Ferranti Ltd.

Fig. 1. A basic transistor inverter circuit is shown at (a) with the transistor characteristics at (b)



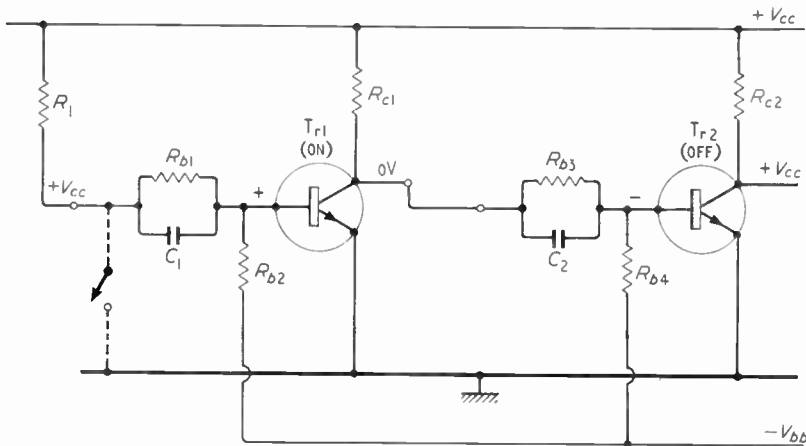
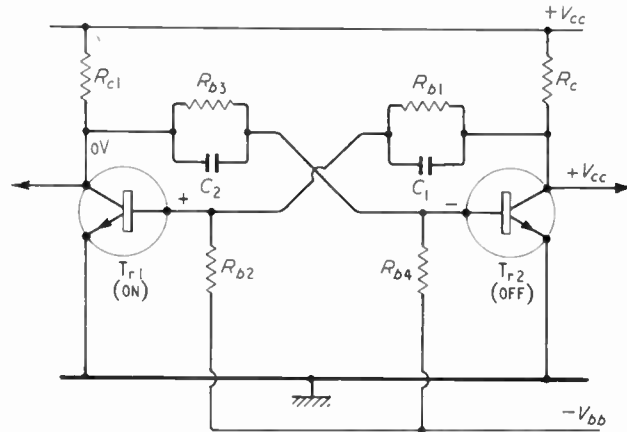


Fig. 2. A pair of inverter circuits is shown here in cascade. The approximate voltage levels are indicated

Fig. 3. The two inverters of Fig. 2 coupled back on themselves form a binary circuit. The approximate voltage levels for one state are shown



Suppose that two inverters are connected together and to an input resistor as shown in Fig. 2.

The approximate voltages at various points in the circuit are indicated in the diagram. T_{r1} is turned ON by the base current flowing via R_1 and R_{b1} , so that its collector voltage is about zero. T_{r2} is OFF, however, because its input point is almost zero and, under this condition, the base voltage is arranged to be slightly negative by suitably proportioning the values of R_{b3} and R_{b4} .

If the input point of the first inverter stage is now earthed, the voltages in the circuit will change. T_{r1} will turn OFF, causing its collector potential to rise to almost $+V_{cc}$, which will turn ON T_{r2} .

It should be apparent, therefore, that a voltage pulse of one polarity applied to the input of a single inverter stage, results in an output pulse of opposite polarity at the collector.

The purpose of the capacitors shunting R_{b1} and R_{b3} is to speed up the switching action of the circuit by providing transients of overdrive and reverse drive to the base of the transistor. A small value of capacitance is used to permit reasonably fast charge and discharge between switching operations.

Bistable Circuit

In the two-stage inverter circuit shown in Fig. 2 the input and output potentials are always identical. By connecting the output back to the input a circuit results which can have two stable states (see Fig. 3).

In one of these states (indicated in Fig. 3) T_{r1} is ON and T_{r2} is OFF while in the second state T_{r1} is OFF and T_{r2} is ON. Since the circuit is symmetrical, chance determines which state the circuit takes up when the supply is connected. The state of this bistable circuit can be changed by momentarily switching OFF an ON transistor or vice versa. Note that the capacitors are small and are used to speed up the switching action.

Multivibrator

The type of multivibrator to be described consists of two capacitor-coupled inverters, Fig. 4(a), connected with outputs to opposite inputs as shown in Fig. 4(b).

This circuit oscillates between two quasi-stable states (T_{r1}

ON and T_{r2} OFF; or vice versa), and has the waveforms shown in Fig. 5.

Simple approximate formulae for the periods t_1 , t_2 , t_3 and t_4 (neglecting transistor leakage current and assuming collector saturation and base-to-emitter ON voltages to be zero) may be derived as follows.

Assuming that T_{r1} base voltage is at $-V_{cc}$ [see Fig. 5(a)] due to the charge on C_1 , it then rises exponentially towards $+V_{cc}$ with a time constant $C_1 R_{b1}$.

$$\begin{aligned} \therefore \text{instantaneous base voltage of } T_{r1}, \\ e_{b1} &= 2V_{cc} \{1 - \exp.(-t/C_1 R_{b1})\} - V_{cc} \\ &= V_{cc} \{1 - 2 \exp.(-t/C_1 R_{b1})\} \dots \dots (1) \end{aligned}$$

At time $t = t_1$, $e_{b1} = 0$, Fig. 5(a),

substituting $e_{b1} = 0$ in equation (1)

$$1 = 2 \exp.(-t_1/C_1 R_{b1})$$

$$\begin{aligned} \therefore t_1 &= C_1 R_{b1} \log_e 2 \\ &\approx 0.69 C_1 R_{b1} \dots \dots \dots (2) \end{aligned}$$

This formula then gives the values of C_1 and R_{b1} required for the period t_1 . Similarly the formula for the period $t_2 \approx 0.69 C_2 R_{b2}$ \dots \dots \dots (3)

These simplified formulae are sufficiently accurate for many practical purposes.

The instantaneous collector voltage for T_{r2} ,

$$e_{c2} = V_{cc} \{1 - \exp.(-t/C_1 R_{c2})\} \dots (4)$$

In time $t = t_4$, e_{c2} rises to $0.9 V_{cc}$ (neglecting the small collector saturation voltage)

substituting $e_{c2} = 0.9$ in equation (4),

$$\exp.(-t_4/C_1 R_{c2}) = 0.1$$

$$\therefore t_4 = C_1 R_{c2} \log_e 10 \approx 2.3 C_1 R_{c2} \dots \dots (5)$$

$$\text{Similarly } t_3 \approx 2.3 C_2 R_{c1} \dots \dots \dots (6)$$

The turn-on time of the transistors is neglected, since it is generally much smaller than t_3 or t_4 .

R_{b1} and R_{b2} are limited to maximum values of $h_{FE} R_{c1}$ and $h_{FE} R_{c2}$ respectively (where $h_{FE} = I_C/I_B$ measured near the working saturation point) in order that the transistors should be switched ON in the saturated state.

The minimum values of R_{b1} and R_{b2} must be such as to allow the collector voltage to complete its full excursion during the pulse period. This is shown below to require a minimum R_b of approximately $5.8 R_c$ when $C_1 = C_2$.

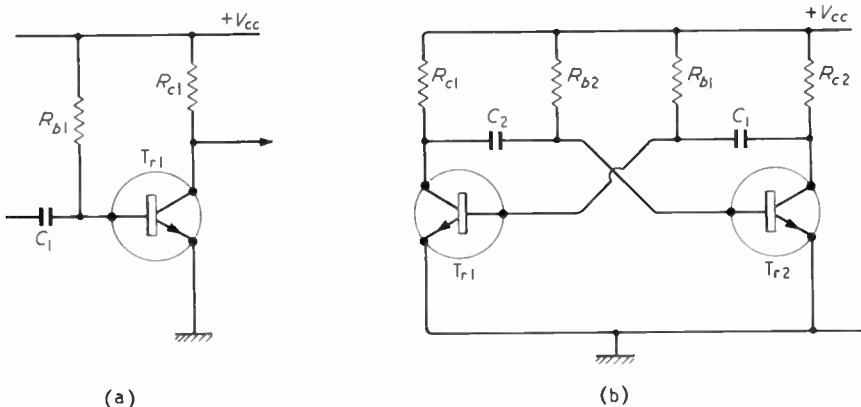


Fig. 4. A capacitance-coupled inverter is shown at (a), and a pair coupled back on themselves to form a multivibrator at (b)

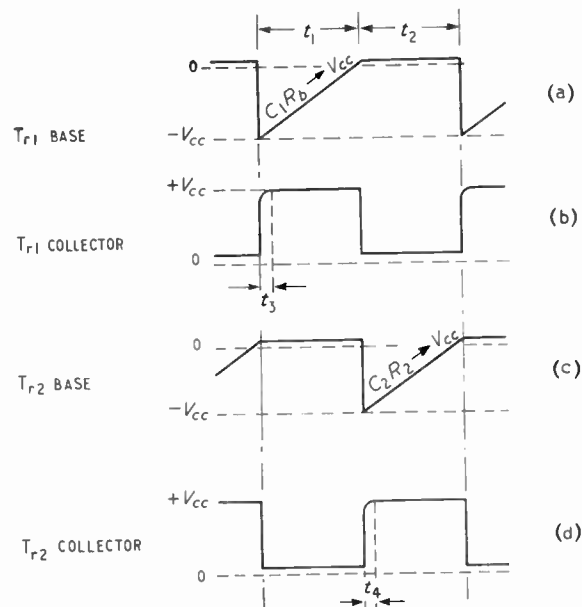


Fig. 5. Waveforms at various points in the multivibrator of Fig. 4

Referring again to Figs. 4(b) and 5. For T_{r1} collector to recover to at least $0.98 V_{cc}$, time t_1 must be at least equal to $4C_2R_{c1}$ (since $1 - e^{-1} \approx 0.98$)

$$\therefore t_1 = 0.69 C_1 R_{b1} \geq 4C_2 R_{c1}$$

If $C_1 = C_2$

$$\text{then } R_{b1} \geq 5.8 R_{c1} \quad \dots \dots \dots (7)$$

Similarly,

$$R_{b2} \geq 5.8 R_{c2} \quad \dots \dots \dots (8)$$

$\therefore R_{b1}$ must lie between $5.8 R_{c1}$ and $h_{FE} R_{c1}$ and R_{b2} must lie between $5.8 R_{c2}$ and $h_{FE} R_{c2}$ where h_{FE} is measured near the working saturation point.

These results assume that R_{b1} , R_{b2} , R_{c1} and R_{c2} are all connected to a common supply line and are modified if different supply voltages are used.

Monostable

The monostable circuit shown in Fig. 6 is made up of a combination of the circuits of Fig. 1(a) and Fig. 4(a).

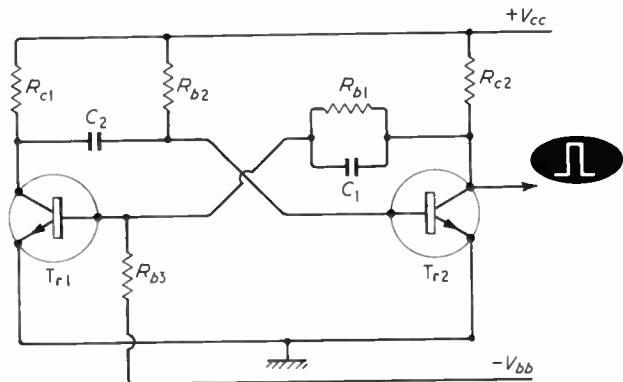


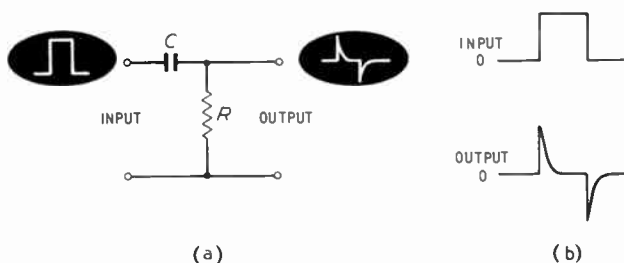
Fig. 6. A monostable circuit is shown here. It is the combination of an inverter Fig. 1(a) with a capacitance-coupled inverter Fig. 4(a)

Since half the circuit is similar to the bistable and half similar to the multivibrator, it should be no surprise to discover that the monostable has one stable and one quasi-stable state. The circuit normally resides in the stable state (T_{r1} OFF and T_{r2} ON), but may be switched to its quasi-stable state by momentarily switching T_{r1} ON or T_{r2} OFF. The period of the quasi-stable state is determined in the same manner as in the multivibrator, and is given approximately by $0.69 C_2 R_{b2}$. At the end of the period, the circuit switches rapidly to the stable state. Thus a rectangular positive-going output pulse of fixed duration is obtained each time the circuit is triggered.

Differentiator and Pulse Selection Circuit

If a rectangular positive-going pulse is applied to a CR circuit as shown in Fig. 7(a), where the time constant CR is much less than the duration of the pulse, the circuit is said to differentiate the input pulse. Typical waveforms are shown in Fig. 7(b).

Fig. 7. Simple differentiator (a) with input and output waveforms (b)



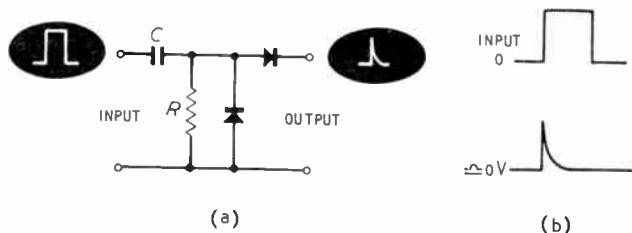
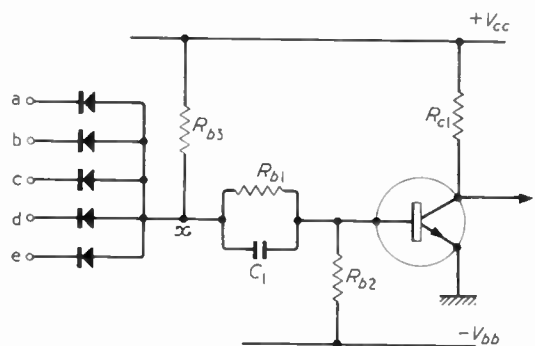


Fig. 8. Differentiator with diodes (a) and the resulting waveforms (b)

Fig. 9. (Right) NAND circuit. If the points a, b, c, d, e are all '1' (i.e., at $+V_{cc}$) point f is '0' (i.e., at zero volts), but if any point a, b, c, d or e is at '0', then f is at '1'



The addition of two diodes as shown in Fig. 8(a) gives the waveforms of Fig. 8(b).

Such circuits are useful to obtain pulses for triggering monostable circuits from long duration rectangular pulses.

NAND Gate

The NAND gate consists of an inverter with an additional resistor and several input diodes (compare Figs. 1(a) and 9).

It is convenient for descriptive purposes to choose the number '1' to represent the collector potential of a transistor

which is OFF (approx. $+V_{cc}$), while '0' represents the collector potential of an ON transistor (approx. 0 V).

Using the above convention, if all input points are '1', the diodes are all reverse-biased and base current flows via R_{b3} and R_{b1} , to turn the transistor ON (i.e., '0' at the output). If one or more of the input points are '0', then the appropriate diodes are conducting and point x is only slightly positive. Under this condition, the transistor base voltage is slightly negative and the transistor is OFF (i.e., '1' at the output).

In other words, if a, b, c, d and e are all '1' then f is '0', otherwise f is '1'.

Television Aids Translation in the Theatre

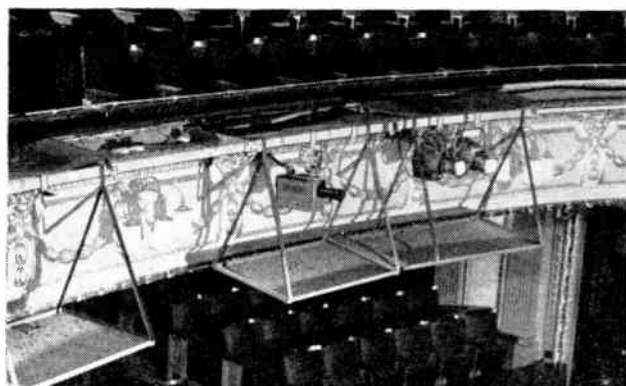
Closed-circuit television enables instantaneous translations to be given of plays from seven countries during the World Theatre Season at London's Aldwych Theatre.

A type 6 camera with wide-angle lens, installed by E.M.I. Electronics in the centre of the dress-circle balustrade, televises the scene on-stage to a television receiver which cues the interpreter in his cubicle in the wings. He listens to the actors on his earphones as they speak, and

studies the timing of their gestures on the screen.

In this way, he ensures that his translations reach their climaxes simultaneously with the passages spoken by the actors. So it is possible to synchronize audience reactions—such as laughter and applause—of those spectators who listen to the actors with those who listen to the translation on battery-operated 'lorgnette' radio receivers.

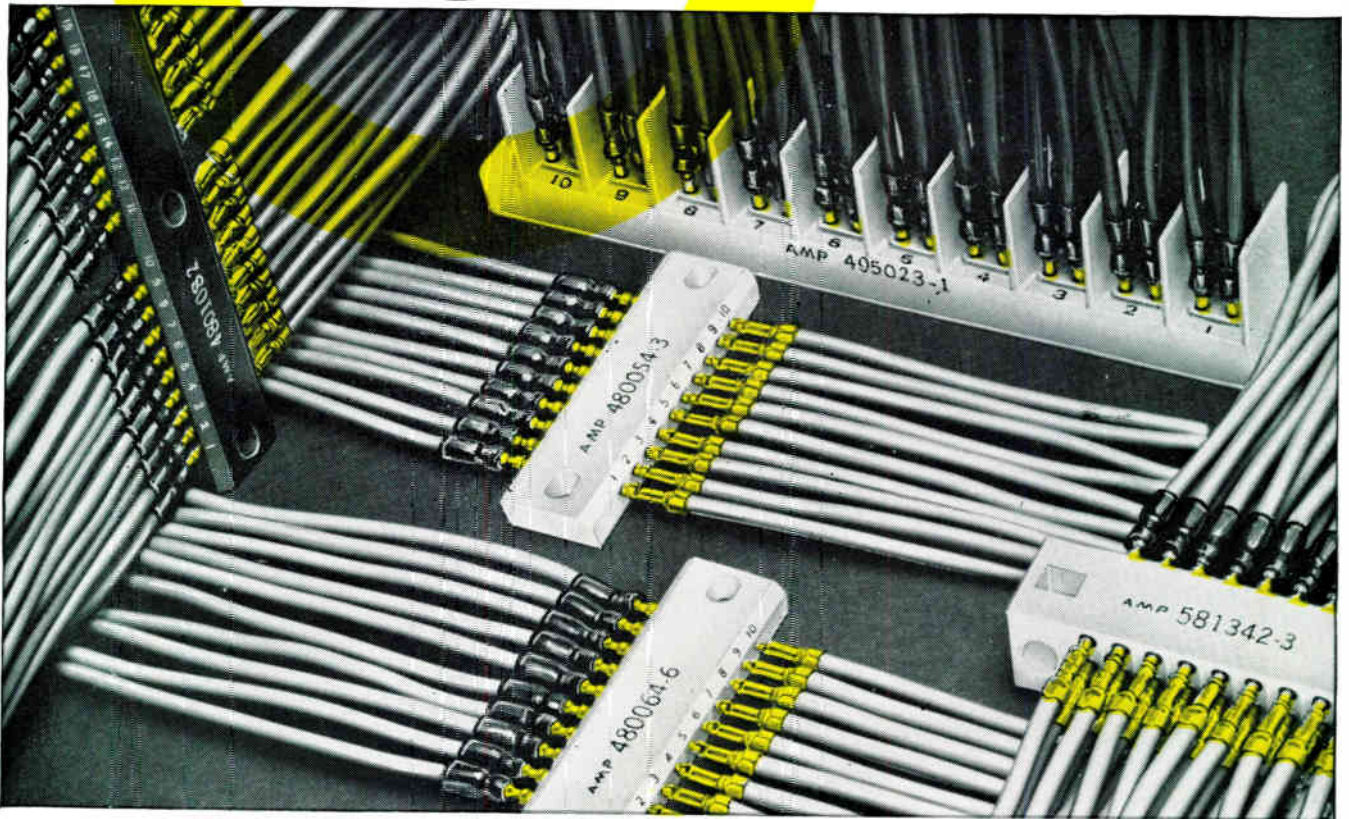
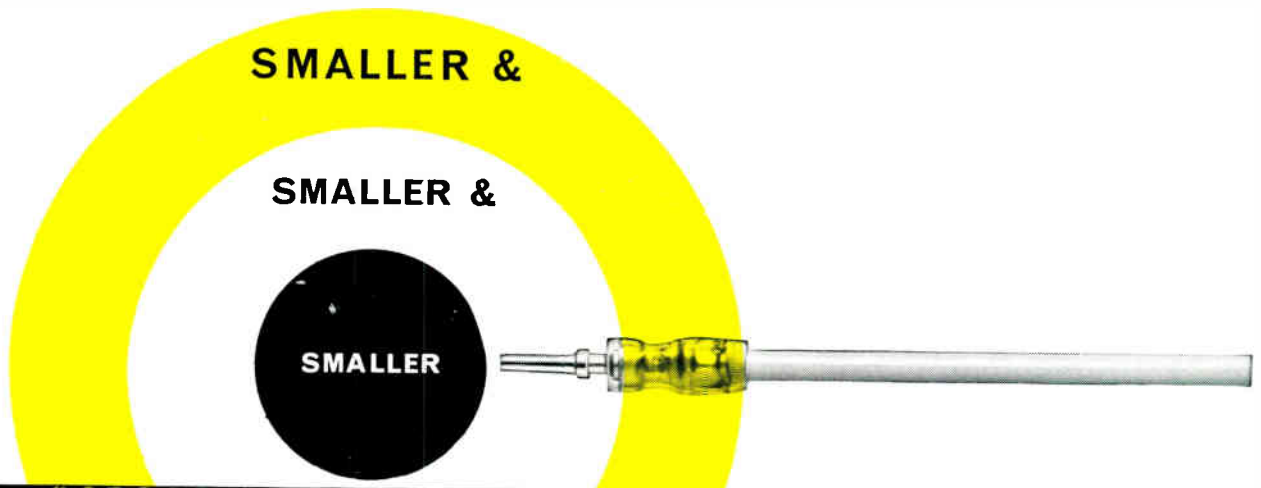
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(Above) Wide-angle television camera mounted on the dress-circle balustrade at the Aldwych Theatre

(Right) The interpreter's cubicle





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Electrical Performance When the Taper pin is driven into its mating socket a self cleaning action takes place. The extremely high contact pressures set up ensure excellent electrical performance and stability.

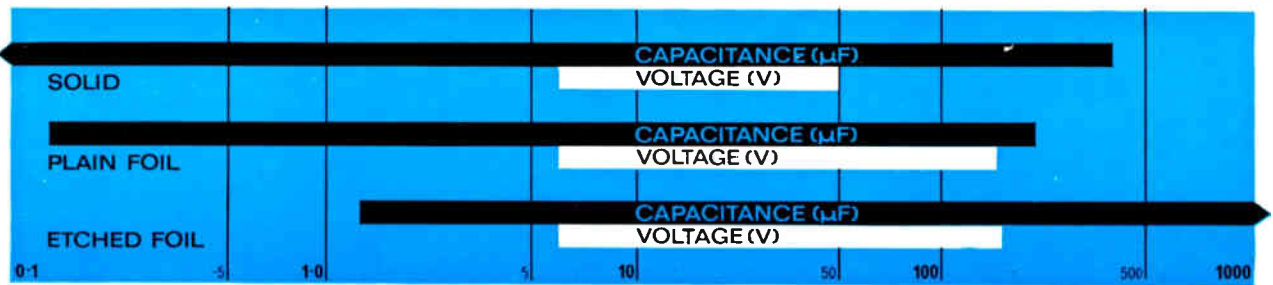
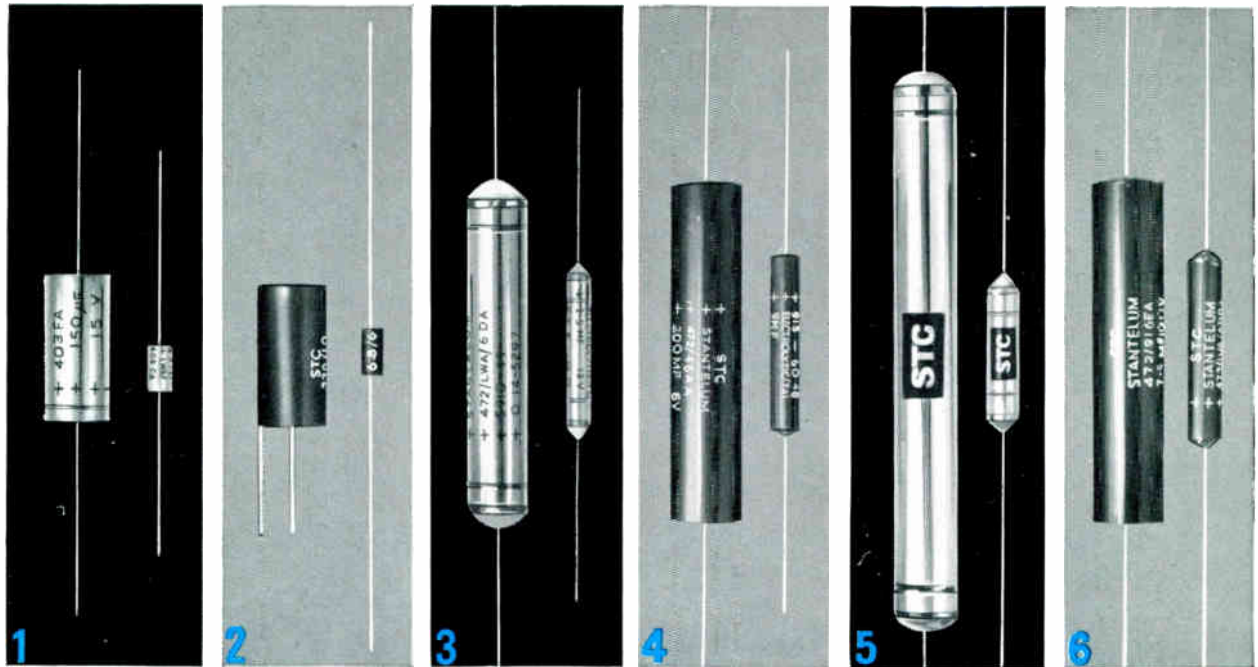
Flexibility Taper pins are easily extracted from mating sockets by using an extraction tool. They can thus be replaced or interchanged at will for circuit modification.

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CHEMICAL PLANT CONTROL BY DIGITAL COMPUTER

IMPERIAL Chemical Industries have purchased six Ferranti Argus 100 process-control computers for the direct on-line control of both continuous and batch manufacturing processes. This follows the successful experiment carried out with an Argus 200 series computer on an I.C.I. ammonia soda plant at Fleetwood, the first in the world to be directly controlled by a computer.

The main function of Argus was directly to control approximately 100 plant variables; it did this by sampling each one in turn and doing all the required calculations during the sampling period. Argus also checked all plant variables and controlled valve positions for deviation from pre-set limits every few seconds, and generated alarms if the limits were exceeded; it logged all plant variables on magnetic tape every few minutes; produced print-outs of values of plant variables and of operators' actions at intervals, and controlled the automatic start-up of parts of the plant.

It also marked an important turning point in the utilization of a digital computer for process-control purposes, for in the past British industry had been rather reluctant to extend its computing activities to this field. The most important feature of this application was that the com-

A typical Argus 100 computer



Internal view of the I.C.I. Argus mobile computer system

puter operated directly on the process. The more orthodox approach was for the computer to work through the agency of conventional controllers as a form of insurance against the possibility of equipment failure. However, the reliability of the computer and its 'fail-safe' techniques, coupled with the fact that the plant itself had no explosive or toxic hazards, made such precautions unnecessary. Indeed, since 1962 when Argus became operational, the overall reliability figure achieved has been 99.8%, not counting teleprinter failures.

The first of the new computers is mobile and is mounted in an 18-ft trailer so that it can be readily moved from plant to plant as an experimental and research tool for control-system studies. Each plant is expected, as a result of these studies, to install permanent equipment. Apart from operating as a data logger to record on punched paper tape the behaviour of the process being studied, it will also operate as a process controller. Initially, it will be used by the Heavy Organic Chemicals Division to evaluate the benefits of computer control on a large reaction system manufacturing high molecular weight alcohols.

The second system, which will be a permanent installation, will be used by the Heavy Organic Chemicals Division at Wilton to control the operation of a large distillation plant manufacturing high purity hydrocarbon feedstocks for the petroleum chemical industry. In addition to controlling the process by feeding analogue signals to valve-positioning mechanisms, it will collect and analyse process data.

The third Argus system will be installed by Mond Division at Widnes where it will be used in a plant making 'Gramoxone', a new herbicide recently discovered by I.C.I.

A cement plant at Buxton will be controlled by the fourth Argus system.

The remaining machines have not yet been specified for any particular application by I.C.I.

For further information circle 63 on Service Card



Personal and Company News

English Electric Valve Co. Ltd. announce that all correspondence concerning exports, government contracts, and microwave tubes should in future be sent to E.E.V. at Chelmsford. Correspondence relating to ignitrons, thermionic rectifiers, glass-to-metal seals, and all other products (except semiconductors) previously available from A.E.I. Lincoln, should now be addressed to English Electric Valve Co. Ltd., Carholme Road, Lincoln. (Telephone 26435; Telex 5663.)

Research Electronics Ltd. announce the appointment of High Volt Linear Ltd., 1 Cardiff Road, Luton, Bedfordshire (Telephone: Luton 23876) as their sales and service agents for London, the Home Counties and the South East of England: enquiries will be handled by D. C. Laval.

The maintenance distribution to radio wholesalers of STC entertainment-type semiconductors, hitherto operated by Brimar, has been taken over by **Standard Telephones and Cables Ltd.** All wholesale orders, requests for data, and guarantee returns should be sent to: STC Electronic Services, Edinburgh Way, Harlow, Essex. Telephone: Harlow 26811, Ext. 422. Telex: 81146.

Eric H. Bernfeld Ltd. of 282 Kingsland Road, London, E.8, are now acting for Dr. Ing. Perthen, G.m.b.H., of Hanover, Western Germany, for their surface finish, contour and roundness measuring equipment.

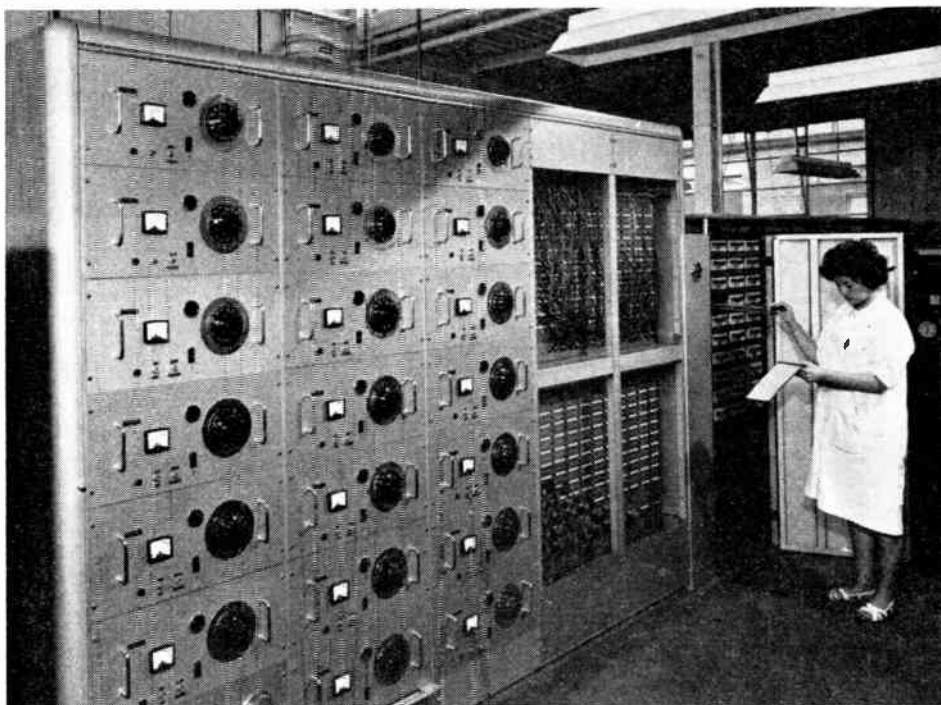
J. W. F. Golley, M.I.Prod.E., M.Inst.B.E., M.Inst.W.S., A.M.I.P.M., A.B.I.M., has been appointed general manager of the Broad Oak Works Division, Portsmouth, of **G.E.C. (Electronics) Ltd.**

Cossor Electronics Ltd. announce the resignation of G. G. Roberts, M.Sc., F.R.Ae.S., as technical director. Mr. Roberts will continue with the company as manager of its technical services.

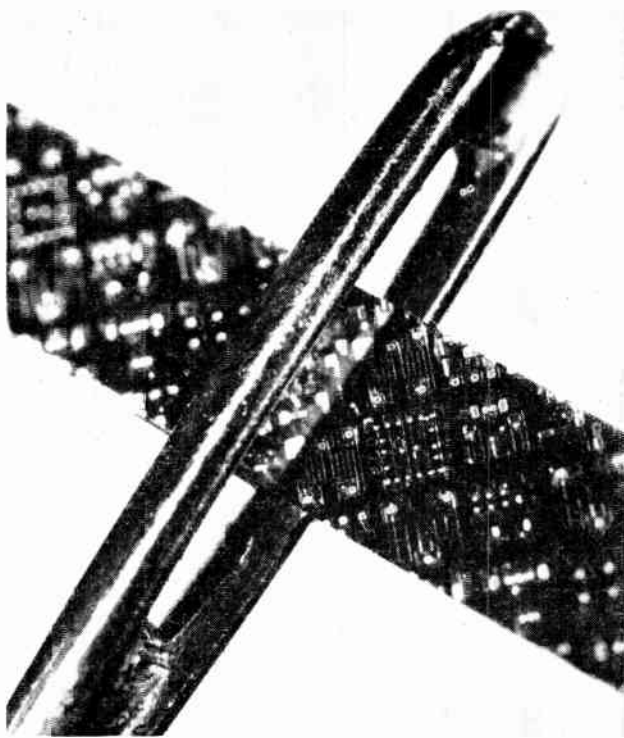
CSF and General Dynamics Corporation are to join forces in a new French company, with CSF holding the majority interest. The new company, which will design and manufacture satellite tracking equipment, is to be known as **Société d'Equipements Spatiaux et Astronautiques (SESTRO)**. Its headquarters will be located at Corbeville, near Paris.

Change of address: all sections of **Wayne Kerr Laboratories Ltd.** previously located at Coombe Road (Sales, Service, Publicity), are now at Sycamore Grove, New Malden, Surrey. The telephone number is unchanged (Malden 2202).

G. J. Morris has been appointed manager of the Planning Division of **International Computers and Tabulators Ltd.**



ENLARGED COMPONENT TESTING FACILITIES—As part of their general expansion programme, **Welwyn Electric Ltd.** have reorganized their testing department and one result is that these new load testing chambers, having a capacity of up to 46,000 components, have been constructed. They are designed to cope with a wide range of conditions and components. The test supplies may be from 6 to 1,500 V a.c. or d.c., cyclic or continuous, and are available in any combination for connection to any tray of components by means of the patchboard of plugs and sockets on the right



THE MEANING OF MICROMINIATURIZATION—This photograph from the Microelectronics Laboratory of Elliott-Automation at Borehamwood shows a section of a micro-circuit board fed through the eye of a needle. Integrated circuits are to be used in the Concord flight control system, for which Elliotts is the prime contractor

Scottish sales and service facilities for oscilloscopes are provided by **Telequipment Ltd.** with the formation of an office at 30 Castle Street, Edinburgh. E. Gibbs has been appointed manager of the branch.

The McMurdo Instrument Co. Ltd. announce the setting up of an Instrument Division, initially to manufacture panel meters of the moving-coil voltmeter/ammeter types. F. W. Peacock has joined the company as sales manager of this division.

F. V. Green (Brimar) has been re-elected chairman of the **British Radio Valve Manufacturers' Association.** A. Deutsch (Thorn-A.E.I. Radio Valves and Tubes Ltd.) has been elected vice-chairman.

Two organizations, engaged in the development, sale and production of the 'Photodip' automatic headlight dipping control, have amalgamated. Originally, development and sales were handled by Photocontrols Ltd., and production undertaken by The Hayward Turbine Engineering Co. (1947) Ltd. A new company, **Hayward Photocontrols Ltd.**, Chiltern Avenue, Woodside Road, Amersham, Bucks., has now taken over all responsibilities.

R. H. Cole Electronics Ltd. have moved to 7-15 Lansdowne Road, Croydon, Surrey. Telephone: Municipal 4411. Telex 262346.

A. S. Marshall has been appointed secretary of the **Electronic Engineering Association** following the retirement of H. E. F. Taylor.

Expansion of **Celdis Ltd.**, merchandising agent and U.K. stockist distributor for Motorola semiconductor products, has necessitated a move from Surbiton, Surrey, to larger premises at 4 Trafford Road, Richfield Estate, Reading, Berks. Telephone: Reading 56256.

Bendix Electronics Ltd. have announced their appointment as sole U.K. agent for the range of digital measuring equipment designed and manufactured by Eldorado Electronics Inc., of Concord, California.

Graham Lumby has become manager of the **A.E.I.** district office at Hull. Mr. Lumby succeeds Dennis Briscoe, who has transferred to London as assistant to C. R. Wheeler, chairman of A.E.I.

The London sales office of **A.E.I.** Radio Components Department is now at 132/135 Long Acre, London, W.C.2. Telephone: Temple Bar 3444.

The directors of **Aveley Electric Ltd.** announce that John R. Erskine has been appointed chief engineer.

MARCONI COLOUR TELEVISION AT CAPE KENNEDY—

Fifteen feet from the jet stream of a Saturn rocket on a recent test launching from Cape Kennedy was a Marconi vidicon colour camera monitoring the initial stage of the blast-off. The camera can be seen in the photograph, mounted at the top of the umbilical tower which holds control connections between the rocket and the launch control centre. These Saturn rockets, each of which develops 1½ million pounds of thrust, are being used in a research and development programme for more advanced manned space flight.

In order to minimize the shock experienced by the camera, it was mounted in a special housing made of wood sheathed with copper, with a protective glass lens window set in one side. An optical system using mirrors set at 45° ensured that the camera received maximum protection from the heat and shock waves. The housing was purged with nitrogen to eliminate the possibility of explosion. A second (unprotected) camera in operation one thousand feet from the launching pad, was remotely-controlled from the launch control centre for pan, tilt and zoom lens



D. Robinson & Co. Ltd. announce that the following have been appointed directors: J. L. Brough, G. G. Fish, L. C. Last and Mrs. C. Randall (secretary).

The Society of Electronic and Radio Technicians announces that Sir Ian Orr-Ewing, Bt., O.B.E., M.A., M.I.E.E., has agreed to become the first president of the Society.

International Marine Radio Co. Ltd. is moving to the former I.C.T. factory at Peall Road, Croydon, to make way for expansion of manufacturing and development activity. Telephone: Thornton Heath 9771-6.

Parmeko Ltd. announce the appointment of R. W. Fennimore, M.B.E., B.Sc.(Eng.), A.M.I.E.E., as managing director.

Geoffrey Brittain has been appointed sales promotion manager of **Amphenol-Borg (Electronics) Ltd.**

Welwyn Electric Ltd. announce the appointments of C. G. Mylrea and B. G. Attwood as representatives in Southern England.

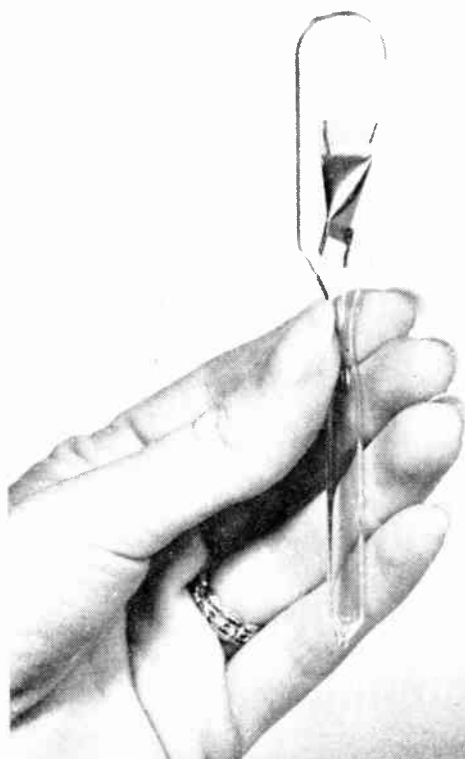
It is announced by **British Insulated Callender's Cables Ltd.** that R. E. Beal, B.Sc., A.M.I.E.E., has been appointed general manager, Telephone Cables Division.

W. R. Spencer, F.C.A., F.W.C.A., has accepted an invitation to join the board of **Gardners Transformers Ltd.**

ALKALI METAL GENERATORS—Large numbers of photoelectric devices which are sensitized by the alkali metals caesium, sodium and potassium are manufactured by E.M.I. Electronics Ltd. The metals are produced by generators of the type shown in the photograph. These generators are now available to workers in universities and industrial laboratories, in which small quantities of alkali metals need to be produced either for experimental photoelectric devices or for chemical and physical experiments of a different nature.

The bulb containing the supply of powder in a nickel pellet is sealed to a vacuum system and after evacuation the nickel container may be degassed by an induction heater. After degassing, the induction heater is used to raise the metal generator to a temperature at which an exothermic reaction takes place, producing the alkali metal vapour which may be allowed to condense in a cooler portion of the tube

For further information circle 64 on Service Card



Two-Channel Closed-Circuit TV

New two-channel closed-circuit television equipment has been developed by Rank Telecommunications. This equipment allows graphic detail such as charts, sectional diagrams, etc., to be superimposed on still pictures.

It basically comprises two television cameras, a signal-mixing unit combined with a camera control unit and a number of television monitors.

Facilities are provided to mix the signals from each camera in almost any proportions.

Experiments with the equipment are now being carried out at Watford College of Technology, where it is being used as an extension of a previously-installed closed-circuit t.v. system.

For further information circle 65 on Service Card

Free 'Robotester' Course

Rapidly rising interest in automatic testing by Britain's electronic industry has prompted Lavoie Laboratories Inc. of New Jersey, U.S.A., in association with Bemex Instruments Ltd., their U.K. representatives, to hold a 'Robotester' school in London (location to be announced) during the week beginning 18th January 1965.

The Lavoie LA303 'Robotester' is an automatic tape-programmed measuring instrument. With it any two of 250 circuit points can be selected for measurement of resistance, polarized d.c. or a.c. voltage, insulation resistance and impedance. Accessory units increase the number of test points to 2,000 and print out facilities are available.

The comprehensive three-day session will cover the operation, programming, application and maintenance of the 'Robotester'.

Tuition is free and engineers wishing to attend are advised to immediately notify Bemex Instruments Ltd., of 54 Victoria Road, Surbiton, Surrey.

Marine Automation System for 'Esso Warwickshire'

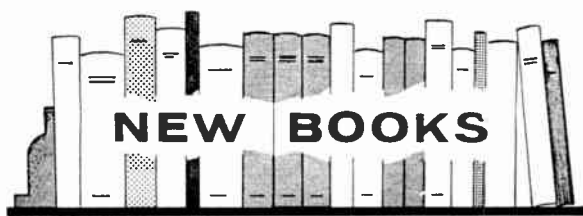
A development which could be of great importance to British shipping is being undertaken by Esso Petroleum Co. As a result of a technical study into the operational requirements of the main and auxiliary machinery of the 80,000-ton tanker 'Esso Warwickshire', it has been decided to install a comprehensive automation system for the ship's steam-raising plant at a cost of approximately £65,000. The study was undertaken jointly by the Marine Department of Esso and Elliott Marine Automation.

This is one of the first such detailed co-operative studies ever undertaken in this country and it has shown that, even with existing plant, it is possible to obtain much higher standards of operational efficiency in ships than are at present accepted as normal.

The 'Esso Warwickshire' study led to the development with Babcock and Wilcox of a comprehensive boiler-control system, which includes close automatic control of boiler combustion, remote control of the burners from the engine room, automatic control of the evaporator, the boiler feed pumps and the boiler water-sampling and chemical-injection equipment. It is expected that the annual savings in operating costs resulting from this conversion will fully justify the installation of the equipment.

The entire project is being handled by the Marine Department of Esso Petroleum and Elliott Marine Automation have been appointed main contractors for the project.

It is expected that the re-equipping of the vessel will be carried out in Holland at the end of this year.



Who Makes Machinery? 1964 Edition

Pp. 1,300. Published by the Association of German Machinery Manufacturers (VDMA) and available in the U.K. from Interbook Ltd., 12 Fitzroy Street, London, W.1. Price 18s.

This directory is a comprehensive guide to sources of supply of German machinery, tools and ancillary products. It contains an alphabetical index of products (approx. 13,000), a classified register of suppliers with over 21,000 addresses and trade marks, and an alphabetical list of firms. The directory is published in five separate language editions: English, German, French, Italian and Spanish.

Introduction to Space Communication Systems

By GEORGE N. KRASSNER and JACKSON V. MICHAELS. Pp. 388 + xiv. McGraw-Hill Publishing Co. Ltd., McGraw-Hill House, Shoppenhangers Road, Maidenhead, Berks. Price 108s.

This book presents an encompassing introduction to space communication systems which covers the broad scope of its elements rather than the details.

Advances in Electronic Circuit Packaging, Vol. 3

Edited by LAWRENCE L. ROSINE. Pp. 457 + vi. Plenum Press, 227 West 17th Street, New York 11, N.Y., U.S.A. Price \$16.50.

This is the Proceedings of the Third International Electronic Circuit Packaging Symposium which was held on 15-17 August 1962 at Boulder, Colorado. For clarity it should be pointed out that packaging does not mean packing for transport! It means rather the constructional forms of electronic equipment.

Acoustique et Electroacoustique: Vol. II

By JEAN-JACQUES MATRAS. Pp. 304 + xiii. Published in French by Editions Eyrolles, 61 boulevard Saint-Germain, Paris V^e. Price 39.40 F.

Brown Boveri 1964 Electron Tube Handbook

Pp. 800. Published by Brown-Boveri and available in the U.K. through British Brown-Boveri Ltd., Glen House, Stag Place, London, S.W.1. (Phone: Tate Gallery 9422).

This handbook replacing the previous 1961 edition includes many supplementary items. Eleven chapters are presented in German, English and French. The first chapter sets out the symbols used. Chapter 2, 'Definitions and Useful Information', has been greatly increased in scope and gives all the necessary information for determining application, choice and operation of transmitting and rectifier tubes and thyratrons. Two hundred and twenty pages are devoted to this chapter which is supplemented by tables for the recognition and prevention of faults in electron tubes. Chapter 3 tabulates formulæ, tables and wiring diagrams for easy reference.

The next seven sections present detailed information on the high voltage rectifier tubes, thyratrons, force-cooled transmitting tubes for communication purposes and industry as well as radiation cooled transmitting tubes. Many interesting new types are included, e.g. rectifier tubes and thyratrons with increased inverse-voltage ratings and industrial triodes with improved operational data which are especially suited to impulse operation (plastics welding).

A detailed table of tube equivalents and a bibliography index conclude the book. This is a valuable work of reference for all those who come into contact with rectifier and transmitting tubes.

Magnetic and Electric Suspensions

By P. J. GEARY, M.Sc. (Eng.). Pp. 162 + viii. British Scientific Instrument Research Association, 'Sira', South Hill, Chislehurst, Kent. Price 50s.

In this monograph the historical development and present state of magnetic and electric suspensions are reviewed from the published literature, which is cited in full with abstracts.

The techniques of suspension examined include the use of permanent magnets for relieving mechanical bearings and for 'floating' moving parts; magnetic levitation using diamagnetic and superconducting materials; electromagnetic levitation by autoregulation of the suspension current and by eddy currents; and electric levitation by electrostatic forces.

Among the topics considered are magnetic suspension of the spindles of watt-hour meters; levitation weighing; levitation melting of metals; levitation of wind tunnel models and rail vehicles; levitation of rotors such as those of electrical machines, centrifuges, gyroscopes, vacuum pumps and gauges, viscometers, rotating multiple mirrors, and beam choppers; drives and damping systems for levitated rotors; and residual torques acting on rotors levitated in a vacuum.

The bibliography comprises 345 literature references ranging in time from the fundamental Earnshaw's theorem of 1839 to recent comparative assessments of the various techniques of suspension, and includes the results of a systematic search of British and U.S. patents.

Analogue and Digital Computer Methods

By D. J. HARRIS, B.Sc. Pp. 106 + vi. Published by Temple Press Books Ltd., 42 Russell Square, London, W.C.1. Price 30s.

The emphasis of this monograph, the latest in a series on rockets and missiles, is on the comparison of computing techniques. Three types of computer, the analogue, the digital and digital differential analyser are examined in connection with the solution of control system design problems and their use is illustrated by an example related to missile work.

Other aspects of the subject given detailed coverage include: the general method of problem preparation for computer solution; the internal operation of each type of computer; and scaling methods and programming techniques related to problems of missile design.

Acoustics

By G. W. MACKENZIE. Pp. 224. Focal Press Ltd., 31 Fitzroy Square, London, W.1. Price 42s.

Without going too deeply into the mathematics of the subject, this book describes and explains the important features of sound sources, rooms and enclosures. In the main, this book deals with well-known fundamentals and microphones of various types. This book will appeal to hi-fi enthusiasts seeking a greater understanding of the subject and to technical college students.

Reference Data for Radio Engineers

Pp. 1150. Produced by International Telephone and Telegraph Corporation and available from Standard Telephones and Cables Ltd., Therese House, 29-30 Glasshouse Yard, Aldersgate Street, London, E.C.1. Price 42s.

This is a reprint of the fourth edition (1956) of a very well established radio engineering reference book. The bulk of the book is a compilation of equations, tables and graphs frequently needed in radio and electronic engineering.

Electromagnetic Slow Wave Systems

By R. M. BEVENSEE. Pp. 464 + xvii. John Wiley & Sons Ltd., Glen House, Stag Place, London, S.W.1. Price 132s.

This book is very definitely one for the specialist. It is highly mathematical and deals with slow-wave structures such as those used in travelling-wave tubes.

Beginner's Guide to Electronics

By TERENCE L. SQUIRES, A.M.Brit.I.R.E. Pp. 194 + vii. George Newnes Ltd., Southampton Street, London, W.C.2. Price 15s.

Aufgaben aus der Fernmeldetechnik nebst Lösungen

By KURT BUTTLER. Pp. 268. Fachverlag Schiele & Schon GmbH., Markgrafenstr. 11, Berlin SW 61. Price DM.24.

Manufacturers' Literature

Long Life Nickel Chrome Resistance Wires. This Publication P9-664 lists in 9 pages the current range of nickel-chrome resistance wires and tapes produced by *Telcon Metals Ltd., Manor Royal, Crawley, Sussex.*

For further information circle 66 on Service Card

Type 8 Closed-Circuit Television. One hundred and thirty uses for this type c.c.t.v. are listed in this 8-page booklet. Details are also given of the many accessories which enable an elaborate network of cameras to be built-up. These include switch units, microphone kit and remote controls. *E.M.I. Electronics Ltd., Hayes, Middlesex.*

For further information circle 67 on Service Card

Hygrometers, Moisture and Dewpoint Meters. In this 8-page fold-out leaflet 12 moisture measuring devices are briefly described. They range from accurate laboratory type instruments to a robust unit designed to measure moisture in sand and aggregates. *Shaw Moisture Meters, Rawson Road, Westgate, Bradford, Yorks.*

For further information circle 68 on Service Card

The Fascinating Story About Static. This 4-page leaflet briefly explains the nature and causes of static electricity, illustrates a range of equipment for the elimination of static, and shows 20 application pictures which demonstrate how the various equipments are used in practice. *Meech Static Eliminators Ltd., 150 Clapham Manor Street, London, S.W.4.*

For further information circle 69 on Service Card

Nuclear Enterprises 1964-65 Catalogue. Listed in this 96-page catalogue is the current range of scintillators, nucleonic instruments and low-level counting installations which are produced by *Nuclear Enterprises (G.B.) Ltd., Sighthill, Edinburgh.*

For further information circle 70 on Service Card

Hi-G Short Form Catalog. Technical descriptions of the range of Hi-G miniature relays are given in this 4-page catalogue number SF 1064.

Hi-G Inc., Spring St. & Route 75, Windsor Locks, Conn., U.S.A.

For further information circle 71 on Service Card

Hengstler Counters. A 4-page leaflet which briefly specifies Hengstler counters and gives the potential user sufficient relevant information to enable him to select the unit needed for a specific job.

J. Hengstler Co. Great Britain Ltd., Highbridge Street, Waltham Abbey, Essex.

For further information circle 72 on Service Card

The Trivector Meter. The Trivector, described in this 6-page leaflet, has been developed to meet the need for a meter to indicate kVA demand accurately on all power factors and to enable supply authorities, by the use of the kVA maximum demand tariff, to induce their consumers to improve their power factor.

Landis & Gyr Ltd., Victoria Road, London, W.3.

For further information circle 73 on Service Card

Correx Mains Transformers: Design Manual. A 16-page booklet which gives information about small power transformers. First it sets out details of d.c. power supply design and continues with details of the 'Fastran' service provided by *Phoenix Telephones Ltd., Grove Park, London, N.W.9.*

For further information circle 74 on Service Card

Nickel-Alkaline Accumulators. The principles of operation, methods of construction, performance, maintenance and advantages of the nickel-alkaline accumulator are given in this 24-page booklet.

The International Nickel Co. (Mond) Ltd., 20 Albert Embankment, London, S.E.1.

For further information circle 75 on Service Card

Muirhead Precision Resistors. The 150 variations of Muirhead's range of precision resistors are given in this 23-page booklet. A section is devoted to the selection of resistors by value, time constant, accuracy, rating, temperature coefficient, etc.

Muirhead & Co. Ltd., Beckenham, Kent.

For further information circle 76 on Service Card

A Guide to Araldite Epoxy Resins. This revised 8-page version of a previous publication, lists several new Araldite products. The epoxide content of Araldite resins and the composition of the hardeners are also given in this brochure. *Ciba (A.R.L.) Ltd., Duxford, Cambridge.*

For further information circle 77 on Service Card

Heathkit: Electronic Kits. Although this 20-page Catalogue 84/3 deals with domestic equipment in kit form, it also gives details of the range of Heathkit electronic instruments. The range of instruments includes oscilloscopes, valve voltmeters, oscillators, etc.

Daystrom Ltd., Gloucester.

For further information circle 78 on Service Card

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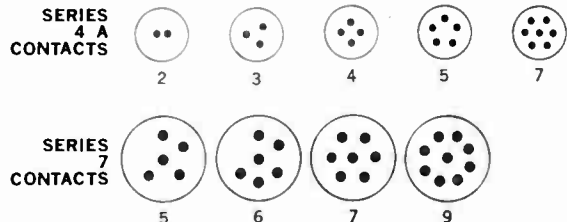
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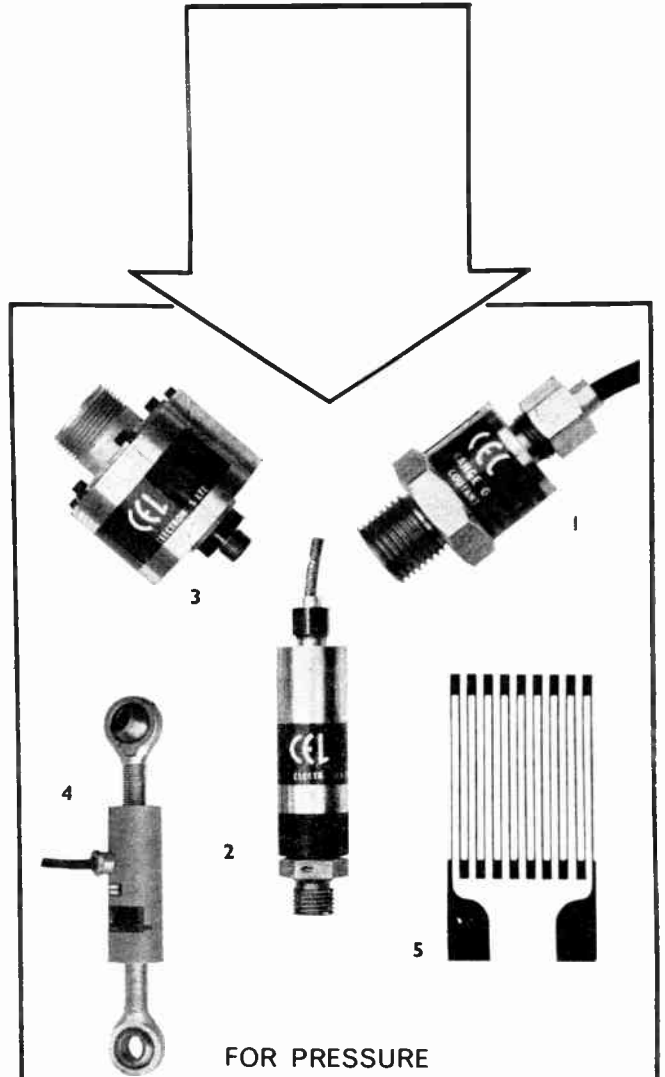
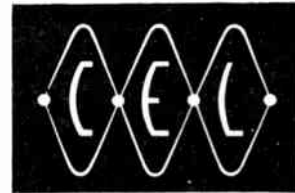
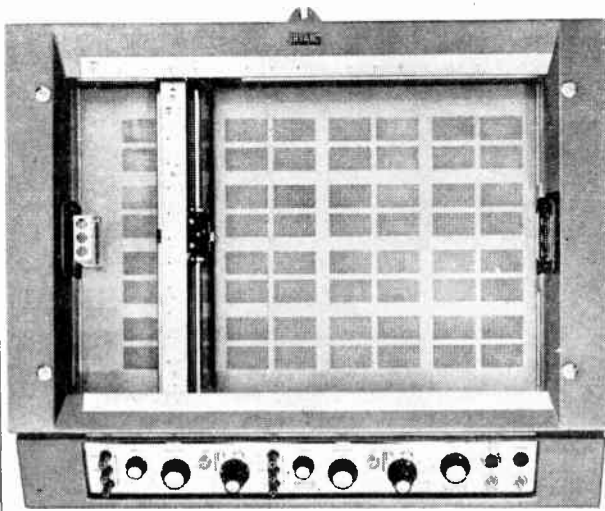
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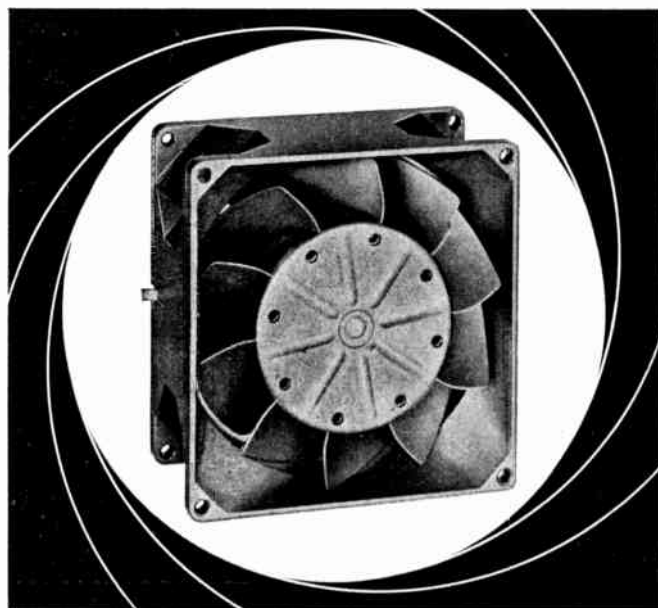
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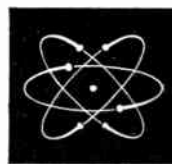


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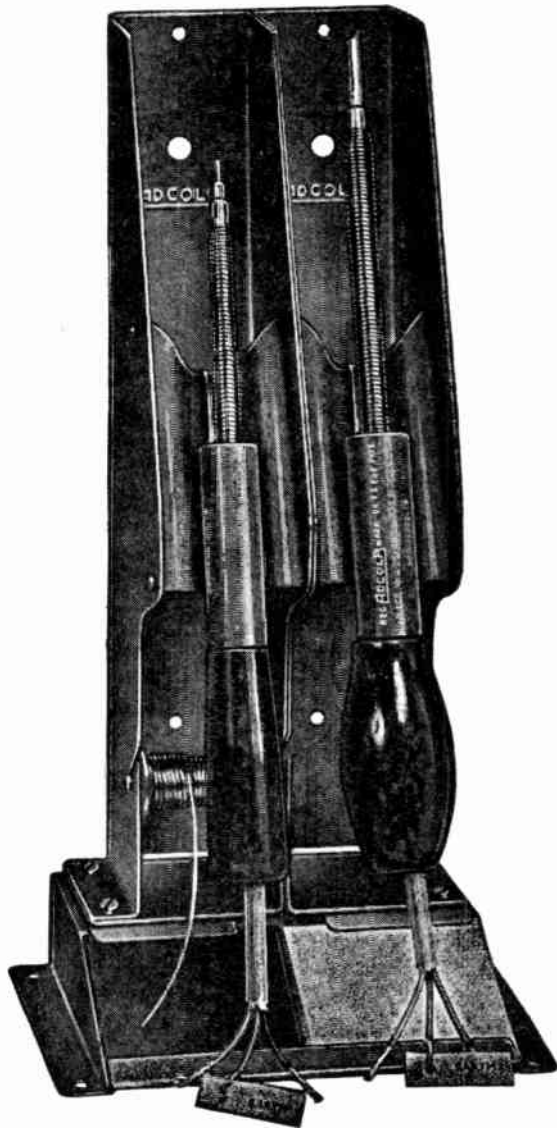
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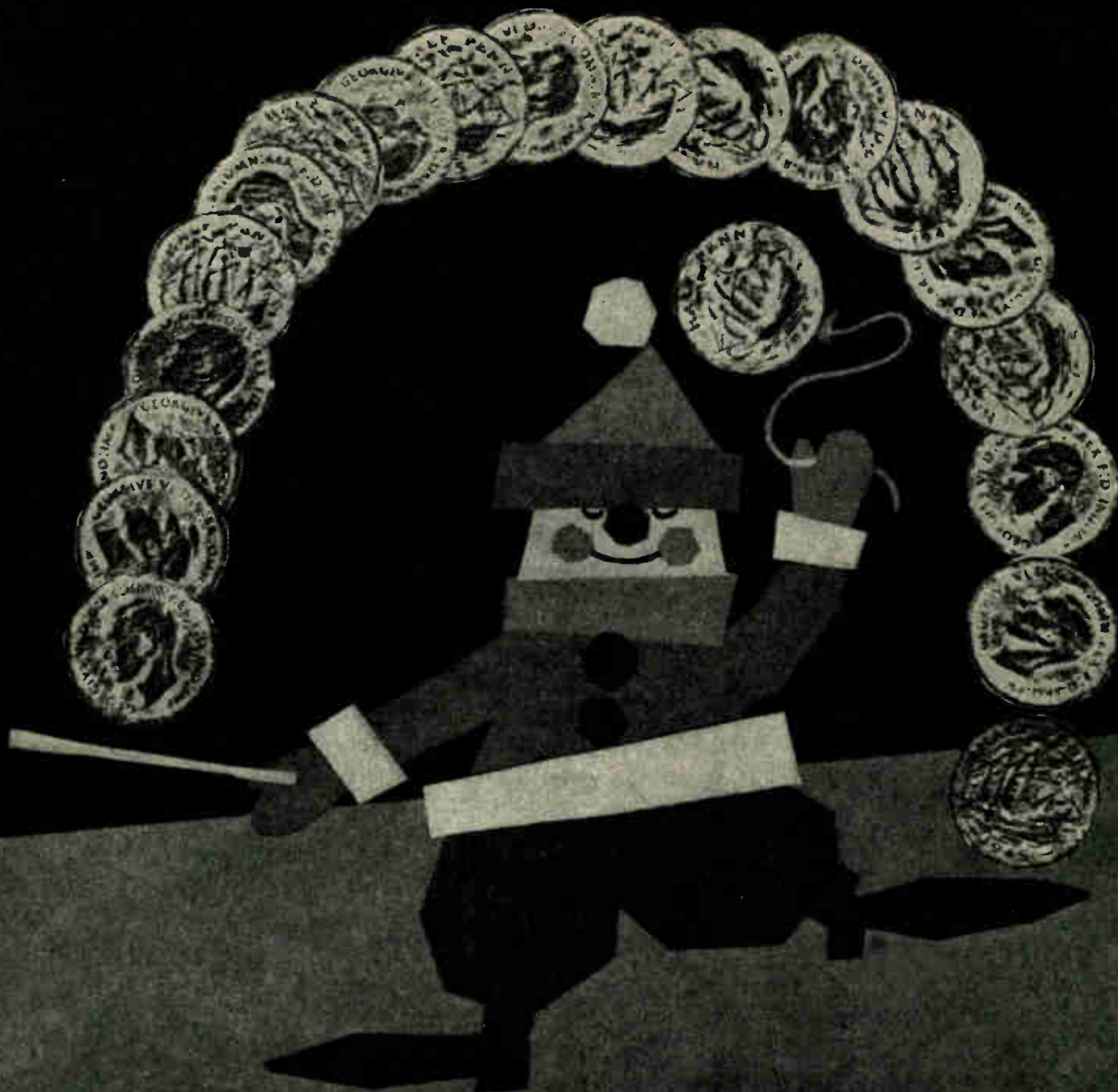
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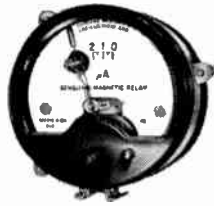
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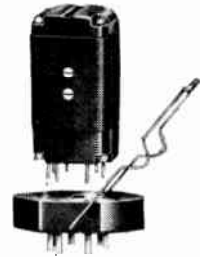
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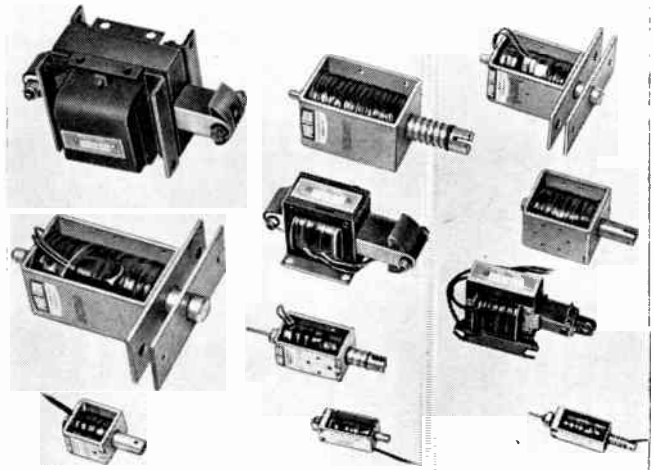
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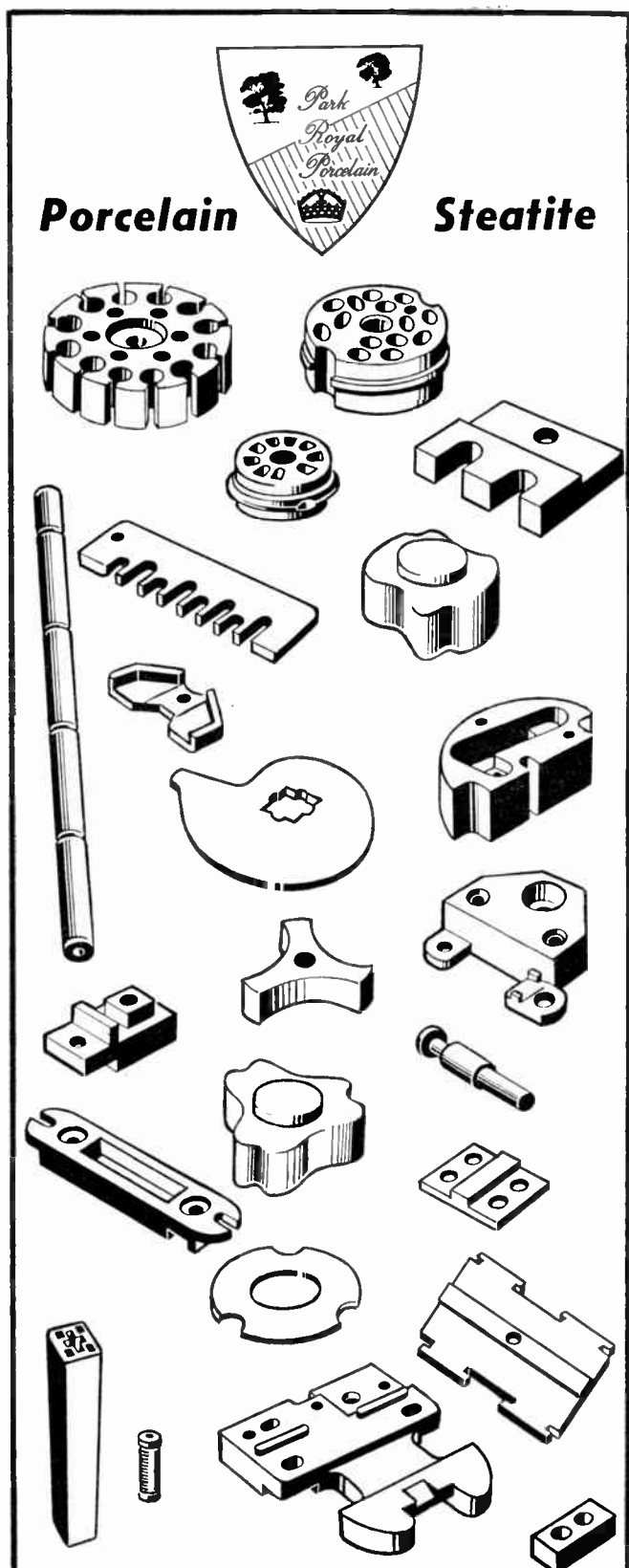


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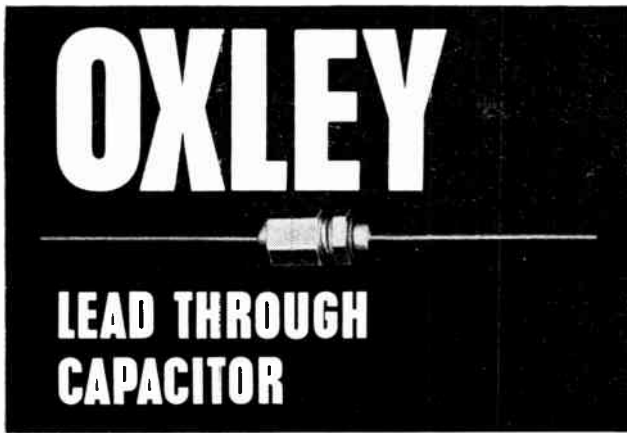
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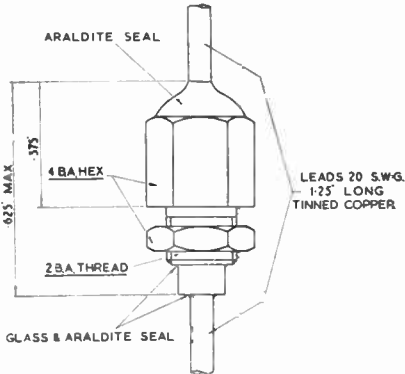
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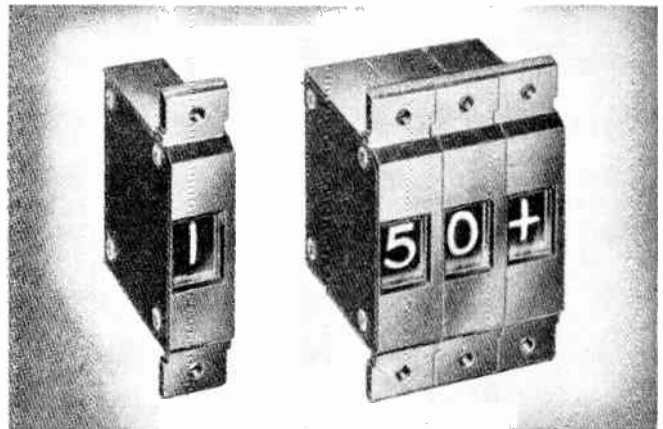


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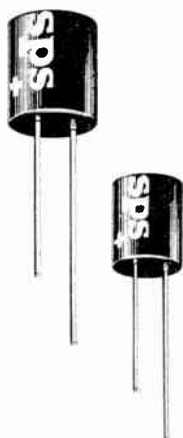
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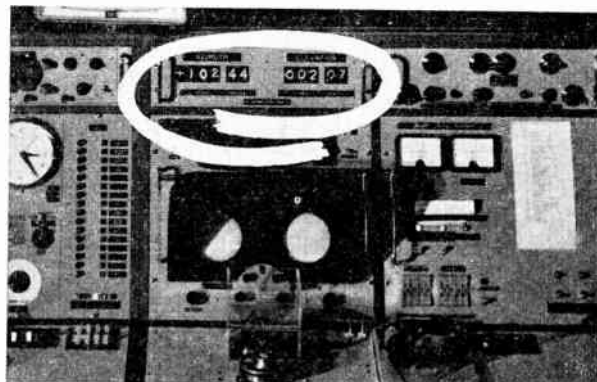
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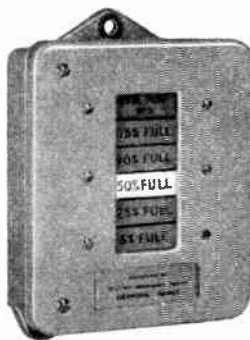
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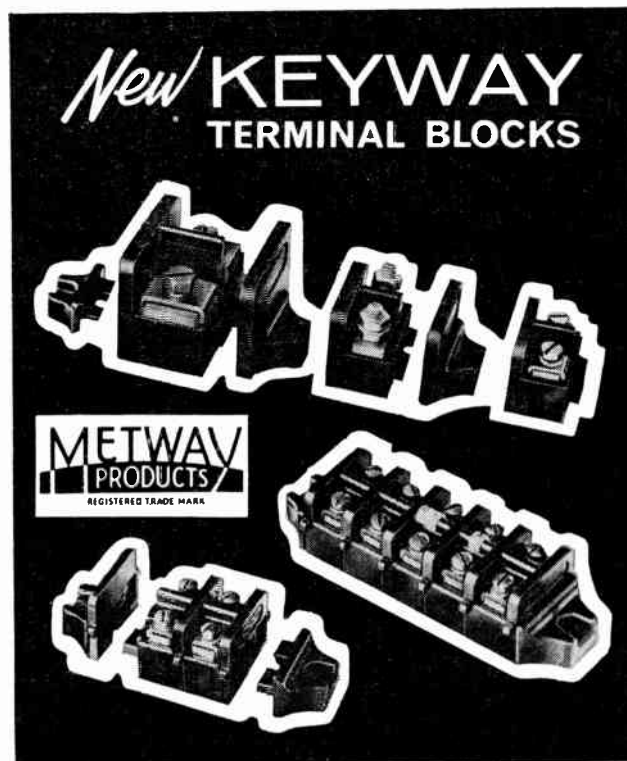
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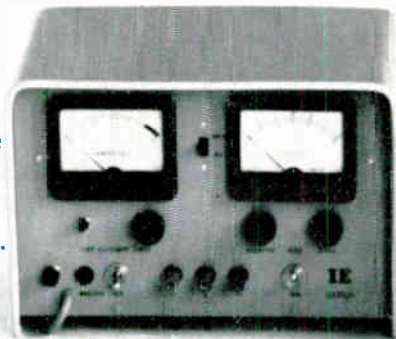
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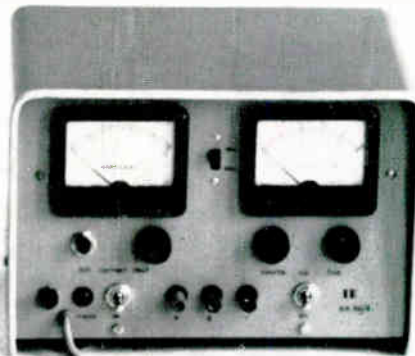
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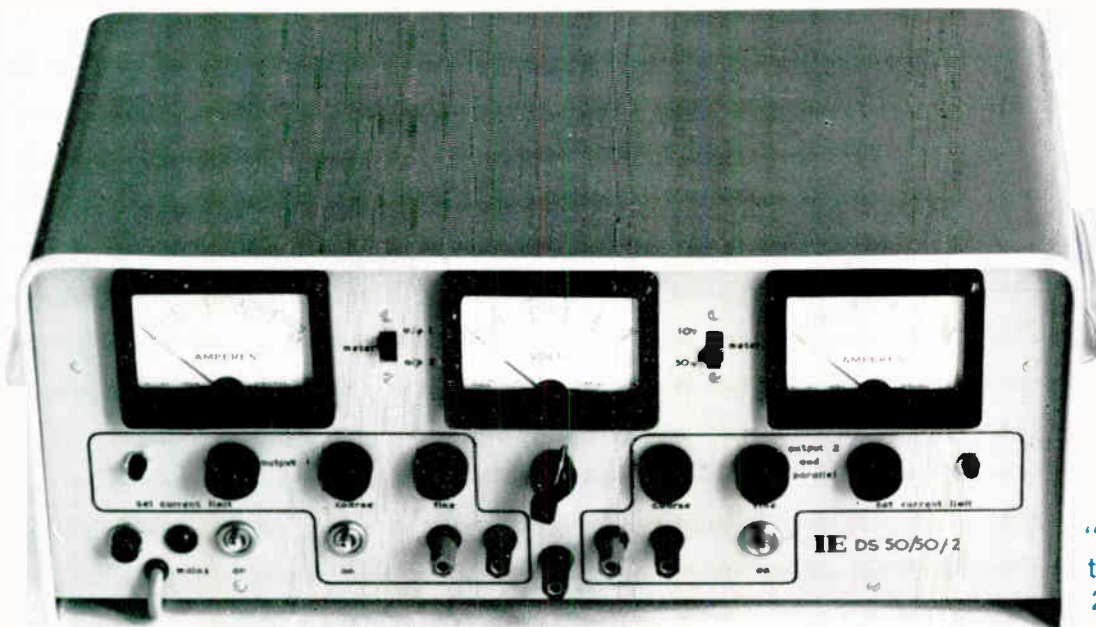
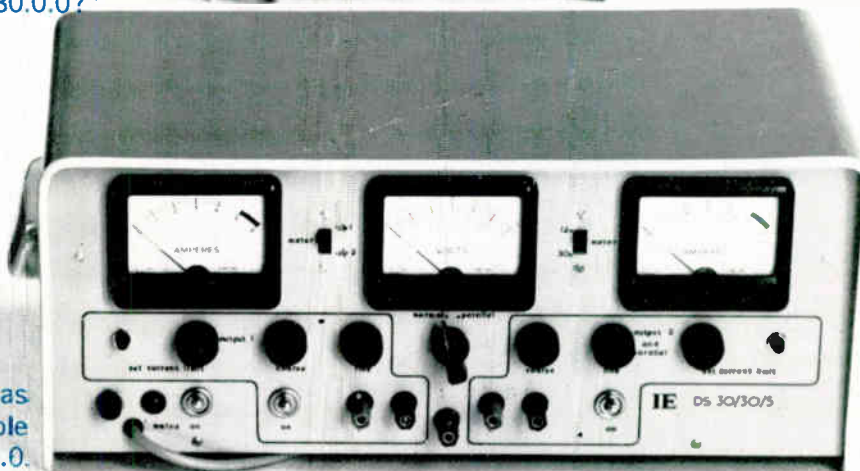
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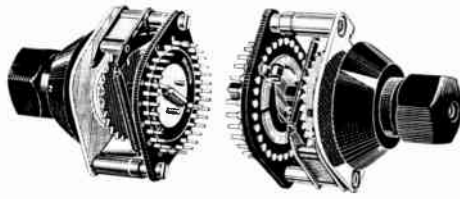
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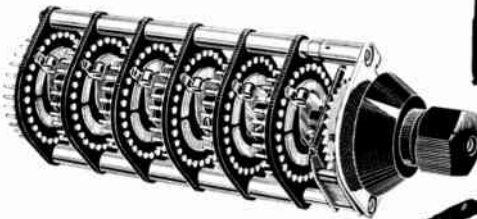
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