

INDUSTRIAL ELECTRONICS

OCTOBER 1964 5s 0d



World Radio History

practical planar

Three new silicon planar transistors, which maintain germanium saturation voltages over several decades of current, now make practical a wide range of amplifying, oscillating and switching applications. They are immediately available at practical prices and are backed with performance data and circuit design information.

A significant feature of these transistors is that a saturation voltage of less than +200mV at 150mA, and less than 1V at 1.0A, is achieved. These voltages are typical of germanium rather than silicon devices. The current gain – which is maintained over four decades of current – and f_T of greater than 50Mc/s, enable most general purpose applications to be readily met.

A booklet, giving performance data and circuits showing typical applications, is available on request. For price and delivery information contact Mullard at the address below.



Mullard Limited,
Industrial Semiconductor Division,
Mullard House,
Torrington Place, London WC1
Telephone: LANgham 6633

	BFY50	BFY51	BFY52	
$V_{CB} (I_E = 0)$	+80	+60	+40	V
V_{CE} (cut-off)	+80	+60		V
I_{CM} max.	1	1	1	A
P_{tot} max. ($T_{amb} = 25^\circ C$)	800	800	800	mW
$h_{FE} (I_C = 150mA)$	>30	>40	>60	
$f_T (V_{CE} = +6V, I_C = 50mA)$	>60	>50	>50	Mc/s
$V_{CE(sat)} (I_C = 150mA, I_B = 15mA)$	<+200	<+350	<+350	mV
Encapsulation	TO-5	TO-5	TO-5	

Mullard



INDUSTRIAL ELECTRONICS

incorporating *ELECTRONIC TECHNOLOGY*

Volume 2 Number 10 October 1964

INDUSTRIAL ELECTRONICS
INCORPORATING ELECTRONIC TECHNOLOGY
OCTOBER 1964
NUMBER 10
VOLUME 2

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Assistant Editor **T. J. BURTON**

Advertisement Manager **G. H. GALLOWAY**

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Equipment for measuring the amount of toe-in of the front wheels of a motor-car is described in this article. It operates with the wheels rotating so that any wobble of rim or tyre is averaged out. The cover picture shows a car under test and, although this is not described in this article, it also shows the headlamp adjusting apparatus, for both adjustments are carried out together.
- 457 **A Direct Analogue Equipment for the Study of Water Distribution Networks** by *R. W. Williams, Ph.D.*
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- 467 **Brewer System** by *C. D. Fruin*
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- 470 **Farnborough Air Show 1964**
The 1964 S.B.A.C. Flying Display and Exhibition opened at Farnborough on Monday, 7th September, for six days. The static exhibition included the largest display of electronic devices of any of the 24 Shows. This report deals with some of those electronic devices. Particular attention has been paid to equipment with potential industrial application.

continued overleaf

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C85	DEF 5115 (Draft) RG4	1.8	200	NRN 21	1.10	200	RN 55D	1.8	200	10Ω-300K
C80	RC4-L	1.8	200	NRN 06	1.8	250	RN 60D	1.4	250	10Ω-1M
C81	RC4-M	1.4	250	NRN 07	1.4	300	RN 65D	1.2	300	10Ω-1M
C82	RC4-N	1.2	350	NRN 08	1.2	350	RN 70D	1	350	10Ω-5M
C83	RC4-P	1	500	NRN 09	1	500	RN 75B	1	500	10Ω-10M
C84		2	1,600	NRN 10	2	750	RN 80B	2	750	10Ω-10M

STORAGE: After 12 months storage, the maximum change in resistance will not exceed 0.7%.

STABILITY: For 2,000 hours full load operation at 70°C, the typical change of Welwyn Moulded Insulated High Stability Carbon Resistors is:—

LOW VALUES	0.2%	} Limits in DEF 5115 (Draft) 1½% to 3%
MEDIUM VALUES	0.5%	
HIGH VALUES	1.0%	

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LOW VALUES	0.5%	}
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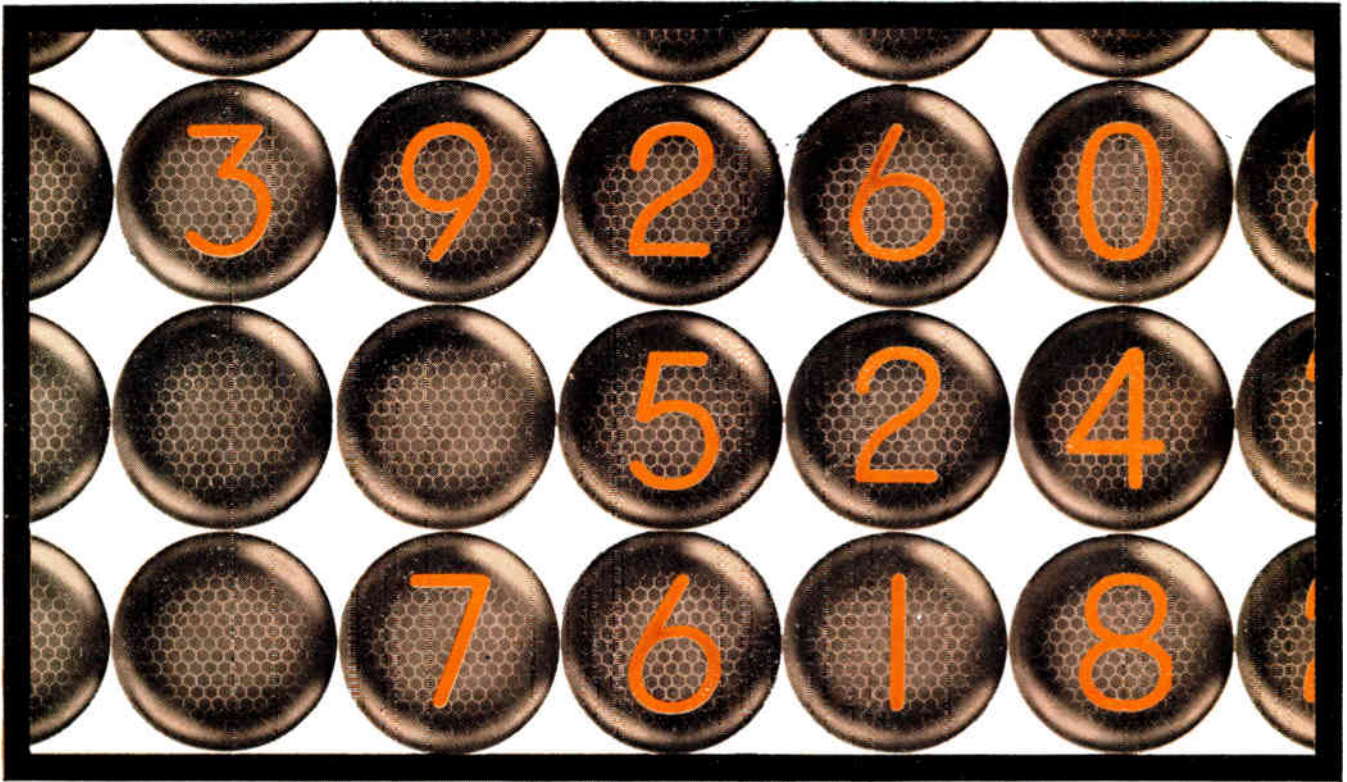


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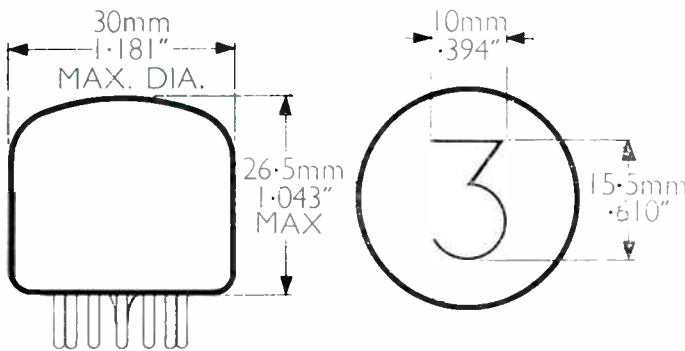
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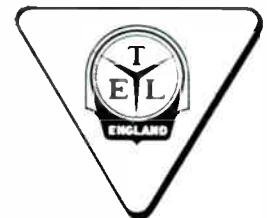
The GR10 M is the latest addition to the Ericsson range of Digitron Display Tubes. This new and aesthetically satisfying, end-viewing tube, with plug-in 13 pin glass base, presents an economical answer to all your digital readout problems. For further information please contact Tube Division, Technical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



OTHER DIGITRON TUBES AVAILABLE

	CHARACTERS	CHARACTER HEIGHT		NOM. CURRENT	VIEWING
GR 7M	+ - V A Ω % ~	15.5 mm.	0.610 ins	2 mA	END
GR 10K	0 - 9	19 mm.	0.748 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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IT ALL ADDS UP TO

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More reliable transmitters and R.F. heating with Mullard silicon rectifiers

*High-voltage stacks
now available
for both new and existing equipment*

High-voltage silicon rectifier modules and stacks, for use in a wide range of transmitting and r.f. heating applications, are to be introduced by Mullard.

These include a module from which high-voltage rectifier stacks can be built, three stacks mounted on various valve bases for direct replacement of valve rectifiers, and a small encapsulated module for building economical h.t. supplies.

The use of solid-state devices with the advantage of zero warm-up time is of particular interest to designers of standby broadcast transmitters. In addition, the reliability of these devices is an important factor in all applications, not least of which is r.f. heating where a breakdown may cause damage to the workpiece. Surge protection, too, becomes relatively easy because of the high forward surge current ratings of these devices.

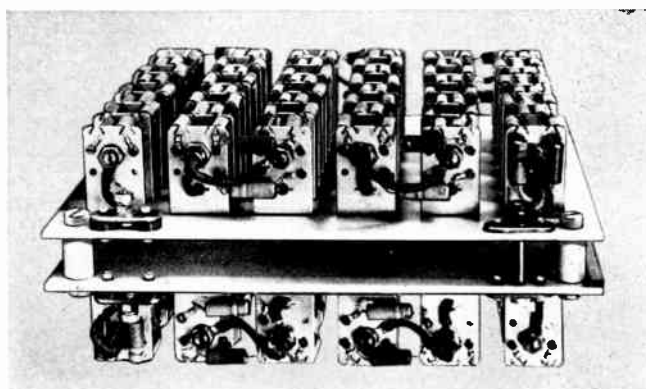
Diode-resistor-capacitor module

A half-wave rectifier module, type OSS4300, consisting of a silicon double-diffused diode connected in parallel with a $0.01\mu\text{F}$ capacitor and $39\text{k}\Omega$ resistor, can provide 360V maximum crest reverse working voltage per module. Up to 55 modules can be connected in series to form stacks producing maximum crest working voltages of 20kV with transient ratings of 40kV. The maximum mean forward current of these modules is 3.5A in an ambient temperature up to 55°C , and the forward surge current rating is 200A for 10ms.

Each module consists of a diode, capacitor and resistor mounted on a bracket suitable for fixing to a tube of 4.5in diameter.

Valve-base mounted high-voltage stacks

Three rectifier stacks, OSS8300-10, OSS8300-15 and OSS8300-20 are available containing 10, 15, and 20 diodes respectively, connected in series to provide crest working reverse voltages of 3.6, 5.4, and 7.2kV. The transient ratings are 8.0, 12, and 16kV respectively. The maximum mean forward surge current is 3.5A in an ambient temperature of up to 55°C and the forward surge current rating is 200A for 10ms. The stacks are mounted on



High-voltage rectifier stack for use in a transmitter

various valve bases to order so that they can be used as direct replacements for valve rectifiers in existing equipment.

Similar stacks are available for incorporation into new equipment. In these cases, the stacks have been designed so that they can be easily installed in the transmitter. All the connections are made at one end of the mounting plate so that the stack can be easily slid in and out of the transmitter cubicle.

2kV potted modules for low-current H.T. supplies

Also introduced is a small module consisting of diodes encapsulated in melamine, to ensure good anti-tracking and thermal properties, which can be used to form compact and economical power supplies. The module has a maximum crest working voltage of 2kV, transient rating 4kV, with a maximum mean forward current of 0.5A up to a temperature of 55°C . The forward surge current rating is 35A for 10ms.

Up to five of these modules, type number OSS6700, can be connected in series to provide a d.c. power supply of up to 10kV from a three-phase supply.

For further information on Mullard high-voltage silicon rectifier modules and stacks, please use the reader reply card of this journal (see reference number opposite).

What's new from Mullard

LITHIUM-NICKEL FERRITE CORES OPERATE OVER WIDE TEMPERATURE RANGE WITHOUT COMPENSATION

Lithium-nickel ferrite storage cores offer considerable advantages to the computer manufacturer in comparison with the cores previously available. In particular, cores made from the new ferrite material can operate over a wide temperature range without the need for current compensation.

These cores readily operate over a temperature range of 60 deg C with constant drive-current amplitude so that neither temperature compensation of the drive current nor temperature stabilisation of the matrix is required. The sense amplifiers of the core store can also be simplified because over this range with a constant drive current, the peaking and switching times remain substantially constant and no compensation of strobing time is required.

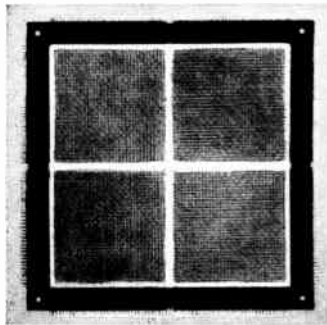
The lithium-nickel ferrite cores have 'usable' properties over the temperature range -20 to +100°C. The magnetostrictive coefficient is very low, resulting in negligible oscillation through magnetostrictive excitation, and low-stress sensitivity.

Two types available

At present, two types of core made from this material are available. These are FX2763, a 0.03in o.d. core, and FX2764, a 0.05in o.d. core.

The FX2763 is intended for use in high-speed stores operating over wide temperature ranges. Store cycle times of less than 2µs are readily achievable. The second core, FX2764, is intended for use in somewhat slower stores designed to operate over a wide temperature range.

Both cores are available assembled as single matrix planes or complete stacks.

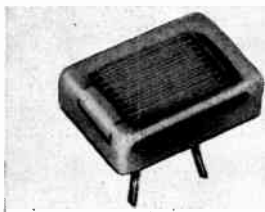


Plastic-encapsulated photocell for low-voltage applications

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.



S.S.B. tetrode with 120W P.E.P.

Third-order
intermodulation
distortion
better than 30dB

A new valve has been added to the Mullard range for single sideband transmissions. This is the YL1150, a beam power tetrode capable of producing a peak envelope power (output) of 120W at the low anode voltage of 600V. The third-order intermodulation distortion without r.f. feedback is better than 30dB for any level of drive voltage, referred to either of the two tones.

The YL1150 has been specially designed for linear amplifiers in single sideband applications up to 30 Mc/s, the maximum operating frequency being 60Mc/s. The valve is radiation and convection cooled.

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.



INDUSTRIAL TRIODE SIMPLIFIES HIGH-FREQUENCY COLPITTS OSCILLATOR DESIGN

The TY4-400C is specially designed for use in Colpitts oscillators and is a development of the established industrial triode TY4-400. In the new valve, the inter-electrode capacitances have been deliberately increased to simplify the design of this type of oscillator.

At frequencies of approximately 50Mc/s—the precise value will, of course, depend on the application and the individual design—the internal capacitances of the valve are sufficiently large to obviate the need for external capacitors. The coil can therefore be connected directly between the anode and the valve base. In this way, the new valve not only reduces the cost of high-frequency oscillators by elim-

inating some of the components normally required, but also enables greater load efficiency to be obtained as the r.f. resistance effects of interconnections are reduced. An additional advantage is that the increased internal capacitances help to eliminate parasitic oscillations, thereby greatly assisting the circuit designer.

The new valve incorporates the proven features of the established type, and, apart from the internal capacitances, has the same ratings.

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.

High-voltage rectifier stacks and modules	206
Lithium nickel ferrite cores	207
Triode TY4-400C	208
S.S.B. tetrode YL1150	209
Cold-cathode diode ZA 1001	210



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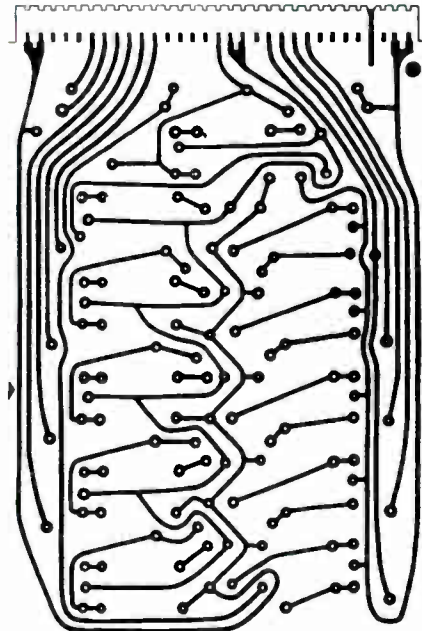
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VERRODUR-E-Cu

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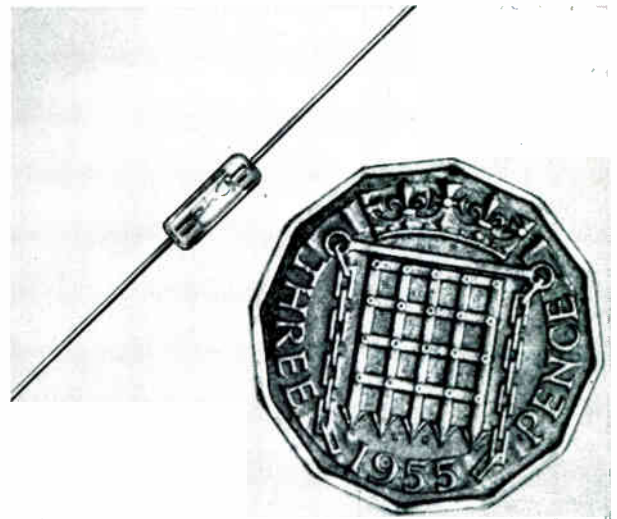
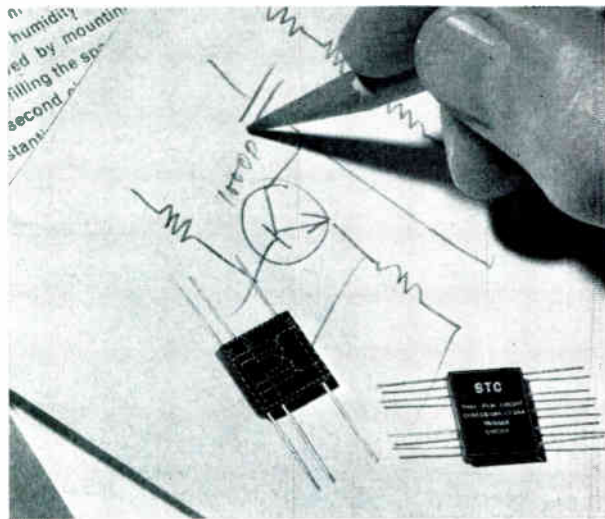
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OCTOBER 1964

STC

components review



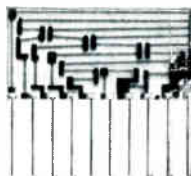
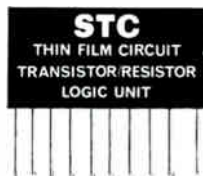
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Custom-built at short notice, or available ex-stock as ready-made circuits, STC Thin Film Circuits offer the circuit designer reliable micro-miniaturization and a wide selection of circuit configurations.

All STC Thin Film Circuits are manufactured under full Quality Control and are subjected to STC Quality Assurance Testing. Examples of standard circuits available immediately are:

- Amplifiers
- Logic Networks
- Trigger Circuits
- Multivibrators
- Attenuators
- Capacitors
- Resistors
- RC Networks

NEW DESIGN HAS ALL LEADS ON ONE EDGE



Transistor/Resistor Logic Circuit—actual size

STC Thin Film Circuits are manufactured on $\frac{1}{2}$ in. \times $\frac{1}{2}$ in. and 1 in. \times $\frac{1}{2}$ in. substrates. The latter are for applications that require the convenience of all leads emanating from one edge, such as insertion in printed or wiring boards. Other special sizes made to order.

Write, 'phone or Telex for Data Sheets and prices to STC Capacitor Division, Brixham Road, Paignton, Devon or London Sales Office, Footscray, Sidcup, Kent. Telephone FOOTscray 3333. Telex 21836.

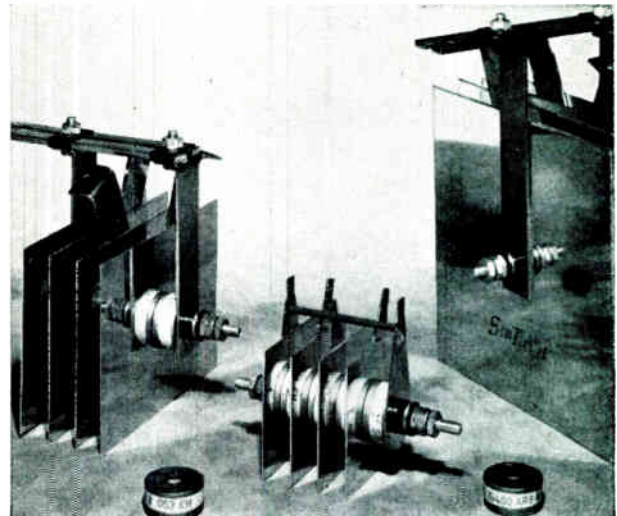
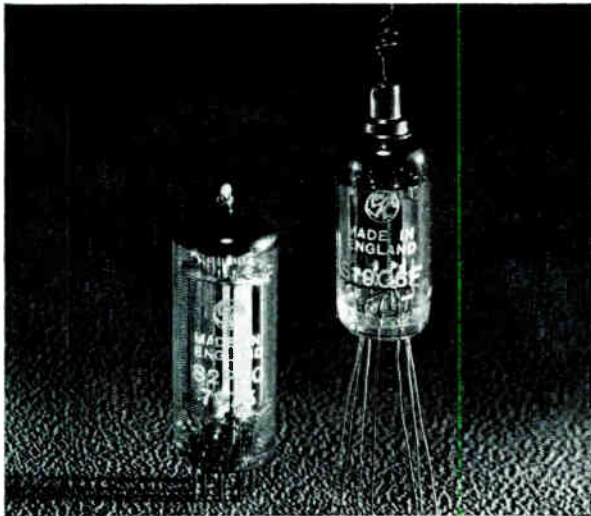
GOLD-BONDED DIODES... RANGE INCREASED

Three new germanium gold-bonded diodes have been added to the STC range. These are the DK19, DK20 and DK21 which are specially designed for use in high speed switching applications; and along with existing types DK13, DK14 and DK15, represent a range having extremely good electrical stability and robust mechanical construction. Each type has a sub-miniature glass encapsulation and conforms to the JEDEC DO-7 outline. They are competitively priced and available from stock.

BRIEF DATA

Type	V_R max (V)	I_R at V_R max (μ A)	I_F max (mA)	Typical capacitance (pF)	Typical stored charge at 10mA (pC)	Equivalent to
DK19	25	160	110	1.0	280	0A41
DK20	50	25	100	0.4	350	HG5004
DK21	8.0	150	30	1.3	20	AAZ13

For further information, write, 'phone or Telex Semiconductor Division (Transistors), Footscray, Sidcup, Kent. Telephone FOOTscray 3333. Telex 21836.



SPECIAL QUALITY VALVES

are produced by STC for a variety of applications including those listed below. Special shock resistant constructions are employed and this feature, combined with stringent quality tests applied throughout manufacture, gives extreme robustness and a high degree of reliability and life expectancy.

STC special quality valves available are:

Type	CV Number	Description
S2P20	4097	Quick heat, filamentary tetrode for transistor hybrid circuits.
S6F17	4040	Low impedance beam tetrodes for use as pulse or linear amplifiers.
S6F17*	4041*	
S6F33	4064	Pentodes with short suppressor base for gate, transistron, and phantastron circuits.
—	4083*	
S11E12	4060	Beam tetrode for use as regulator valve.
S19G6	4057	High vacuum e.h.t. rectifiers.
S19G6F*	4042*	

*Flying lead versions.

Write, 'phone or Telex for Data Sheets to STC Valve Division, Brixham Road, Paignton, Devon, or London Sales Office, Footscray, Sidcup, Kent. Telephone FOOTscray 3333. Telex 21836.

SILRINGS · SILICON RECTIFICATION USING SELENIUM STACK PRACTICE

New in Britain, SILRING rectifier stacks from STC offer the circuit designer and equipment engineer a unique combination of compactness, simplicity and low cost. □ The SILRING stacks shown above have outputs of 4.2 kW, 2.1 kW and 9.45 kW. □ SILRING power diodes are rugged ceramic/metal case ring diodes with diffused silicon junctions. Their heavy gauge copper end-plates form the anode and cathode of the device and act as thermal conductors to the stack cooling fins. This arrangement provides maximum efficiency without overloading and consequent lowest price-per watt rectification □ The simplicity of stack construction enables STC to offer quick delivery of SILRING diodes in the range 50-600VRWM. When assembled into stacks these diodes give outputs from 5 to 232A.

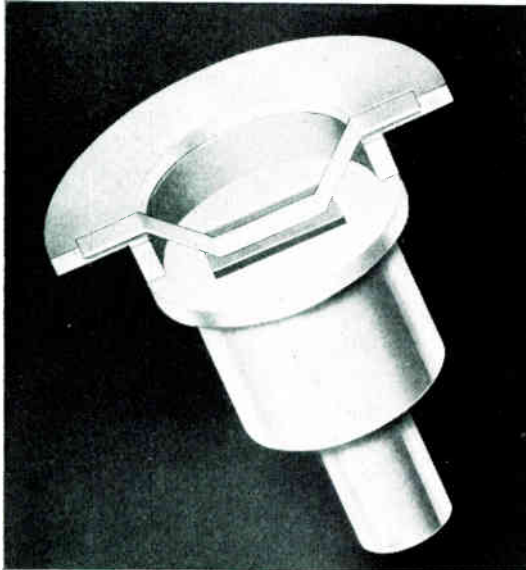
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- Applications include...Frequency multipliers, RF Switches, Limiters, Reactance Tuners, Modulators

VHF VARACTOR DIODES

- High cutoff frequency...10 kmc minimum at breakdown
- High Working Voltage...up to 200 volts

ELECTRICAL CHARACTERISTICS $T_A = 25^\circ\text{C}$ (Tentative Data)			
RCA Developmental Type	Junct. Cap. at Working Volt. C_j min. (pf)	Cutoff Freq. at Working Volt. f_c (kmc/s) min.	Working Volt. V_w (volts) min.
V500	4-10	10	125
V501	4-9		150
V502	4-8		175
V503	4-8		200

UHF VARACTOR DIODES

- High cutoff frequency...to 50 kmc at breakdown
- High Working Voltage...up to 200 volts

ELECTRICAL CHARACTERISTICS $T_A = 25^\circ\text{C}$ (Tentative Data)				
RCA Developmental Type	Junct. Cap. at Working Volt. C_j min. (pf)	Cutoff Freq. at Working Volt. f_c (kmc/s) min.	Working Volt. V_w (volts) min.	Std. "A" Series
V510	1-2.5	25	125	2.5-5
V511	1-2		150	2-4
V512	1-2		175	2-4
V513	1-2		200	2-4
V520	1-2.5	50	125	2.5-5
V521	1-2		150	2-4
V522	1-2		175	2-4
V523	1-2		200	2-4

NEW RCA GALLIUM ARSENIDE VARACTORS OFFER CUTOFF FREQUENCIES TO 225 KMC IN 6 AND 30 VOLT SERIES

6 VOLT VARACTOR DIODES

- Very low noise figure...less than 3db at 25°C in non-degenerate x-band paramps
- High cutoff frequency...to 225 kmc at -6 volts
- Available in both the "Pill" and "Prong" packages shown
- Power Dissipation...up to 200 mw
- Applications include...Parametric amplifiers and harmonic generators

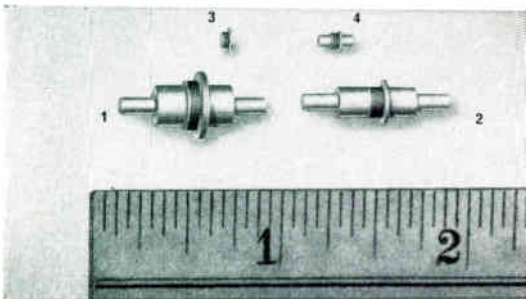
30 VOLT VARACTOR DIODES

- High cutoff frequency...to 220 kmc at -30 volts
- Available in "Prong" package shown
- Power dissipation...up to 500 mw
- Applications include... Harmonic generators and microwave switches

ROCK-SOLID CONSTRUCTION...

of RCA Varactor Diodes eliminates the problems of C-spring construction—offers these features:

- Thermally bonded contacts—no pressure springs
- Welded ceramic-to-metal seal—hermetic case
- Low thermal resistance
- 20,000 G acceleration
- 15 G shock
- Designed to meet MIL-S-19500



RUGGED RCA CERAMIC-METAL PACKAGES provide exceptionally low thermal impedance. (1) and (2) silicon varactors, (3) and (4) Ga As varactors.

For experienced application engineering assistance... for custom types to your specifications... for technical information on RCA Silicon Varactor Diodes... contact



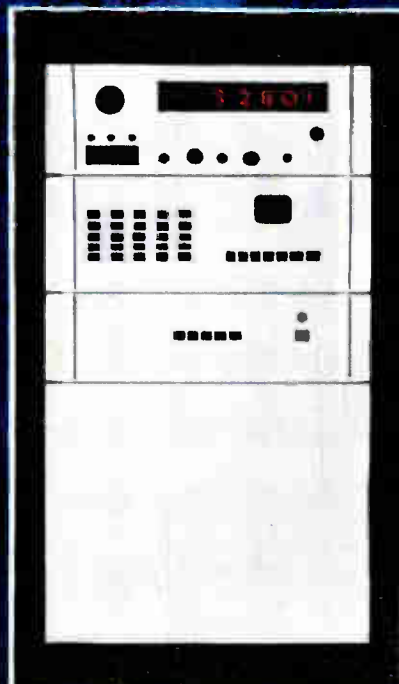
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RCA GREAT BRITAIN LIMITED, Sales Division, Lincoln Way, Windmill Rd., Sunbury-on-Thames
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data systems

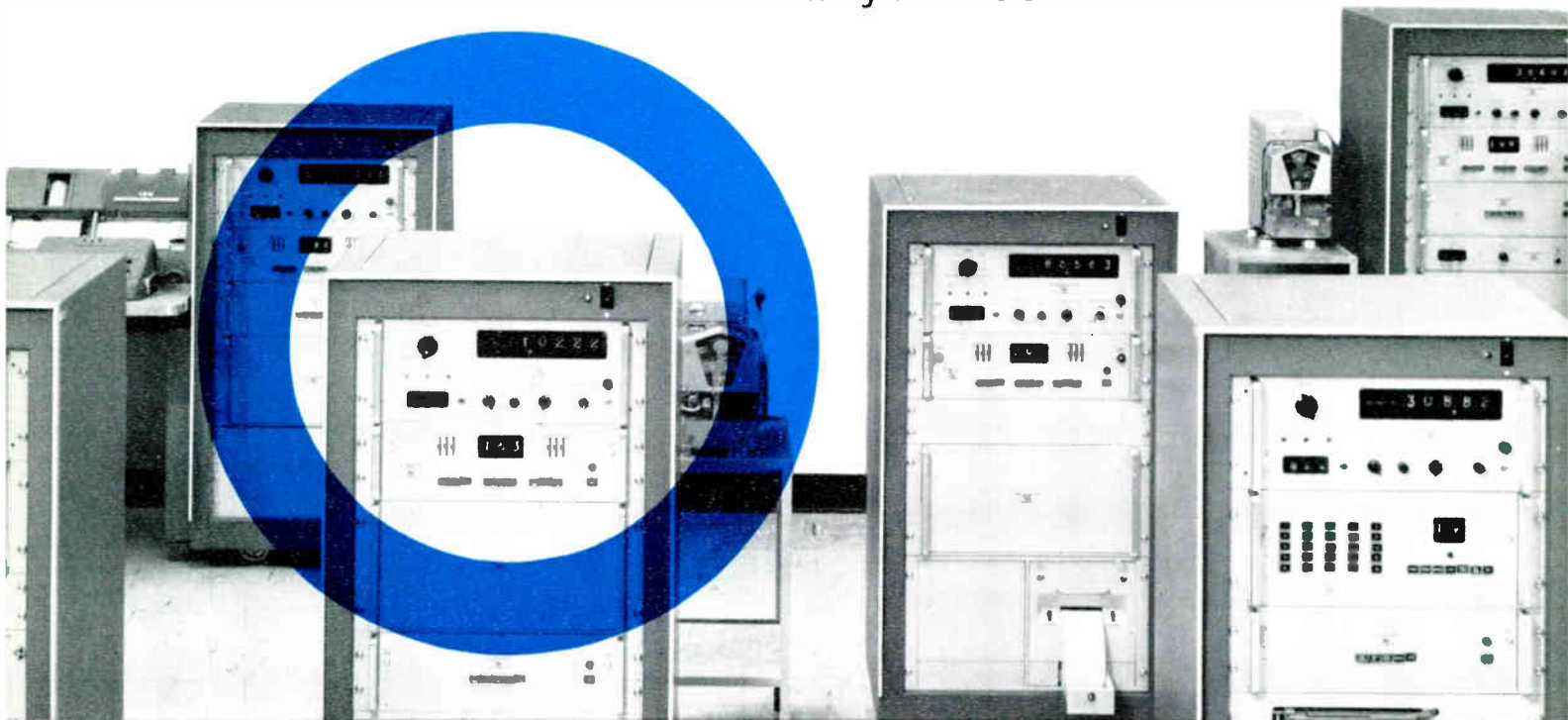


- * DATA ACQUISITION FOR COMPUTER PROCESSING,
- * WIND TUNNEL INSTRUMENTATION,
- * ENVIRONMENTAL TESTING,
- * AUTOMATIC CHECK-OUT OF COMPLEX SYSTEMS,
- * DATA LOGGING FOR PROCESS CONTROL,
- * COMPONENT TESTING.



Look at the Hewlett-Packard data handling equipment

and get exactly
what you need



STANDARD DIGITAL DATA ACQUISITION SYSTEMS

High Reliability, Moderate Price:

The best performance is available to-day with seven standard Dymec digital data acquisition systems. All are ready for delivery . . . engineered and built using standard production techniques.

Wide Choice of Inputs, Outputs:

Dymec 2010 Systems provide accurate measurement of multiple inputs of DC and AC voltage, resistance and frequency, with recording of measurement on printed strip, perforated tape, or punched cards. Mixed inputs are easily accommodated by built-in


system programming. A combination of printed record and perforated tape or punched cards is available. The multi-channel input scanner has facilities for continuous scan, single scan and step modes of operation.

Noise Rejection:

Each system incorporates the DY-2401A Integrating Digital Voltmeter, which permits accurate measurement of very low-level DC signals in the presence of severe common mode and superimposed noise.

COMPLETE SYSTEM SPECIFICATIONS:

	DY-2010A	DY-2010B	DY-2010E	DY-2010C	DY-2010D	DY-2010F	DY-2010G
SCANNER INPUT	Up to 25 3-wire inputs; to 100 channels with slave scanners. Programming permits mixing signal types and levels.			Up to 200 guarded 3-wire inputs. Also accepts 100 6-wire, 300 2-wire, and 600 1-wire inputs.			
COMMON MODE NOISE REJECTION	105 db			130 db			124 db
DC VOLTAGE RANGES	100mV to 1000V full scale; overranging to 300% of full scale on four most sensitive ranges. 0.01% stability on four highest ranges. Sample period 0.01, 0.1 or 1 sec. 10mV full scale range optional.						Adds 10mV full scale range
FREQUENCY RANGES	10 cps to 300 Kc/s. Sample period 0.01, 0.1 or 1 sec. Accuracy ± 2 ppm ± 1 digit, over 1 week.						
AC VOLTAGE RANGES (Optional)	100mV to 1000V full scale; overranging to 300% of full scale (except 1000V). Frequency range 50 cps to 100 Kc/s.						
RESISTANCE RANGES (Optional)	100 ohms to 10 megohms full scale; overranging to 300% of full scale (except 10M).						
DISPLAY	5 digits of data, range function (e.g., \pm Vdc, Vac), channel number; all included in front panel readout and logged on output recorder.						
MEASUREMENT SPEED (Max. dc volts)	5 channels/sec	10 channels/sec	1 channel/sec	5 channels/sec	10 channels/sec	1 channel/sec	10 channels/sec
OUTPUT	Printed paper tape	Perforated tape	Punched card (on IBM 526)	Printed paper tape	Perforated tape	Punched card (on IBM 526)	Perforated tape

Call in a Hewlett-Packard Systems Engineer. He will show you that our range of data acquisition and data handling equipment is so wide that we can provide for the handling of data from most sources and connect it to a multiplicity of recording media. In this advertisement we show you some of the , Dymec, Sanborn and Moseley equipment.



SANBORN MULTI-CHANNEL OSCILLOGRAPHS

Rectangular-Coordinate Recording by Heated Stylus

These systems include plug-in amplifiers for recording :

- DC and AC volts (Linearly or Logarithmically)
- AC watts
- True rms volts and amps
- Frequency
- Digital to Analogue Conversion
- Servo response
- Transducer outputs, e.g. Force, Pressure, Displacement, Velocity, Acceleration, Strain, Temperature, etc.

MOSELEY 680 6" STRIP CHART RECORDERS




5mV to 100V Full Scale
8 Chart Speeds
0.5 sec. Balance Time
0.2% Full Scale Accuracy

MOSELEY 135 X-Y RECORDER



0.5mV/Inch—50V/Inch
0.2% Accuracy
Built-in X Time Base

 offer a complete range of Moseley X-Y and strip-chart recorders, programme controllers, servo voltmeters, digital translators and analogue converters. Accessories available include magnetic and optical line followers, AC/DC and logarithmic converters, character printers and keyboards.

Dymec Data Plotting Systems DY-2030A, B, C and D are available to provide graphical displays of digital information stored on punched cards or perforated tape.

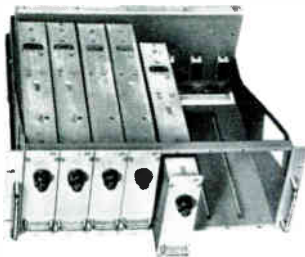


GUIDE TO SANBORN SYSTEM SELECTION

System	150	350	850	950
Selection Characteristics	Allows for less than 4 Channels	Maximum Flexibility and Performance	Economic Range of Preamplifiers	Maximum Economy System with Identical Channels
Flexibility (No. of preamp types)	11	12	8	6 in modules of 6 or 8
Input Channels	1 - 8	4 - 16	4 - 16	6 - 16
Frequency Response	DC to 100c/s	DC to 150c/s	DC to 150c/s	DC to 150c/s
Maximum Sensitivity (1 division is normally 1 mm)	10 μ V/div.	2 μ V/div.	10 μ V/div.	10 μ V/div.
Overall Linearity	1%	< 0.4%	< 0.4%	< 0.5%
Common Mode Rejection	60db	160db	160db	140db
Drift Referred to Input at Constant Temperature	5 μ V/hr.	2 μ V/day	2 μ V/day	20 μ V/day
Noise Referred to Input	1% of Input Signal	< 2 μ V p-p	< 3 μ V p-p	< 5 μ V p-p
Chart Speeds	0.25 to 100 mm/sec. and/or mm/min	9 Selected by Gear Lever	9 or 18 Push Button with remote operation	As for "350" System
Circuitry	Valve	Hybrid	Hybrid	Mainly Solid State

MINIATURISED, ALL SOLID STATE DC DATA AMPLIFIERS:

For Precise Control of Low-Level Signals from Thermocouples, Strain Gauges, Resistance Bridges and other Millivolt Output Transducers



SANBORN 860-4000 amplifier



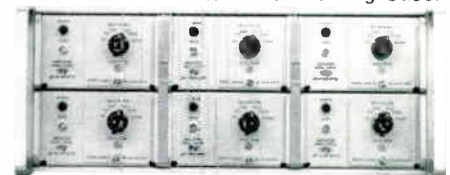
SANBORN	"FIFO" 860-4000	WIDEBAND 860-4200	NARROW BAND 860-4300
Bandwidth	DC - 10 Kc/s within 3 db	DC - 50 Kc/s within 3 db	DC - 100 cps within 3 db
Linearity	$\pm 0.1\%$ of 10V f.s. at DC	$\pm 0.01\%$ of 10V f.s. at DC	$\pm 0.03\%$ of 5V f.s. at DC
Gain	1000, 500, 200, 100, 50. Smooth gain control covers intermediate ranges	1000, 500, 200, 100, 50, 20, 10. Does not phase invert	1000, 500, 200, 100, 50, 20, 10. (Gain of 10 to 20000 in 12 fixed steps available on special order)
Overload Rec.	For 500% overload-300 μ s to 1% of full scale output	Less than 300 μ s	For $\pm 10V$, 200 ms to within 25mV of original output
Drift	$\pm 2\mu V$ ref. to input. $\pm 0.01\%$ of f.s. at output at constant ambient for 40 hours	$\pm 0.02\%$ of f.s. at constant ambient for 40 hours	$\pm 2\mu V$ ref. to input. $\pm 0.1mV$ ref. to output for constant ambient for 40 hours
Noise	5 μV rms, DC - 10 Kc/s (ref. to input at gain of 1000)	7 μV rms, DC-50 Kc/s (ref. to input)	1 μV p-p, DC - 20 cps (ref. to input, at gain of 1000)
Input	Isolated from gnd. and output. Impedance 100 meg. min. at DC in parallel with 0.001 mfd.	Impedance 100 meg. at DC in parallel with 0.001 mfd.	Isolated from ground and output. Impedance 500K
Output	Isolated from input and ground. $\pm 10V$ at 10mA. (-4000P has grounded output, $\pm 10V$ at 100mA)	$\pm 10V$ at $\pm 100mA$. Sustained short across output will not cause damage to amplifier	Isolated from input and ground. $\pm 5V$ at $\pm 2.5mA$. Part or all of internal 2K in parallel with 25 mfd. may be removed, connected externally
Common Mode Characteristics	120 db rejection at 60 cps. 160 db rejection at DC (1000 ohms in either input lead). Tolerance $\pm 300V$ DC or peak AC	Amplifier floats with respect to chassis. Isolation impedance is greater than 3000 megohms in parallel with 5 pfd.	130 db rejection at 60 cps, 160 db rejection at DC (1000 ohms in either input lead). Tolerance $\pm 300V$ DC or peak AC

DY-2460A AMPLIFIER uses all transistor circuitry and photoconductive chopper for maximum reliability. Built-in power supply consumes only 4 watts. Amplifier provides output up to $\pm 10V$ at 10mA, with automatic overload protection. Fast settling time and rapid overload recovery enhance the amplifier's usefulness in systems applications. Zero drift less than $1\mu V$ /week, noise less than $4\mu V$ p-p. Various plug-ins available to adapt amplifier to specific applications.



DY-2460A Amplifier with DY-2461A-M2 Plug-in.

Up to 6 Amplifiers may be rack mounted in Combining Case.



SANBORN MOTION, PRESSURE & FORCE TRANSDUCERS :

Displacement Probes give f.s. recording from 0.001" displacement, with max. non-linearity $\frac{1}{2}\%$. Ten versions, numerous adapters. Model 580.	Linearsyn differential transformers, strokes from $\pm 0.005"$ to $\pm 1.0"$. High sensitivity, shock and vibration immunity; immersible. Many specials available.	Differential and single-ended liquid or gas Pressure Transducers. sensitivities $21\mu V/0.01$ psig/volt excitation and $210\mu V/0.01$ psig/volt excitation. Model 267A
Low Force Transducer available in standard ranges from 0-1 gram to 0-10000 grams. Model FTA-1.	DC-excited miniature DC Differential Transformers - can drive DC meters or amplifiers directly. Displacement ranges $\pm 0.050"$ to $\pm 3.0"$. Model 7DCDT.	LVsyn linear velocity transducers need no excitation. Rugged, immersible, unlimited resolution, linearity better than 1%. Working stroke ranges 0.5" to 20".

A complete range of modules is available for rapid assembly into complete systems. Input scanners, amplifiers, digital voltmeters, digital clocks, voltage to frequency converters, AC/ohms converters, output couplers, printers.

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European Office: Hewlett-Packard S.A., 54 Route des Acacia, Geneva, Switzerland



New from Sigma/OED



Actual size

Photochoppers with superior signal-to-noise capability and higher conversion efficiency

Higher Conversion Efficiency: 99% at 60 cps*; 90% at 400 cps*; usable signals to 10,000 cps.

Improved Signal-to-Noise Capability: Low offset voltage; random noise below 2 microvolts; drive circuit electrically isolated from output circuitry through optimum electrostatic and electromagnetic shielding.

Solid-State Reliability: Over 10,000 hour life. No moving parts, resists vibration and shock.

Reduced Power Requirements: OED photochoppers accept 115 volt AC (at 2 ma) and need less drive power than mechanical choppers.

Interchangeability: Directly interchangeable (physically and electronically) with existing photochoppers while providing higher performance.

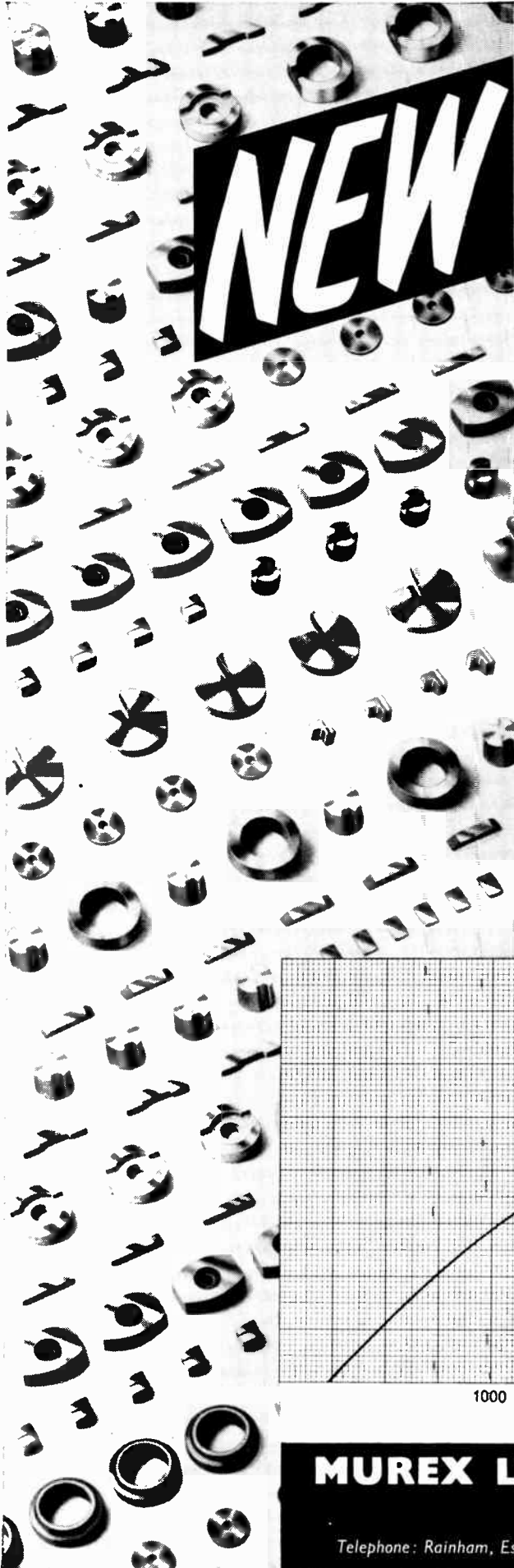
System Economy: Lower cost than equivalent mechanical choppers yet provides considerably longer life; eliminates the need for phase shift tuning circuitry.

Specify Sigma/OED photochoppers for your high gain operational amplifier designs. Call your Sigma/OED representative today, Scientific Furnishings Ltd., Poynton, Cheshire.

Or for further information write International Sales Manager, Sigma Instruments, Inc., Braintree, Mass. 02185, U.S.A.

*with PC 3 MC: Source impedance $R_s = 0$ Load impedance $R_L = 1 \text{ meg } \Omega$
Dynamic Switching ratio at 60 cps. = 1000:1 400 cps. = 10:1

OPTO-ELECTRONIC DEVICES  SIGMA INSTRUMENTS INC
Inc., Subsidiary Advanced Design Through Optical-Electronics/Braintree, Massachusetts 02185

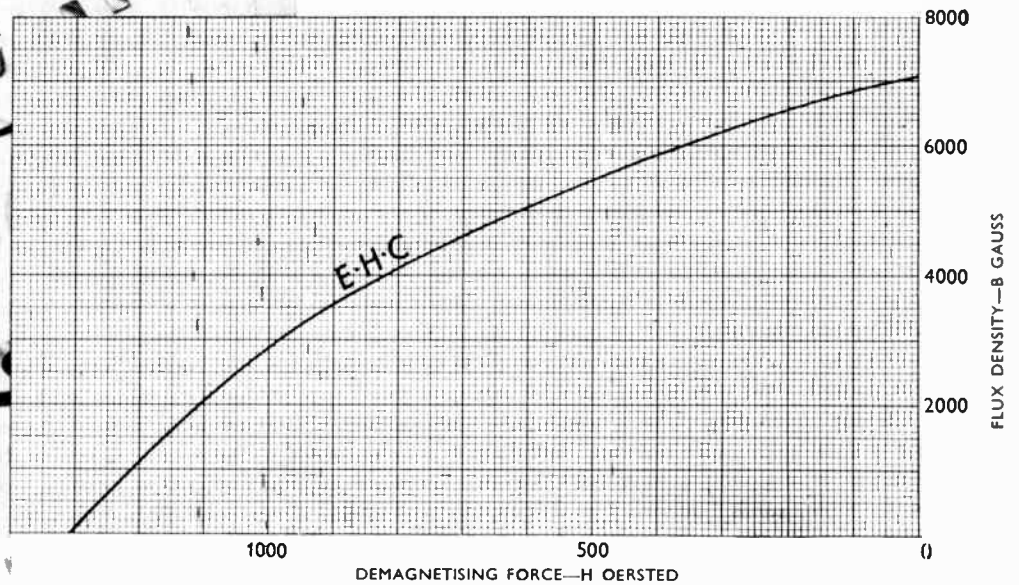


E.H.C.

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This new sintered magnet alloy has been developed by Murex for use where space restrictions require subminiature components of extra high coercivity with HIGH ENERGY OUTPUT AND GREAT STABILITY AT HIGH TEMPERATURES

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Reliable RECTIFIERS



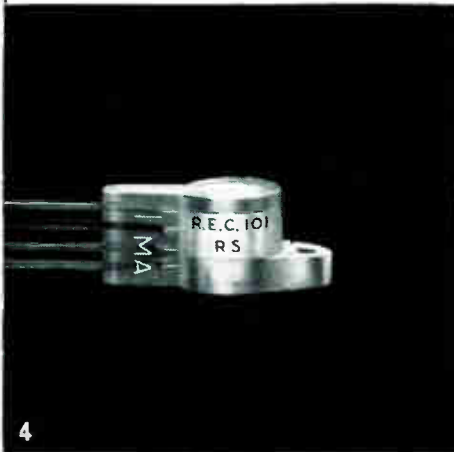
1



2



3



4

A few of our wide range of rectifiers. All feature advanced techniques and exacting specifications. They are all available for delivery absolutely "by return of post".

1. Low current H.T. rectifier, 125V. r.m.s. 120 mA.— Type REC. 3A
2. Medium current H.T. rectifier, 250V. r.m.s. 250 mA.— Type REC 4A
3. Miniature low-voltage, high current silicon diode 27V. r.m.s. at 10A.—Type REC 30
4. Copper oxide meter rectifier, for 1 mA. f.s.d. — Type REC 101

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SILICON PLANAR TRANSISTORS

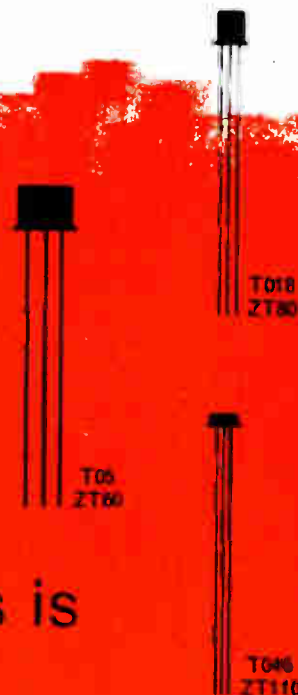
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in Britain for you

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*** BURN IN**

statistics show that this is
the only way to achieve
MAXIMUM RELIABILITY

*** Every Ferranti transistor from the production
line is FULLY DYNAMIC TESTED FOR 48 HOURS !**



Rating or Characteristic	Symbol	ZT60 ZT80 ZT110	ZT61 ZT81 ZT111	ZT62 ZT82 ZT112	ZT63 ZT83** ZT113	ZT64 ZT84** ZT114	ZT66 ZT86** ZT116	ZT67 ZT87 ZT117	Test Conditions
Collector Base Voltage	V_{CB0}	25	45	45	60	60	100	25 volts	$I_E = 0$
Collector Emitter Sustaining Voltage	$V_{CE0(Sus)}$	25	35	35	45	45	80	25 volts	$I_B = 0$ $I_C = 5mA$
Emitter Base Voltage	V_{EBO}	4	4	4	5	5	5	4 volts	$I_C = 0$
Collector Peak Current	I_{Cpk}	500	500	500	500	500	500	500mA	
DC Collector Current Gain	h_{FE}	38-162	38-162	78-250	25-85	75-170	35-85	78-250	$I_C = 10mA$ $V_{CE} = 6V$
Collector Base Reverse Current	I_{CBO}	0.5	0.5	0.5	0.05	0.05	0.05	0.5µA	$V_{CB} = V_{CBO}$
Collector Saturation Voltage	$V_{CE(Sat)}$	0.4	0.4	0.4	0.4	0.4	0.4	0.4 volts	$I_C = 50mA$ $I_B = 5mA$ $I_C = 10mA$ $I_B = 2mA$
AC Current Gain (typical)	h_{fe}	10	10	10	10	10	10	10	$f = 20mc/s$ $I_C = 10mA$
Power Dissipation	P_{tot}	300	300	300	300	300	300	300mW	$P_{tot} = 350mW$ for ZT60 series
Minimum Burn-In Period	t_{BPmin}	48	48	48	48	48	48	48 hrs.	P_{tot} $T_{amb} = 25^\circ C$

** CV 7371 · CV 7372 · CV 7373

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... diodes with superior performance and maximum reliability

GERMANIUM SWITCHING DIODES

HG1005	Point-Contact	PIV	up to 100V	CV448
HG1006		$I_F @ 1V$	> 5mA	CV7041
HG1012		$I_b @ 50V$ Capacitance	< 50 μ A 0.2pF	CV7130
HG5003	Gold-Bonded	PIV	up to 100V	CV7076 CV7127 CV7128
HG5004		$I_F @ 0.8V$	> 100mA	
HG5008		$I_b @ 50V$	< 25 μ A	
HG5009		Capacitance Stored charge	0.4pF 400pC	
HD1810	Gold-Bonded	PIV	up to 50V	
HD1840		$I_F @ 0.7V$	> 100mA	
HD1841		$I_b @ 10V$	< 5 μ A	
HD1870		Capacitance	1.5pF	
HD1872		Stored charge	65pC	
HPS1670	Ultra-Fast Point-Contact	PIV	up to 20V	
HPS1672		$I_F @ 1V$ Reverse recovery time	10mA 0.8 nanosec	

SILICON SWITCHING DIODES

1N643	High voltage diffused	PIV	up to 200V	
1N643A		$I_F @ 1V$	100mA	
1N806		Capacitance	5pF	
1N809		Stored charge	500pC	
1N914	Diffused Planar	PIV	up to 75V	CV7367 CV7368
1N914A		$I_E @ 1V$	20mA	
1N916		$I_b @ 20V$	< 0.025 μ A	
1N916A		Capacitance	2pF	
1N3064		Stored charge	60pC	
1N3067				
HD5000	Ultra Fast	PIV	up to 20V	
HD5001		$I_F @ 1V$	5mA	
HD5004		$I_b @ 5V$	< 0.2 μ A	
		Capacitance Stored charge	1pF negligible	



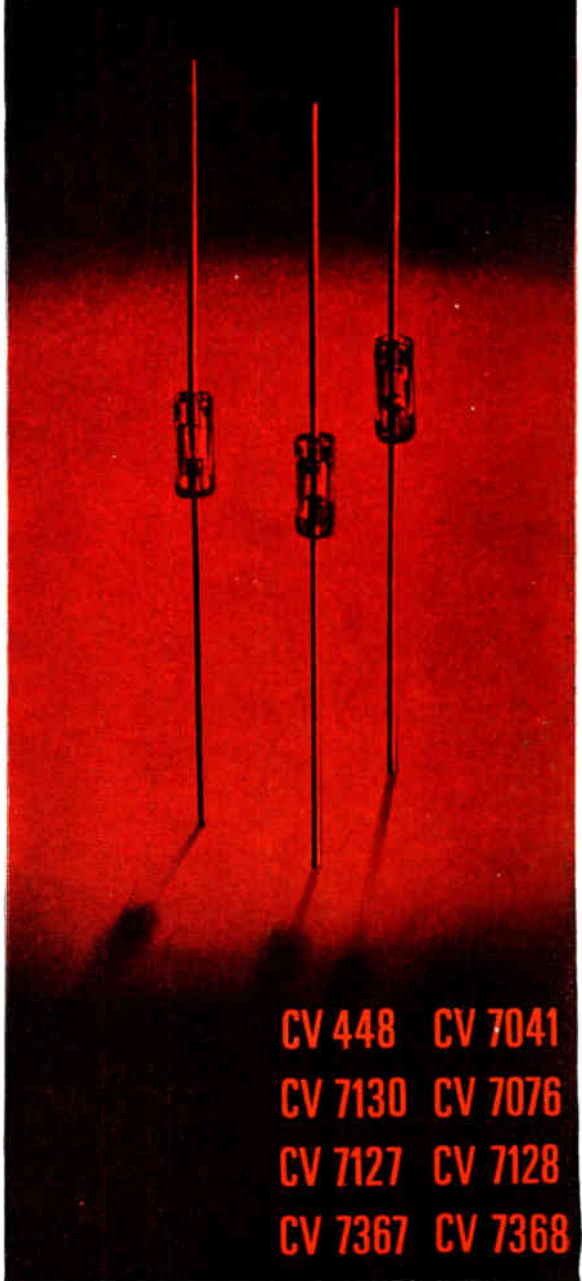
Write now for complete data on the full range of Hughes semiconductor products, which also includes:—Silicon sub-miniature power diodes/rectifiers, Voltage reference (zener) diodes, High voltage cartridge rectifiers, PNP and NPN Silicon Transistors.

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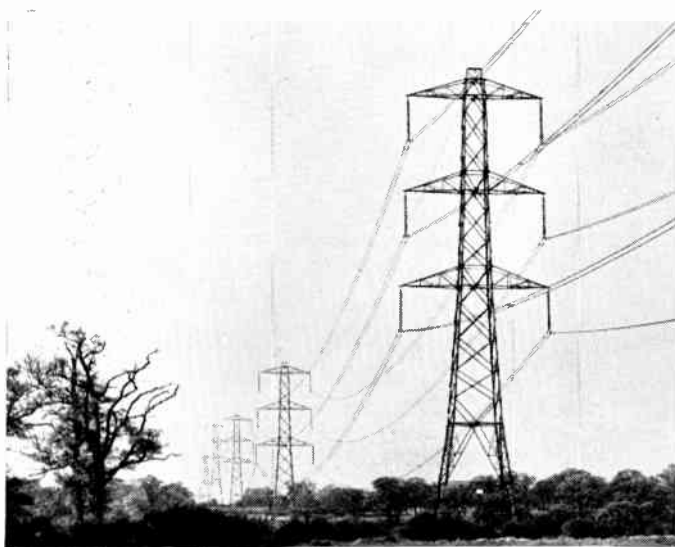
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G.E.C. MODULAR EVERY PROBLEM OF



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.

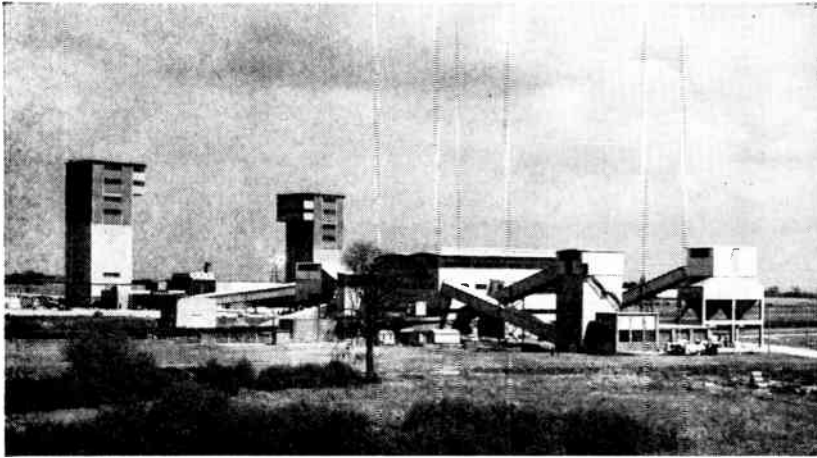


Refineries and Pipelines G.E.C. (Electronics) Ltd. has installed remote control systems for many different applications on behalf of major oil companies. A typical example is the use by Shell-Mex and B.P. Ltd. of G.E.C. equipment to operate motorised valves at isolated points on pipelines. Control in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



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.



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.



**modular
remote control
and telemetry**

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Comment

We commented last month on the National Electronics Research Council and said that it is already tackling one problem, that of the retrieval of information. Since then we have come across a new system which is called Videofile and is being produced by Ampex.

It is basically a ready-access filing system. Each document is televised and the television signal is recorded on magnetic tape, together with the address of previous relevant documents. The machine then finds taped records of these previous documents and adds the new record to them. A file is thus automatically up-dated and kept on magnetic tape.

When anyone wishes to look at a document he dials the file number on a control unit. The equipment then finds the relevant length of tape and copies its contents into a temporary storage unit. The master record is then free for use by anyone else. The contents of the storage unit can then be reproduced on a television screen and examined at leisure. By pressing a button an electrostatic printer is brought into action and a printed copy of any document can be made.

There is no need to go to the apparatus to look at any document. Control boxes and viewing screens can be sited at remote points.

The first Videofile will be used by the National Aeronautics and Space Administration as a reference library for reports on component tests and reliability data. It is expected that the cost of a Videofile installation will be from \$200,000 to \$1,000,000 according to the amount and kind of reference material to be filed and the number of reference points.

One thing, of course, is obvious. One must have an index to find the code number of the file one wants. In one application this becomes unnecessary. This is the case of an insurance office, for then the policy number can be the file address. For more general use, such as for the retrieval of scientific information, a subject index would be needed. However, perhaps this already exists in the Universal Decimal Classification system.

Perhaps something of this nature may be the answer to N.E.R.C.'s problem, but we suspect that there will be too many files and each will be too bulky even for Videofile.

Generating Electric Power

The production of electricity without moving parts is being carried out experimentally on a small scale in Russia. Known as Romashka, the apparatus comprises a nuclear reactor which produces heat by the fission of uranium 235. The fuel elements are plates made from dicarbide of uranium and graphite. The maximum temperature is 1770 °C.

The heat is conducted to thermo-electric elements outside the reactor.

These are a silicon-germanium alloy and produce a current of 88A, the power being 500 W.

This is, of course, a hard way to produce 500 W, but the purpose of this apparatus is not to generate power per se. It is to find out how to do it.

Valve Exports

Figures for the exports of valves, tubes and semiconductors during the second quarter of 1964 have been

issued by B.V.A. and V.A.S.C.A. They are based on the Customs & Excise returns. At £2,626,723 they are slightly down on the first quarter. The figures for valves alone show an increase.

The biggest single item is valves below 50-W anode dissipation but excluding X-ray tubes. This amounts to £807,473. The second largest item is television picture tubes at £413,979. Cathode-ray tubes other than these amount to only £64,730, but 'others including camera tubes' reached £208,628.

For the rest, the categories range from microwave tubes other than klystrons and travelling-wave tubes exceeding 1 kW at £127,654 to crystal semiconductor devices other than diodes and transistors at £10,332.

Quasar

We note here new and strange words as we come across them. Quasar is the latest and out of context it will mean nothing to most people. It is being used in some quarters for a quasi-stellar radio source.

Radio astronomy is concerned with sources of extraterrestrial radio signals, which occur in the form of noise. The sun is the source of much noise, but there are many sources outside our solar system, indeed, there are many outside our galaxy.

Some of the sources are known to be stellar and there are various hypotheses about the others. Some are considered to be high-speed electrons travelling in a magnetic field.

Apparently enormous amounts of energy are involved in quasars and some of the theories to account for them involve negative mass. We recently tried to give an idea of what negative temperature means. We shall not attempt to try to explain negative mass! Fortunately, it seems to be right outside our field but, who knows, it may not always be.

Automatic Control

It is reported from the U.S.A. that a railway engine without any crew is in regular use on some goods trains. It is used as a second locomotive on trains which require two engines. Normally, two manned engines are used, one at the front and the other at the rear. With the automatic engine, however, there is a manned engine at the front in the usual way and the second is placed in the middle of the train.

Strain gauges are placed in the couplings, and their outputs are processed electronically and used to control the throttle. Details of the system are not yet available but it is clear that given the initial idea its implementation is a reasonably straightforward control problem.

We imagine that the requirement is basically for the second engine to draw the

second half of the train. If it does this, it is merely following the first half, neither pushing it nor dragging on it. In that case, there will be zero strain in the coupling and the control system will adjust the throttle opening for zero strain. This assumes a rigid type of coupling which will undergo a compressive strain if the back half of the train tries to overrun the front. We believe that such couplings are usual in American railways, however.

Alternatively, of course, it is possible to prevent overrun by measuring the strain in the rear coupling. That adds complications, however, for there must be an adjustment for the weight of the train and automatic compensation for gradients would be needed.

Gradient adjustment could no doubt be carried out automatically by measuring the gradient by some equivalent of a spirit level. Compensation for the train weight would probably require a manual pre-set control.

We are, of course, speculating here and we shall await details of how it is actually done with interest.

Aircraft and Electronics

This year's S.B.A.C. show (reported on p. 470) served as yet another reminder of the major role played by electronics in almost every aspect of modern aviation. Indeed, it can fairly be said that, without electronics, flying as we know it today would not be possible; this applies as much to the design and construction of aircraft as to their operation.

With civil and military aircraft now costing millions rather than thousands of pounds each, the designer must be able to check the performance of a projected airliner or bomber—and hence determine the optimum design—long before any expensive metal is cut: electronic analogue and digital computers provide him with this essential facility. In the highly competitive world of commercial aviation where delivery dates can make or break a project, and in military aircraft production where obsolescence can set in before the maiden flight, the time required to translate design data into the finished product has been drastically reduced by the use of electronically-controlled machine tools. Finally, the operation of modern aircraft at ever-increasing speeds and traffic density would be wholly out of the question without electronic aids to navigation, landing and air traffic control.

However, where one branch of engineering is so dependent upon another, the benefits are seldom in one direction only: and this is no exception. Many of the recent advances in electronics stem directly from the exacting requirements of the aerospace industry.



By F. R. TOWNER, A.M.I.Prod.E.*

TOE-IN INDICATION EQUIPMENT

Equipment for measuring the amount of toe-in of the front wheels of a motor-car is described in this article. It operates with the wheels rotating so that any wobble of rim or tyre is averaged out. The cover picture shows a car under test and, although this is not described in this article, it also shows the headlamp adjusting apparatus, for both adjustments are carried out together.

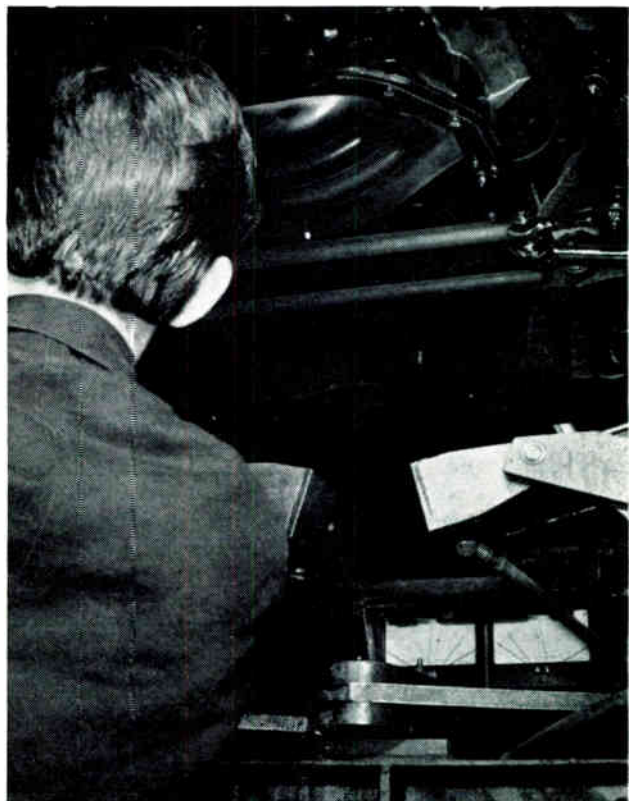
THE toe-in indication equipment about to be described has been designed and made at the request of Messrs. Vauxhall Motors Ltd., Luton. It is being used for setting the front wheels of Victor, Velox and Cresta cars, and is the last operation on the final assembly line.

For the very best steering characteristic to be obtained and to ensure consistent accuracy on a volume production basis, the toe-in setting on a modern car has to be extremely accurate, the setting for the cars in question being $0^{\circ} 12'$ from straight ahead; i.e. each wheel is offset 0.035 in. at a diameter of 20.24 in. The setting tolerance is $\pm 0^{\circ} 4'$ (0.012 in. at 20.24 in. diameter). Because this angle is small its setting from a stationary rim may give a false result as the rim itself is likely to have some slight run-out relative to the stub axle. Vauxhall make use of the tracks on the walls of the tyre. These have the advantage of being easier to get at, as well as presenting a large diameter for setting purposes. Tyres of any manufacturer rarely, if ever, run absolutely true with the stub axle. Thus it is necessary to rotate the wheel and 'average out' the running error.

Pit Equipment

Irrespective of the method of indication of toe-in, it is necessary to have the means of following the angular movement of each front wheel as it is adjusted. For this purpose the car is positioned over a floor pit, with the steering wheel locked in the straight-ahead position and with its front wheels each supported on driving rollers. The wheel-to-roller contact is at floor level. At each of the driving rollers is a cradle. This is pivoted about the same centre line as the particular front wheel king pin. Each cradle contains four contact rollers, two of which run on the inside of the tyre wall, while the others run on the outside.

Pneumatic clamping serves to ensure intimate contact between inner and outer rollers and tyre (Fig. 1). Thus



The indicating meters are fitted in the pit so that they can be read while the toe-in is adjusted

* Sperry Gyroscope Co., Ltd.

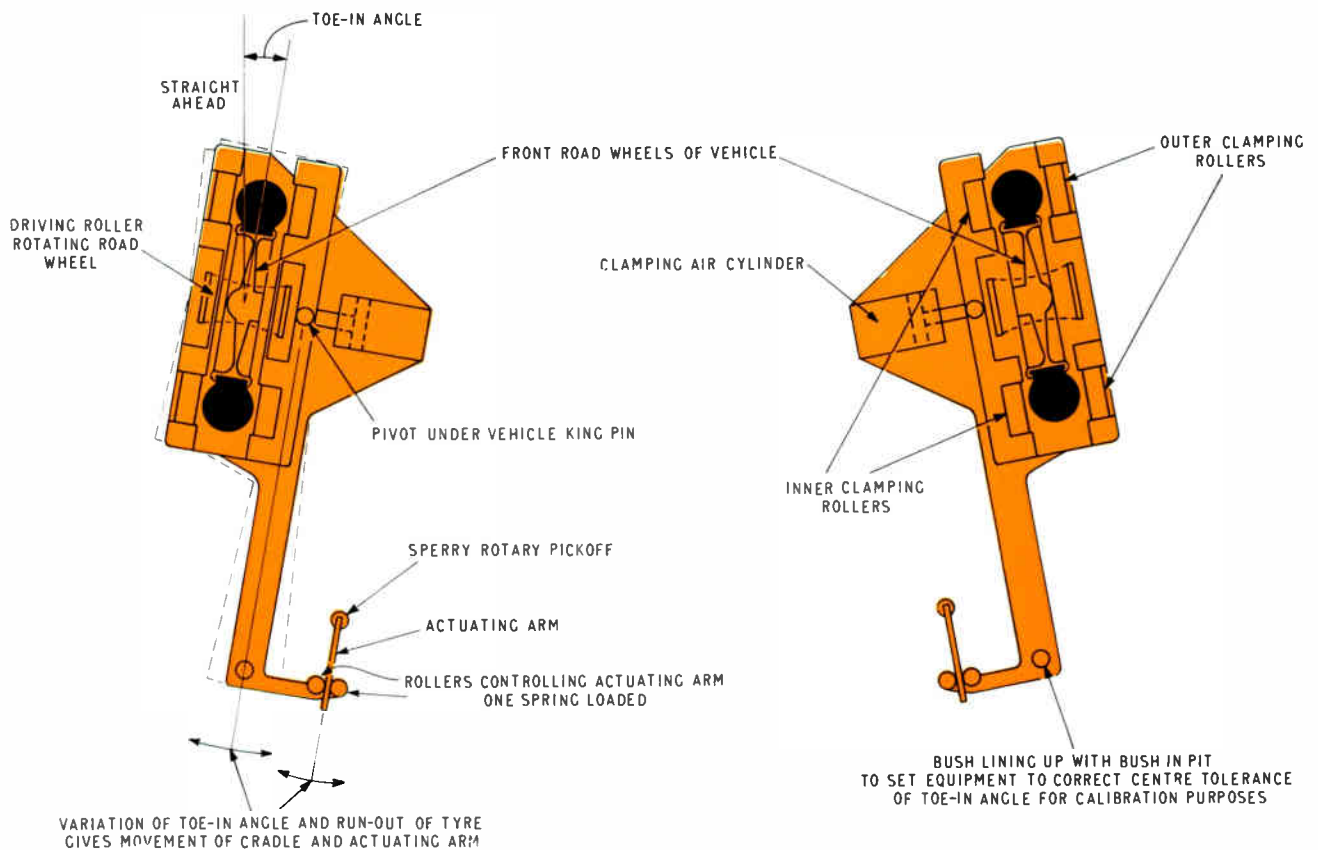


Fig. 1. Mechanical arrangement within the pit

setting movement of tie-rods, or movement of the steering wheel which causes the wheel to turn, will be followed exactly by the cradle. Similarly, as the driving roller causes the wheel to rotate, any run out is also followed. An operator is stationed in the pit and sees the amount of toe-in indicated on equipment fixed in front of him at eye level, and can thus adjust as is necessary.

Methods of Indication

Earlier systems have used mechanical or pneumatic methods. The pneumatic systems had damping introduced to remove the major effects of tyre run-out. Although more satisfactory than mechanical systems in practice, the pneumatic system required re-setting frequently; in some cases

more than twice a day. The Sperry system is electromagnetic and uses a rotary pickoff, working on 50 c/s a.c. The output from the pickoff is rectified and filtered to remove the tyre run-out signal, the toe-in being finally indicated by a centre-zero moving-coil meter.

Rotary Pickoff

The rotary pickoffs are fairly small in size, being roughly 1 in. dia. by 1½ in. long, and largely conform to the International frame size 11 Synchro. They are a form of a variable transformer wherein the magnetic coupling between primary and secondary varies according to the position of the armature. This, in the case of the rotary pickoff, gives an almost straight line output of voltage to

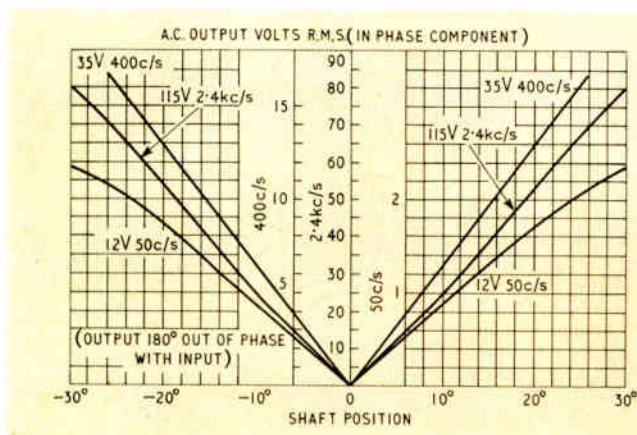
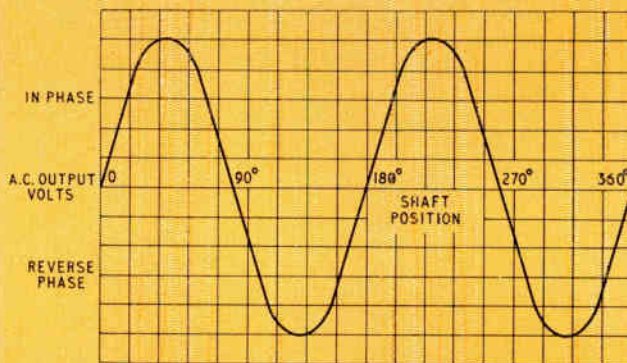


Fig. 2. Output-displacement characteristics of pickoff at various frequencies

Fig. 3. Typical relation between output and shaft rotation of a pickoff



radial position for $+30^\circ$ to 0° in phase and 0° to -30° in reverse phase, repeated at each 90° position.

The outputs at various input frequencies and voltages are shown in Fig. 2 while the output-displacement curve is shown in Fig. 3.

The method of operation used is the one least likely to give trouble from temperature variations. This uses the pickoff as a nulling device in which the toe-in setting is correct when the pickoff output is reduced to zero.

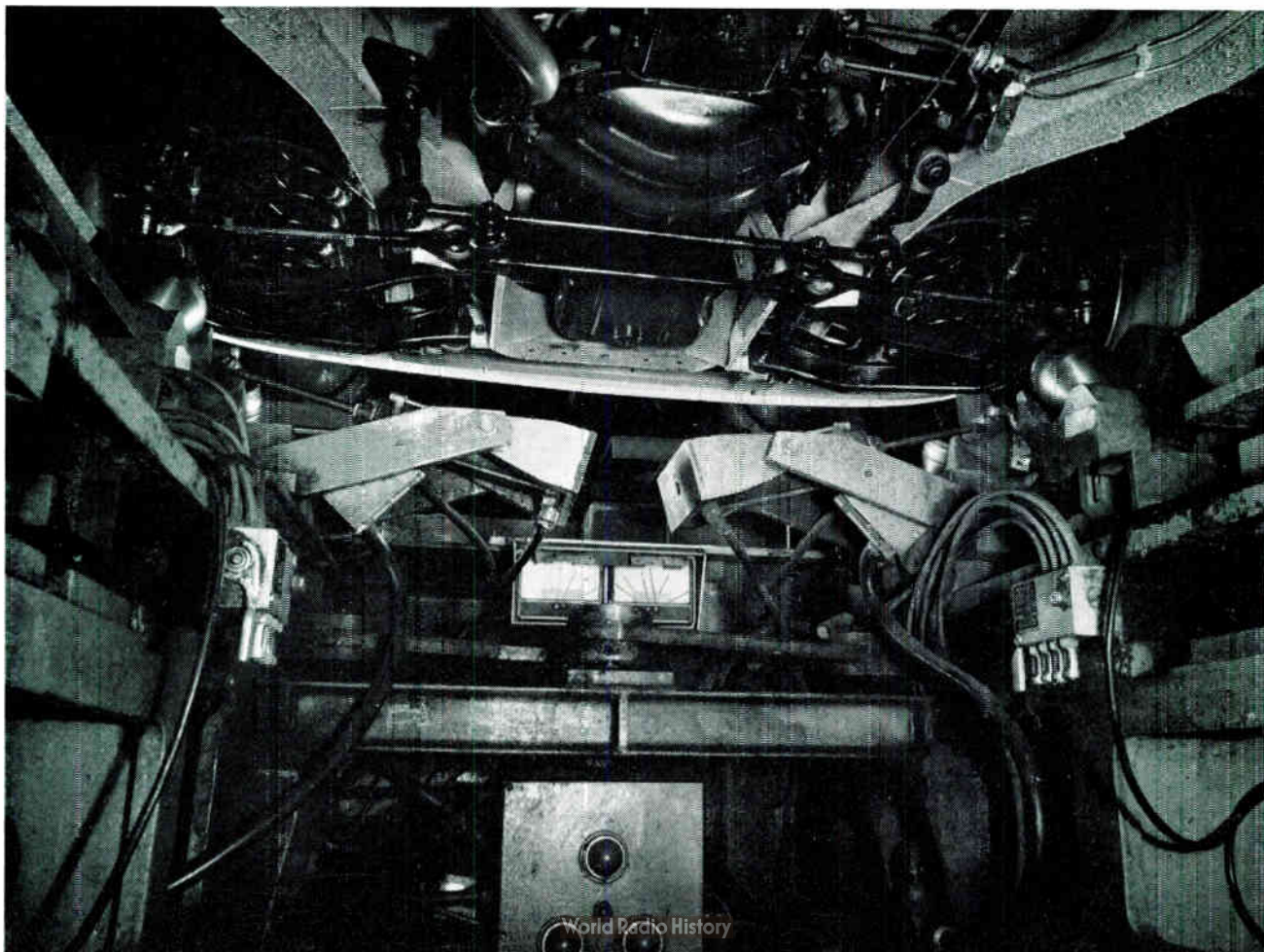
To prevent overloading of the pickoff bearing, the actuating arm attached to the pickoff shaft is held between two rollers. These rollers are contained in an extension of the cradle, one roller being spring loaded (see Fig. 1). Thus the movement of the cradle is accurately transmitted to the pickoff.

The Circuit

A mains transformer with six secondaries supplies power for two indicators, three secondaries for each wheel. In each group of three, one secondary powers the pickoff while two energize a rectification circuit. The output of the pickoff is stepped up 4:1 by auto-transformer, and its output contains a $1\text{-}\mu\text{F}$ capacitor for phase correction (see Fig. 4).

Because the indicator works as a nulling device it is important that the rectification circuit should not distort the pickoff signal as it nears zero output. For this reason the 'perfect rectifier' system is used wherein a transistor circuit running in phase with the pickoff output acts as a switch to supply rectified a.c. from the pickoff circuit. This circuit is duplicated to give full-wave rectification of the signal. The

General view of the apparatus in the pit with a car overhead



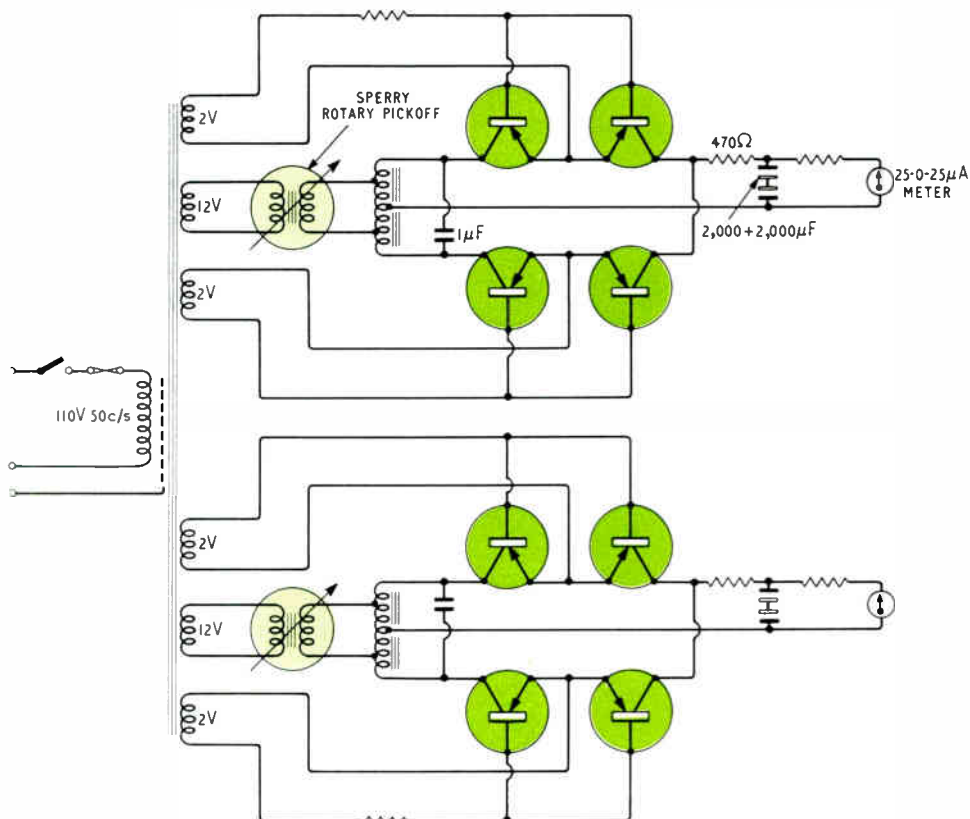


Fig. 4. Circuit diagram of apparatus

rectified signal is smoothed by an RC filter circuit with a time constant of about 0.5 sec (the car wheels run at approximately 120 r.p.m.). The filtered output is fed to a 25-0-25 μ A meter with a scale length of approximately 5 in. Adjustable cursors on the meter are set for the $\pm 0^\circ 4'$ tolerance. The needle has a black blob to make it more easily seen. The $\pm 0^\circ 4'$ tolerance gives a scale length of approx. 2½ in.

Because of its sensitivity, with mid-tolerance at centre zero, the adjustment of the tie rods before locking is often just off the scale (tightening the lock nut takes up play in the screw thread). This makes initial setting difficult so that in practice the pickoff is set to show the tolerance zone offset to one side of the centre zero on

the meter, bringing the initial setting always visible on the meter. This is possible because the wheels are always adjusted from the same direction. A photograph shows the two meters and the tolerance cursors in the pit with a car above. For calibration purposes a stick pin serves to line up bushes in the cradle and pit at the correct mid toe-in angle. The pickoff is adjusted causing the meter to read mid tolerance at this setting.

The equipment has been running some months and has only been reset on two occasions. It has proved completely reliable. The same equipment could be used in any application where a steady-state condition and an oscillating one occur simultaneously and requires the steady-state indicated or gauged.

A car stands on the apparatus and at the same time the headlights are adjusted



A DIRECT ANALOGUE EQUIPMENT FOR THE STUDY OF WATER DISTRIBUTION NETWORKS

The principles of apparatus which provides a direct analogue of a water distribution network are described in this article. Electronic units are used as analogues.

By R. W. WILLIAMS,
Ph.D., A.Inst.P.*

A PUBLIC water supply system comprises one or more sources (reservoirs, pumping stations) feeding into a complex network of pipes from which consumers draw off their requirements at a large number of points. Provided the necessary data is available regarding the draw-off rates, the hydraulic resistances of the pipes and the pressures at the sources, the network equations may be solved to obtain a complete steady-state description of the system. An iterative method, named after its originator (Hardy Cross) has been available for many years as a practical means of solving the equations. However, the process is tedious and time-consuming. The optimization of the expansion of a system to meet future demands requires the examination of several different network configurations, each of which is associated with a number of different sets of input and loading conditions; the computing task then becomes immense. Even for an existing system, the distribution engineer must be prepared to adjust resistances and draw-offs, and repeat the solution several times before satisfactory agreement between observed and calculated figures is obtained. As a result of the widespread development of computing devices in recent years, the means of substantially reducing this burden are now to hand

Possible Techniques

There are three main approaches to the solution by computer of water distribution problems. In the first of

these, the Hardy Cross or similar iterative method is retained, but the computing time is very much reduced by the use of a general-purpose digital computer programmed to carry out the iterations. The second method employs a general-purpose analogue computer which is set up to solve the network equations; this it does by performing the Hardy Cross iterations in a sensibly instantaneous manner. Finally, there is the direct electrical analogue technique; here a model of the system is created in which electric current and potential represent flow rate and head respectively. Electronic units simulate the properties of pipes, loads and sources, and their interconnections correspond to those of the real system under study. The advantages and disadvantages of these methods may be summarized in the following terms:

Digital Computer:

The distribution engineer cannot programme a digital computer for himself without specialist training and at best the link between engineer and computer is weak and indirect. The initial stages of study, when it is necessary to adjust resistance and draw-off values until the model matches the real network, tend to be very tedious. The digital computer shows to better advantage when the model has been well established and solutions on a more-or-less routine basis are required. The general-purpose nature of the digital computer is of course attractive for economic reasons.

*British Aircraft Corporation Ltd.

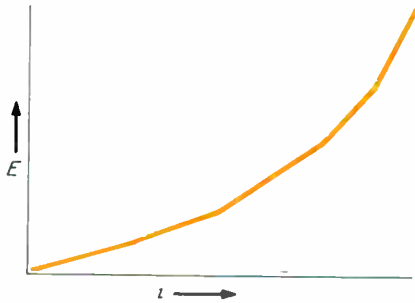
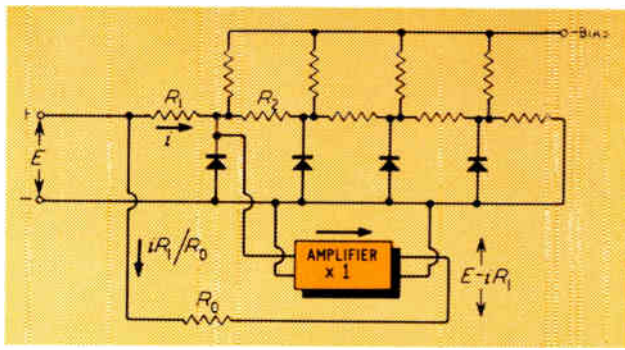


Fig. 1. Basis of pipe cell design

General-Purpose Analogue:

Here the link between engineer and computer becomes much stronger and the effects of adjusting the network conditions are quickly apparent. The solution is somewhat expensive since the technique is extravagant in its use of operational amplifiers and function generators. Training is needed before the distribution engineer can set the computer up for himself. The technique is adequate to meet casual requirements for network studies, the work being best done in computing centres at which trained staff is available.

Direct Analogue:

This technique is well suited to the needs of the distribution engineer, especially for studies of an exploratory nature and for the optimization of network expansion. No special training is required and the association between user and computer could hardly be closer. To achieve the best results, the equipment must be carefully designed, special attention being paid to the means of setting in and reading out the network data. The modest accuracy of analogue methods is not a serious hindrance when the limitations in the knowledge of the input data are considered. Since the installation is suitable only for distribution analysis, the economic case for its use must be established.

History of the Direct Analogue

Direct analogue equipment for fluid distribution studies was pioneered in the United States by McIlroy and in Europe by the German concern Montan-Forschung. Growing British interest in the subject led to the holding of a conference by the Water Research Association in 1962, the outcome of which was the setting up of a distribution analogue centre (WRADAC) at the Medmenham laboratories of the W.R.A. A Water Network Distribution Analyser (WANDA), developed by the Industrial Systems Group of the British Aircraft Corporation at their Stevenage works, is the main item of equipment in WRADAC and it has been in service there since the end of 1963.

Operating Principles of WANDA

WANDA employs three main types of unit—pipe cells, load cells and sources—which simulate the behaviour of the elements of the real system. Their modes of operation are now reviewed.

Pipe Cell

The flow of water at a rate Q through a pipe of hydraulic resistance R results in a head loss H , given by the equation $H = RQ^n$. The value of the index n is approximately 2. The pipe cell is a two-terminal network, to which the application of a voltage E results in the flow of a current I where $E = kI^n$; E , k and I are the analogues of H , R and Q respectively. Fig. 1 explains the basis of the cell design. When a voltage E is applied to the network of biased diodes and resistors, the diodes cease to conduct in turn as E increases from zero and so generate a succession of 5 linear segments, which approximate to the n th power law over the range $0 < E < 25$ V. The current i through the network is given by $E = k_0 i^n$. In order to embrace a complete range of k values rather than the single k_0 , use is made of a unity-gain amplifier of high input impedance and low output impedance, fed from the junction of the first two resistors (R_1 , R_2) in the law-forming network. The amplifier output is $E - iR_1$; if a resistance R_0 is connected between the cell input terminal and the amplifier output terminal, a current $\{E - (E - iR_1)\} / R_0 = iR_1/R_0$ flows through R_0 . The total flow I through the cell is therefore $i(1 + R_1/R_0)$. Substituting for i , we

have $I = \left(\frac{E}{k_0}\right)^{\frac{1}{n}} \cdot \left(1 + \frac{R_1}{R_0}\right)$, which re-arranges to give

$$E = \frac{k_0 I^n}{\left(1 + R_1/R_0\right)^n}$$

is thus a function of R_0 ; the use of a variable resistor enables k to be adjusted over a range of 10,000:1. Typically, $n = 1.85$ and at $E = 25$ V, the cell current lies within the range 2.6–380 mA. Protective circuits disconnect the cell from the network and warn the operator if the direction of current flow reverses or if E exceeds the design limit of 25 V.

Load Cell

In distribution practice, a consumer is assumed to draw water from the network at a constant rate of flow despite any variations in the head at his premises. The load cell must therefore have the E/I characteristic shown in Fig. 2, I remaining at a preset value I_0 . To realize the requirement, recourse is again made to a unity gain amplifier. The voltage across the cell terminals is E ; a floating voltage source V is connected in series opposition to E , so that the input to the amplifier is $(E - V)$. As in the pipe cell, a resistance (R_0) is connected between the cell input terminal and the amplifier output. The current flow through R_0 is $\{E - (E - V)\} / R_0 = V/R_0$, which is independent of E . Adjustment of V and R_0 enables the current to be pre-set

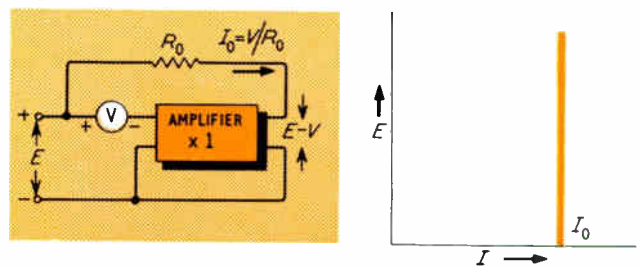
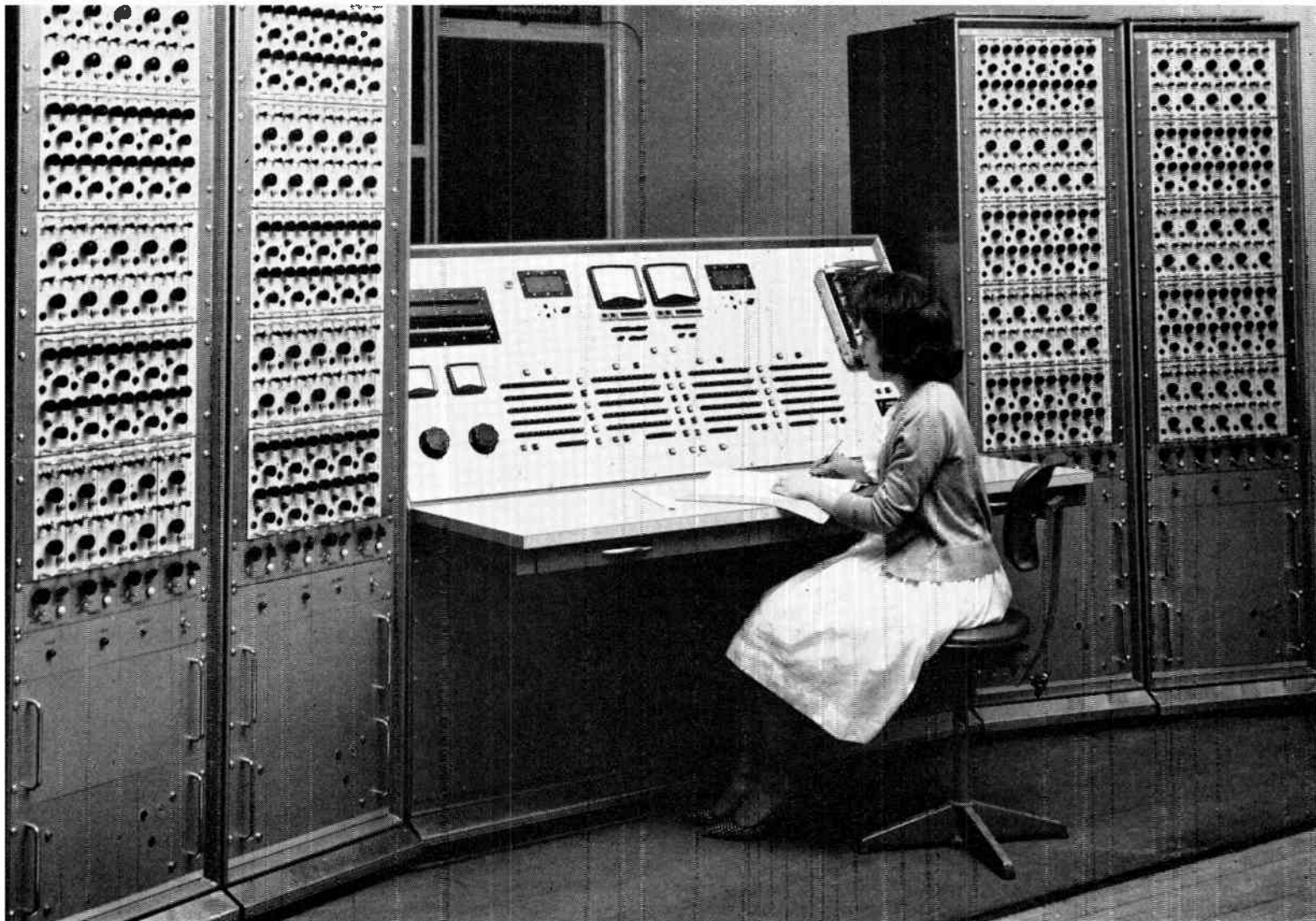


Fig. 2. Principle of load cell



General view of WANDA

anywhere in the range 0.1–50 mA. The constant current characteristic is realized over the range 0–50 V of the voltage across the cell terminals.

Source Units:

The sources are no more than stabilized d.c. power units of conventional design, each capable of delivering up to 500 mA at a voltage level adjustable over the range 0–50 V. The head/flow characteristics of particular types of water source are not simulated. When a source unit represents a pumping station, for example, it is adjusted to supply a certain flow at a certain head as required by the pump characteristics.

The Complete WANDA Installation

The complete WANDA equipment is shown in a photograph. Pipe cell and load cell units, each housing two separate cells, are installed in the racks in modular fashion. Each rack accommodates a total of 50 cells and four source units.

The racks are free standing and are connected by cables to the central console which provides the means for interconnecting, monitoring and controlling the individual cells and sources. Network connections are made on a removable patch panel; this enables problems to be set up and stored away from the equipment. Two digital voltmeters provide direct readings of head and flow; there are also standby moving-coil meters for these quantities. Every cell and source has its own monitor push-button on the

console panel; the operation of a button connects the head and flow meters in circuit with the selected cell or source.

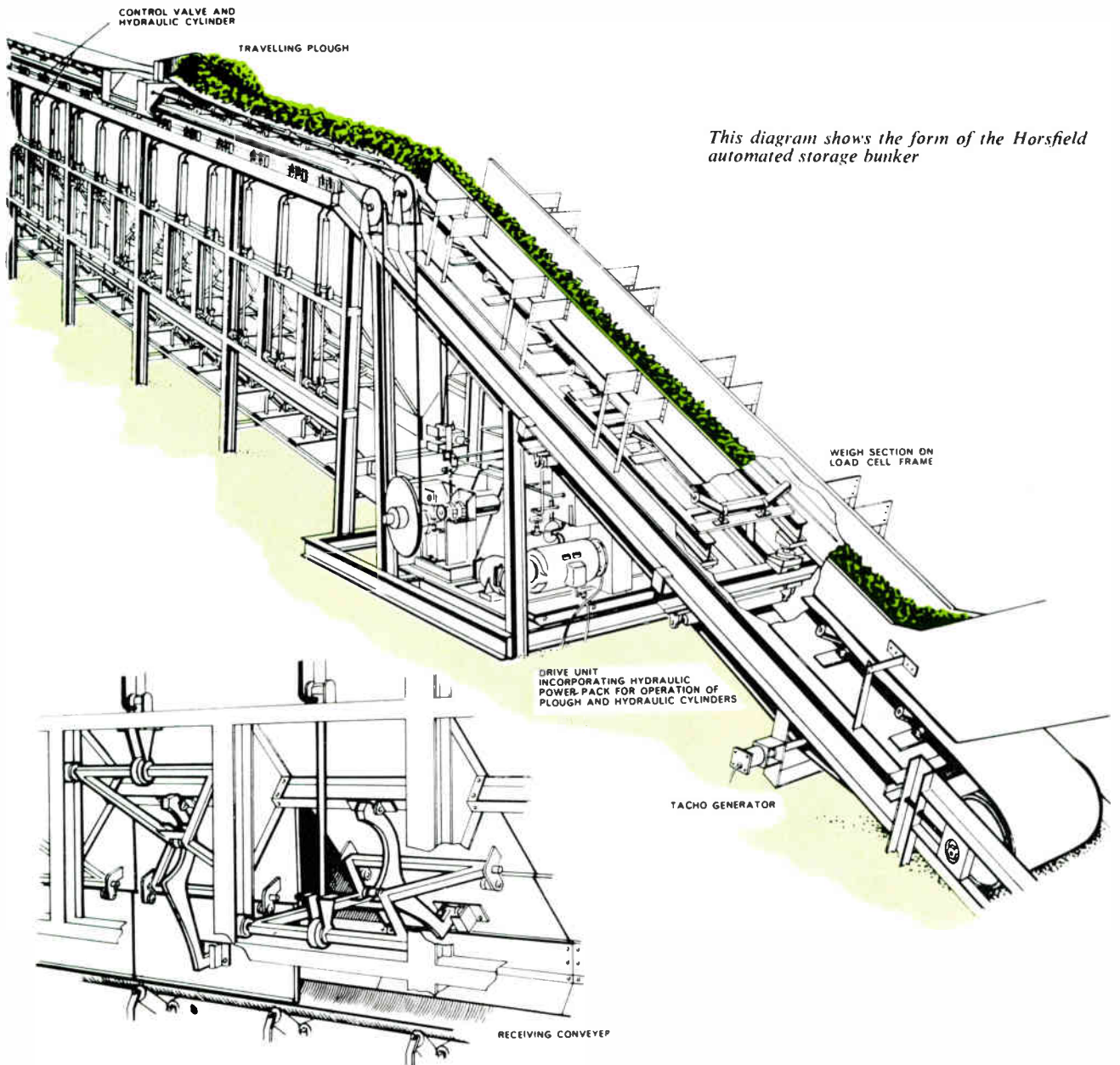
An important feature of WANDA is the use of variable rather than fixed values of the head and flow scale factors. Although the total possible range of hydraulic resistance is several millionfold, a range of a few thousand to one is all that is necessary in any one problem. The variable scale factor feature gives full coverage of the resistance spectrum without requiring more than one model of pipe cell for its realization. Push-button switches permit the selection of one head scale factor from a total of four values (0.125, 0.25, 0.5, 1.0 V/ft) and one flow factor from a choice of six (0.5, 1.5, 5, 15, 50, 150 mA/million gallons per day). When scale factors are selected, the series and shunt resistors of the head and flow meters are changed automatically to maintain their direct reading properties.

In the load cell, the source V is derived from a transformer/rectifier circuit. If the transformer primary is excited from a continuously-variable autotransformer, V may be remotely controlled. The console design enables load cells to be grouped together and their draw-offs simultaneously varied by the same percentage change about their nominal levels, using this technique. This feature is very convenient during the study of network expansion problems; two groups may be selected and controlled independently.

Transistor circuits are used throughout WANDA and the equipment operates in an ordinary office environment, requiring only a standard a.c. mains supply.

AUTOMATIC CONTROL OF

A digital system for controlling automatically the capacity of a storage bunker for coal is described in this article. The bunker is used between the conveyor from the coal face and the output conveyor so that the latter may have a constant loading despite large variations in the coal coming from the face.



This diagram shows the form of the Horsfield automated storage bunker

MINERAL BUNKERS

By G. COOPER*

MANY systems for which digital logic and numerical methods are used can only be tackled by such techniques, and some of the articles of this series have described such equipments. There is, however, a perhaps larger class of problem which can (in principle at least) be solved by more than one technique, and the application to be described here is in this category. This application looked at first sight more suitable for analogue methods until it was fully studied, and the way in which the eventually-used digital-control system evolved may be instructive.

Both mechanical equipment manufacturers and the National Coal Board are at present giving increasing attention to the problem of the efficient handling of mined coal, both underground and on the surface. This problem is made difficult by the fact that the output of a modern mechanized face is far from uniform throughout a shift. The average output, taking into account zero-output periods while the face is advanced, is only a fraction of the peak output which occurs during the actual traverse of the coal-cutter across the face.

One approach to the transport problem underground is to use a bunker to store temporarily the peaky flow from the face, and to discharge to the main underground trunk road conveyor belts a uniform flow. This means that the conveying equipment and handling equipment following the bunker need not be rated to cope with peak output flows, and also that the all-important coal face can

be kept working in the event of hold-ups on the conveying and winding systems.

One of the several types of bunker used for this duty is shown diagrammatically in Fig. 1. The bunker is basically an open trough-like structure commonly between 50 ft and 300 ft in length and holding, when fully loaded, about one ton of coal per foot of bunker length. The bottom of the bunker consists of a series of independent doors 3 ft 4 in. in length, opened and closed by hydraulic power controlled by the motion of a plough, which can traverse above the full length of the bunker.

The function of the plough is two-fold. First, it is required to plough off coal from the incoming conveyor belt, which runs over the bunker for its full length, so that the bunker can be loaded progressively from one end. As the plough travels from right to left, it closes the doors (originally all open) a few feet in advance of itself, and puts, as it were, the bottom into the bunker. As it travels back from left to right, it reopens the doors behind it. The action of the bunker can perhaps best be understood by considering the response of an empty system to a peak coal flow, followed by a period of low flow. When the bunker is empty, all the doors are open, and all the flow of coal passes straight down through it on to the output conveyor which runs beneath it. If the flow now builds up to a rate greater than the desired output, the plough is moved forward, closing the first door and allowing the surplus coal to fill into the bunker. The plough must continue to move forward at an average speed proportionate to the excess coal flow, closing further doors to create

* Lancashire Dynamo Electronic Products Ltd.

Interior of the bunker



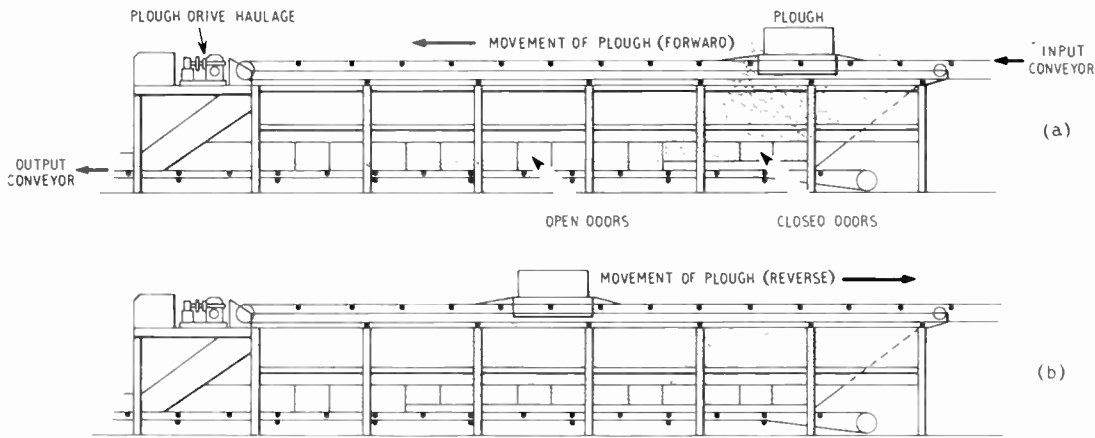


Fig. 1. With a high input flow of coal, the plough moves slowly to feed the required output tonnage and bunker the surplus. With a low input (b) the plough moves back to feed the input straight through and to make up the shortage from the bunker

additional storage capacity as it does so. If the input flow now decreases below the desired level the plough is moved back, allowing coal to spill from the bunker as the doors are opened, so as to 'make-up' the input flow to the required uniform output flow.

To operate this type of bunker manually requires the uninterrupted attention of an operator, who judges the plough movements required to load the bunker and to give the required output flow. Automation has the dual purpose of eliminating the operator and improving the consistency of output control. The control action required, therefore, is at first sight no more than a simple (possibly analogue) system controlling the forward or reverse speed of the plough proportionately to the 'error' between the actual input rate and the desired output rate.

Unfortunately, however, the input must be weighed at a fixed point, by using a continuous belt weigher at the input end of the bunker; but the plough which is actually to be controlled may be anywhere along the bunker. The input conveyor speed is typically of the order of 250 ft.p.m. and therefore the 'transport time' of the coal from weigher to plough in a 300-foot bunker may range from a few seconds up to well over a minute depending on the contents of the bunker at the time.

The peak input flow may be 600 tons per hour, and, therefore, anything up to 12 tons of coal could be lying along the input belt between the weigher and the plough at any particular time. Further, it is often necessary to stop mine conveyors for periods of several minutes, so that the means of transmitting the information about the coal lying between weigher and plough must be capable of holding its information for quite long periods of time without degradation.

The best way of constructing a suitably robust 'transport time' simulator appeared to be to use digital techniques in the form of a shift register constructed from transistor binary elements such as were described in an earlier article, since no comparable simple and robust analogue storage technique is available.

The 'rate of input flow' information from the weigher could be averaged over perhaps 5 seconds, digitized, and fed to the shift register as a number representing 'input rate'. An information transmission accuracy of about 1% would be suitable, and thus the '5 sec mean rate' could be stored as a seven-digit binary number (1 part in 128). Since the shift register must hold the information for the minute-plus the coal may take to traverse the input conveyor (if the conveyor is stopped, the shift signals to the register will be stopped also), there will in this time be 15 rate-of-flow samples (at 5 sec intervals) and the minimum size of the register will be 15 lines each of seven

digits, making a total of 105 binaries in all. While this number of binary units is not impossibly large, nevertheless a considerable bulk, cost and complexity is involved and this solution was not immediately attractive.

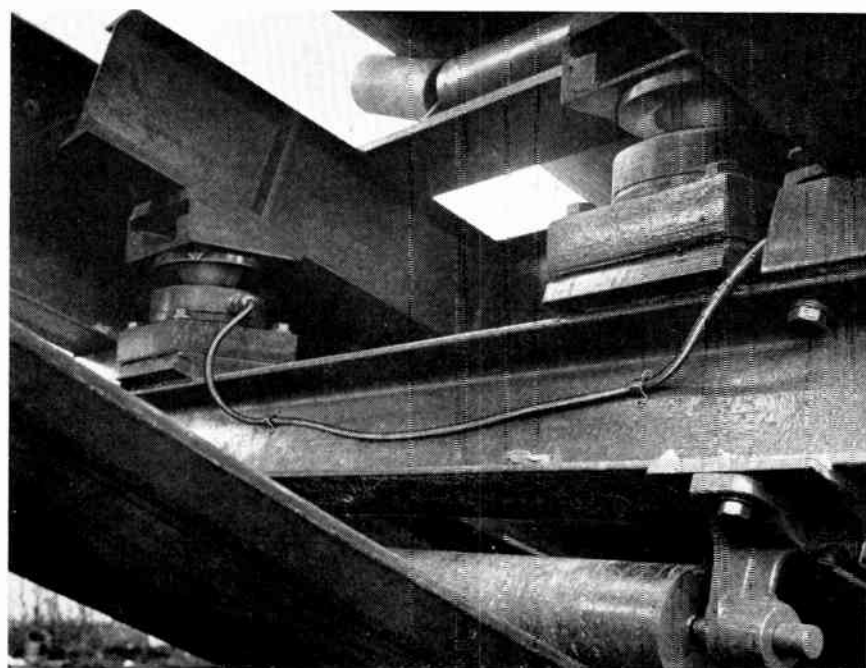
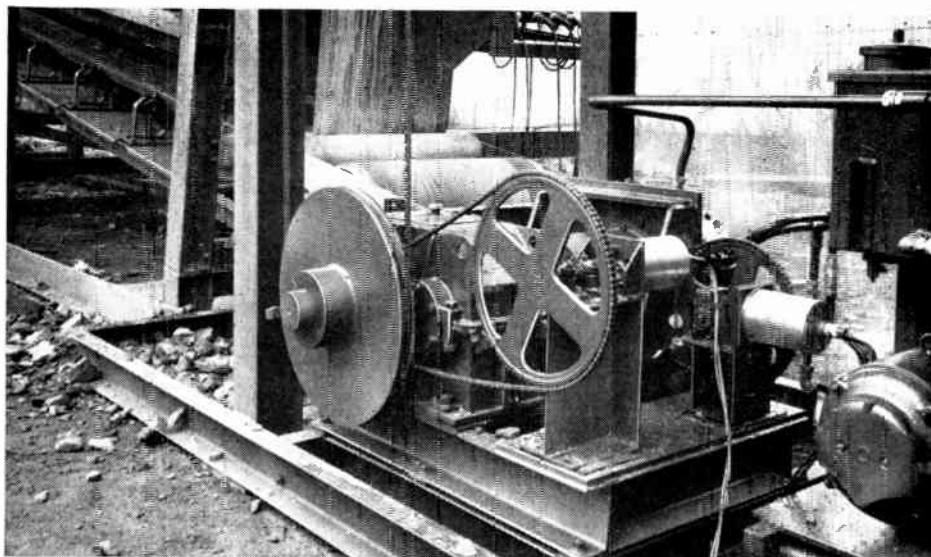
Quantity Control

So far the problem had been examined as a 'rate-of-flow' control. But the bunker is fundamentally a structure for containing a *quantity* of coal, normally of the order of 1 ton of coal per foot of length of the bunker. Thus, for instance, advancing the plough by 10 feet along the bunker (which automatically would cause the appropriate bottom doors to close) would create an additional capacity of 10 tons of coal. Might it not, therefore, be possible to devise a 'quantity' control system rather than a 'rate' system?

If the weigher output, which will normally be available in the form of a 'rate' signal, say 1 volt/ton/minute, on an electrical retransmission output, were to be fed to a conventional electronic integrator, the integrator output would rise proportionately to the amount of coal run over the weigher. If now the integrator output were fed to a 'Schmitt trigger' type of circuit, which turned on when, say 0.01 ton has run over the weigher, and in turning on both generated a pulse output and reset the integrator to zero, then the integrator would cycle continuously, giving a chain of output pulses of 0.01 ton significance. Clearly, 0.01 ton is far too small an increment to be significant in terms of controlling the plough, and, therefore, the pulses could be fed to a 'divide by 50' binary counter, which would give output pulses of 0.5 ton, a much more suitable increment. Since, in our example, the maximum possible quantity of coal on the input belt between plough and weigher is 17 tons, then 24 binary circuits would store the information about all the '½ ton increments' which could be in the 'transport lag' at any time. Effectively, therefore, the '15 × 7' shift register could be reduced to a '24 × 1' register; i.e., less than a quarter of its former size. This was clearly a promising line of thought worth further investigation.

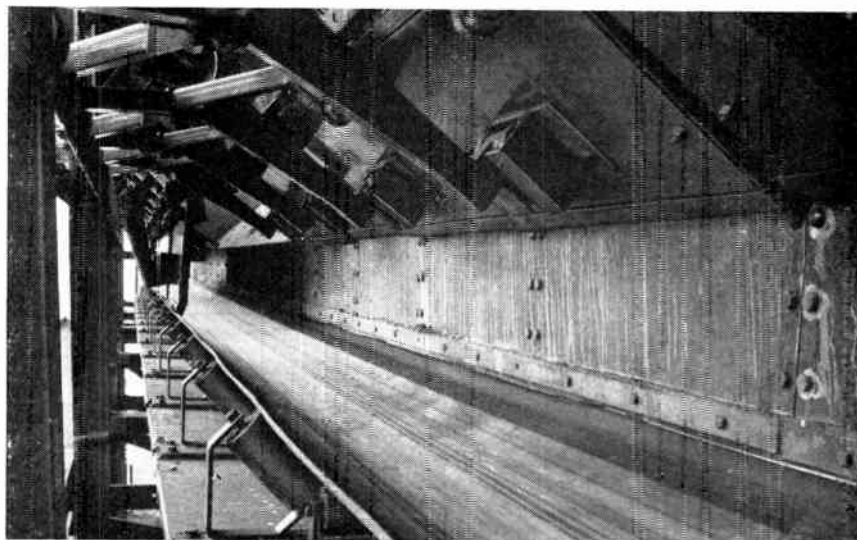
A simple 24-line shift register is not the whole solution to the problem of obtaining a picture of the input at the plough, however, since the plough is not always at the far end of the bunker and the transport lag is consequently not always of the same duration. Arrangements must, therefore, be made either to take off information part way along the shift register, in the same way as the coal is taken off part way along the input belt when the plough is not at the far end of the bunker, or alternatively, under these conditions, the rate of travel of the information through the register must be accelerated as the plough comes nearer to the weigher.

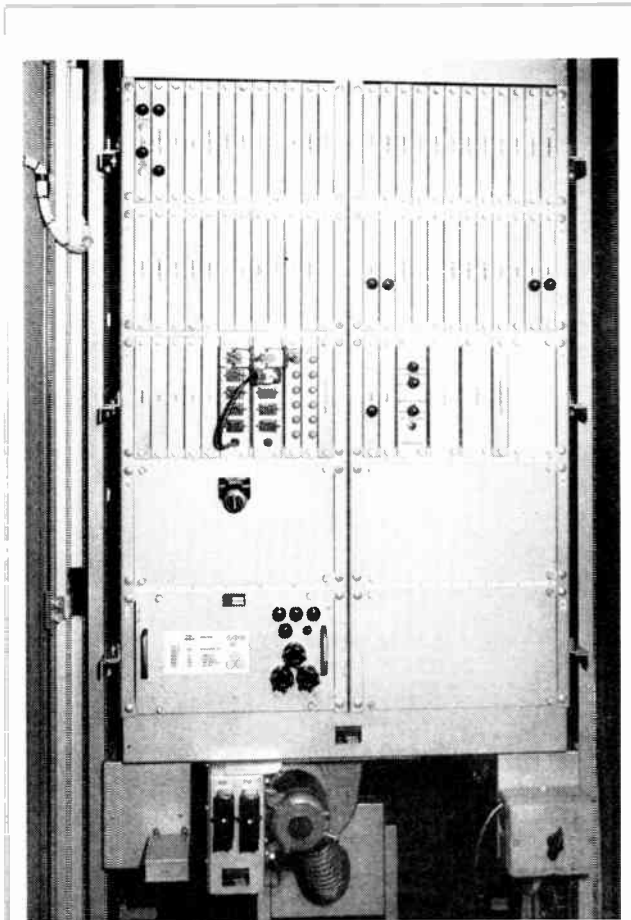
Hydraulic haulage unit, showing electromagnetic pulse generators for plough position and travel feedback



Load cell input weigher

Output conveyor with bunker doors (closed) above





Control logic rack, showing monitoring, plug-in units, power supply and ventilating fan

The control panel for the electronic apparatus



It turns out that this latter is the more economic solution. Information of the plough position is obtained by driving an electromagnetic digitizer (see photograph) from the wire-rope haulage which pulls the plough up and down the bunker, the gearing being such that the digitizer turns through one complete revolution as the plough travels the length of the bunker. The digitizer output is a five-digit binary number, so that effectively the length of the bunker is divided into 32 zones, defined as '00000' (0) to '11111' (31), the number decreasing as the plough approaches the weigher. Each digit of the digitizer output is used to close a sealed reed relay. The contacts of the five reed relays are now used to connect capacitors of binary-coded values to a resistance-capacitance timer (2^0 digit, $1 \mu\text{F}$; 2^1 digit, $2 \mu\text{F}$; 2^2 digit, $4 \mu\text{F}$, etc.). Thus, the total timing capacitor is proportionate to the distance of the plough from the weigher. Hence, the timer delay is also proportionate to this distance, and if the timer is arranged to be continuously re-cycling, then the time between resetting pulses will be similarly proportionate. These resetting pulses are now used to provide the common shift to the shift register. It will be seen that the information relating to a particular section of coal will always reach the output of the shift register at the same time as the coal reaches the plough, since the time taken for the complete transit of the register will be proportionate to the weigher-plough distance. If, as briefly mentioned earlier, the input conveyor is stopped, the recycling timer is arranged to stop also, so that the shift pulses stop. The profile of coal on the input conveyor is now stored in a stationary pattern of 'set' and 'reset' states of the binaries, and can be held indefinitely, until the conveyor is restarted.

Control Logic

We have now information available in the form of 0.5-ton input increments at the plough, and clearly it is relevant to investigate the possibility of making the rest of the control system work on 'quantity' rather than 'rate', and in a digital rather than analogue manner.

This turns out to lead to a remarkably simple solution. The block diagram of Fig. 2 shows the main features of the control system adopted. The error counter is the heart of the system, and consists of two parts. The actual counting is done on four binary units, which together with associated logic circuits controlling the gates, form a reversible counter with a capacity of 16 counts. The counting section has two inputs, one for add and one for subtract pulses. The error counter is required to be able to accept four inputs from the control system, however, two add and two subtract. Further, these four inputs are randomly spaced in time, and may sometimes be coincident. An input spacing section is, therefore, added to the front of the counter, whose function is to store the four input signals temporarily on four flip-flops, and then, by scanning the flip-flops in order under the control of a four-binary ring counter, extract by resetting action any stored input pulses and feed them to the add or subtract lines of the reversible counter as required.

The upper add input is fed from the output of the transport lag shift register, and therefore the error counter will be counted up by one digit every time 0.5 ton of coal reaches the plough. The lower subtract input is fed from a pair of delay-on units, so connected as to recycle continuously, generating an output square-wave. The frequency of this square-wave simulates the 'output demand' for which the bunker has been set up. Thus if, for instance, the 'output demand' is 300 tons per hour (equals 5 tons/

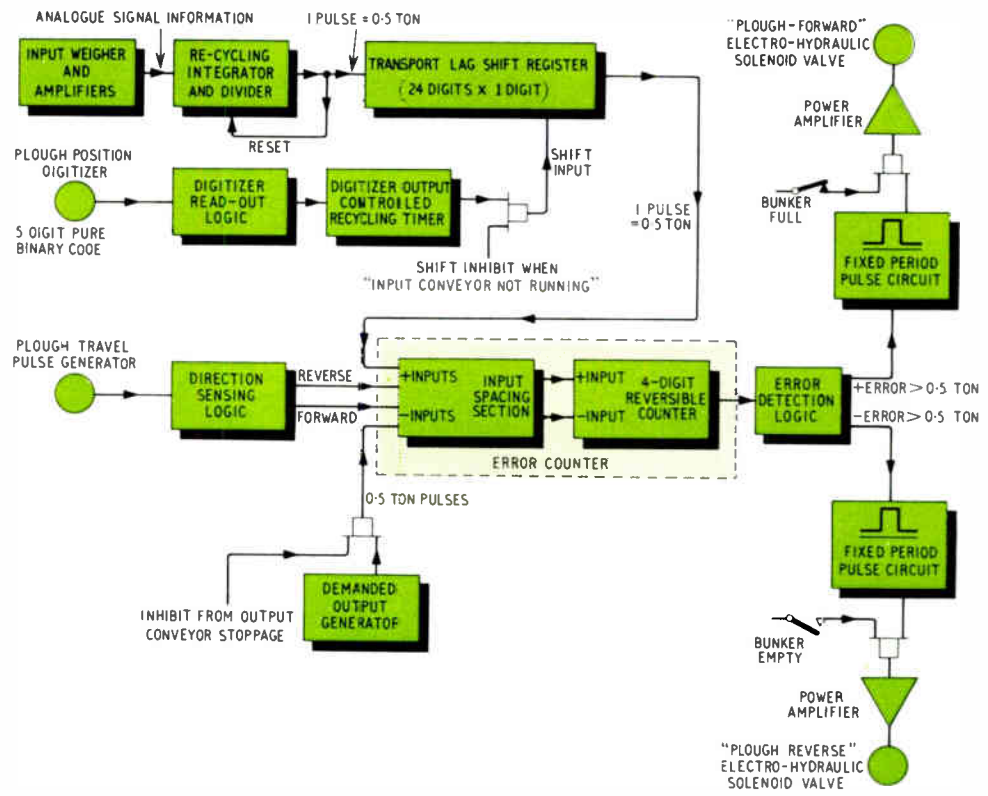


Fig. 2. Block diagram of bunker control system

minute), then the delay units run at 10 cycles per minute, providing a chain of 0.5-ton significance output pulses. The remaining add and subtract inputs are fed from a plough travel pulse generator driven from the plough haulage in the same manner as the plough position digitizer. This pulse generator is, in fact, an identical unit to the digitizer, but the output is taken from one of the digit outputs only, in the form of a chain of pulses as the pulse generator revolves in response to plough travel. The drive ratio is selected so that one pulse is generated for every 0.5 ton of bunker capacity (6 in. approximately) over which the plough moves. A train of pulses is also taken from a second pick-off on the same digit track, which is 90° out of phase with the first. By using these two trains of pulses in conjunction with a small amount of logic circuitry, it is possible to detect in which direction the plough is travelling. The two chains of '0.5-ton capacity' pulses so obtained are fed to the counter, the pulses generated as the plough is closing doors (and hence creating bunker capacity) to the 'subtract' input, the reverse pulses to the 'add' input.

If at a particular time the input flow at the plough equals the demanded output, therefore, the counter will stay at or near zero, since the add and subtract counts from the input and demanded output will over a period be equal. No movement of the plough will be taking place, so that no plough travel signals will reach the counter from the plough travel pulse generator to upset this equality.

If now the output demand drops, say, to zero, because the output conveyor has been stopped, then the output demand pulses will stop, and the counter contents will start to rise in a positive direction. This departure from zero, which effectively means that an excess of coal is building up, is detected, and causes a fixed-period energization pulse to be fed to the electro-hydraulic valve controlling the forward movement of the plough. The period is selected so as to give a total plough movement during the increment equivalent to 0.5-ton of bunker capacity. This plough

movement causes the plough travel pulse generator to generate a 0.5-ton capacity pulse in such a sense as to reduce the positive counter content, the excess of coal having been catered for by the creation of bunker capacity for it.

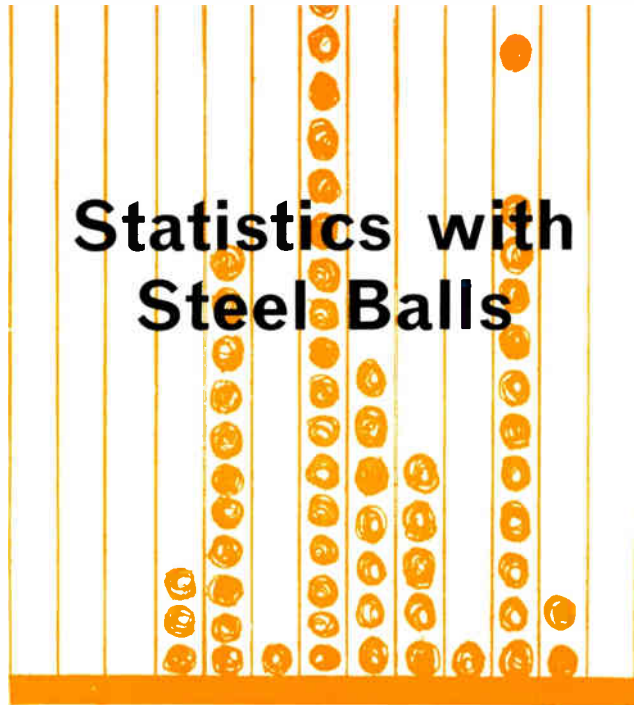
Shortage of input over demanded output initiates a similar corrective plough movement, the counter this time going negative, and the plough moving in a reverse direction to open doors and release stored coal. These forward and reverse plough movements continually balance the variations of input flow conditions to provide the required output, coal being stored and discharged as necessary.

The essential simplicity of the eventually-adopted system is of considerable advantage in mining conditions. Since after the weigher only ON/OFF signal levels are present, system monitoring can be carried out with only test lamps.

Although the prototype was constructed in an industrial-type housing for system proving in a surface closed-circuit experimental installation all the equipment used is suitable for intrinsic safety certification, and in fact the first underground bunker control systems are now being installed. These are actually being used on different types of bunkers to the type described above, but the control system design is virtually identical for all the types of bunker in use, the small necessary variations being readily catered for by virtue of the standardized modular construction used.

The single bunker control described above is only a start in what can potentially be achieved in the automatic control of underground bunkers. Although not strictly admissible in a series of articles dealing with the practical and the proven, it is worth noting that the digital techniques used are very easily extended to permit several bunkers feeding into a common conveyor or winding system to be integrated in their action so as to maximise the use of the available bunkering capacity by allocating feed rates to individual bunkers in proportion to their contents. System studies for this work are currently being undertaken.

Statistics with Steel Balls



AN unusual application for Hoffmann steel balls is their use in a statistical analyser. The machine graphically displays the distribution curve derived from a sequence of tests. As each test result is received a steel ball is dropped into the appropriate one of a hundred slots provided in a plastic display panel. Thus at the end of a run, the pattern of results is immediately apparent. The varying heights of the columns of balls indicate the number of results obtained in each measurement band.

An interesting feature of the machine is that a permanent record of a statistical display can easily be obtained by placing a piece of dye-line paper over the front of the transparent plastic panel and then switching on a light provided at the rear to expose the paper. When developed, the paper constitutes a permanent record of the readings taken.

Originally devised in the Psychological Laboratory of Cambridge University as a means of recording muscle reaction times, the histogram plotter is now being developed commercially by Datran Ltd., of Hitchin. It is envisaged that the machine will be of value in mass production industries for monitoring the performance of automatic machines. For example, supervisors will be able to see at a glance the variation in critical dimensions of parts as they are being produced, or changes in the gross weights of automatically

packed products. The histogram plotter could also be employed for such purposes as recording transistor parameters. In fact, machines of this type would prove of value in all those situations where variations in the quality of a standard item have to be controlled.

The display panel of the plotter comprises two Perspex sheets, one of which contains one hundred channels. These sheets are mounted face-to-face and supported in the vertical plane. A small carriage fitted with a potentiometer wiper arm is provided which can be traversed across the top of the display panel. This carriage transports the steel balls, one at a time, from a hopper to the appropriate channel of the display panel. A mechanism releases balls singly from the hopper, and the carriage is equipped with an electromagnet which is capable of picking up one ball.

Electrical input signals within the range of 0 to 5 V d.c. are used to operate the machine.

Upon a recording cycle being initiated the carriage with a ball suspended below the electromagnet is traversed outwards from the loading position across the top of the display panel. When the voltage fed back from the wiper arm as it moves across the potentiometer equals the input signal voltage, the current to the electromagnet is switched off and the steel ball drops into the appropriate channel of the display panel. The carriage is then returned automatically to the loading position and another steel ball is picked up ready for the next recording cycle.

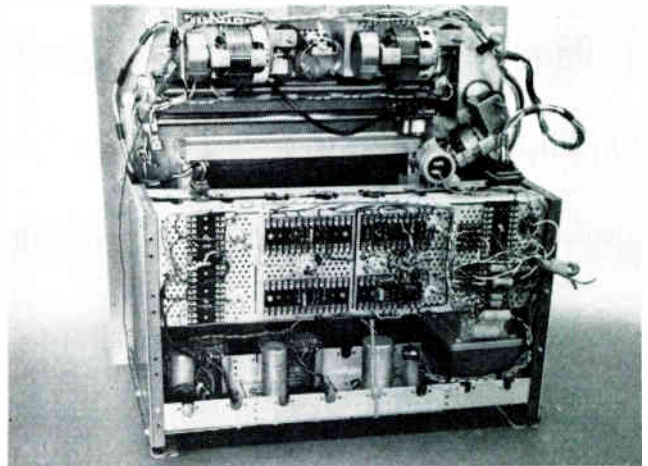
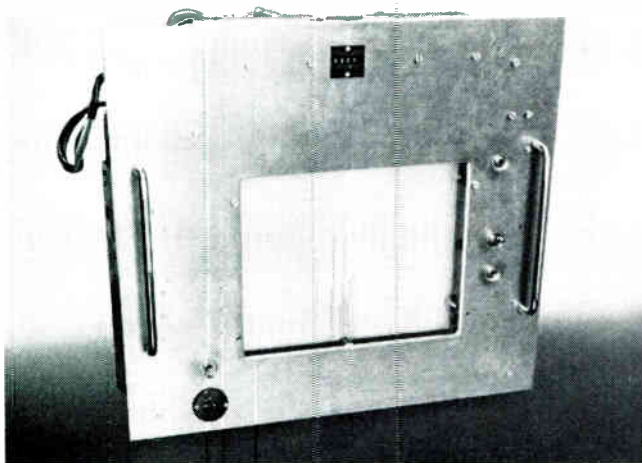
Recordings can be made at a frequency of one per second to an accuracy of $\pm 1\%$. That is, to \pm one channel on the display panel. The feedback voltage from the potentiometer can be matched with the input signal voltage received from the gauging device to an accuracy much better than 1%.

Each channel of the display panel can accommodate 100 balls. And the hopper can hold more than 10,000 balls, sufficient to fill all hundred channels of the machine.

One of the advantages of this machine from a statistical point of view is that no result can be recorded more than once. Should the carriage stop midway between two channels, chance will determine into which channel the ball falls when it is released. With other recording devices it is possible for a marginal reading to be either missed, or registered in two adjacent channels.

A counter on the front panel of the machine records the total number of readings taken: i.e., balls dropped.

Application has been made for patents covering the design of the machine.



Left: The front of the prototype statistical analyser. Right: A view of the inside of the analyser

BREWER SYSTEM

By C. D. FRUIN*

THERE are many situations where small costly items must be quickly available when required but securely controlled against unauthorised use. The trend to miniaturization of electronic components, the use of additives in chemical processes, and the industrial use of precious metals are examples of items used in manufacturing processes which lead to stock control problems.

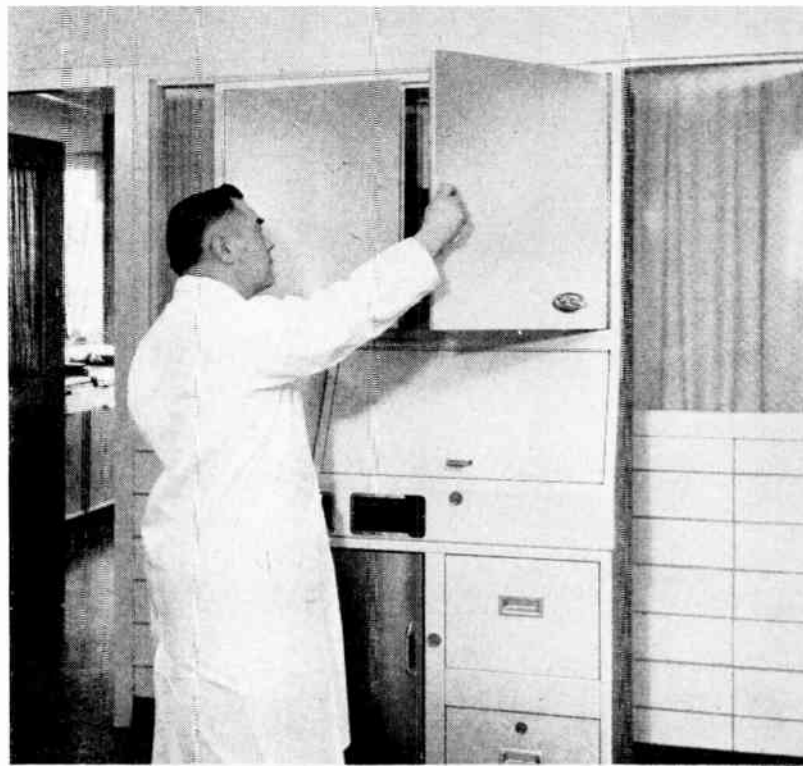
While it may be possible to predict requirements of a certain material over the next week or month, management is often unwilling to lose control over stocks by releasing them before the time they are to be used. The fact that the material is not immediately available may be particularly serious at night, or when the point of use is remote from the store. Another field where this problem arises is in the control of drugs in hospitals. The drug control problem is not very different from industrial security problems. It is essential that drugs are available whenever they are needed; but it is also important to guard against their misuse, whether accidental or deliberate.

About two years ago, the Brewer Pharmacal Engineering Corporation of Pennsylvania developed the Brewer System which provides a method of controlling the flow of drugs in hospitals. This system is now being marketed in Europe by Elliott Medical Automation Ltd. Details of the Brewer System are given here, so that the industrial applications of this equipment may be more fully appreciated.

In a hospital using the Brewer System, drugs are pre-packed in the pharmacy in boxes which will hold an average four to seven days' supply for an individual patient. The drugs may be in the form of tablets, ointments, injection ampoules, or liquids. By predicting probable drug requirements, the pharmacist is able to prepare the boxes at times convenient to the work of the department, rather than making up a prescription at the time he receives it. Peak work loads can thus be avoided.

As required, once or twice a week, the boxes, labelled with drug name, strength, quantity and batch number, are transferred to the Brewer Drug Station. This is a locked, electronically-controlled unit for the storage and automatic issue of drugs in the hospital ward. Alternatively, the station may be sited in a branch hospital whose drugs are supplied from another hospital in the group. The dimensions of the station on its base are 42 in. by 24 in. high. If the base designed for storage of bulk items is not required, the station may be mounted on a wall. The drug station has

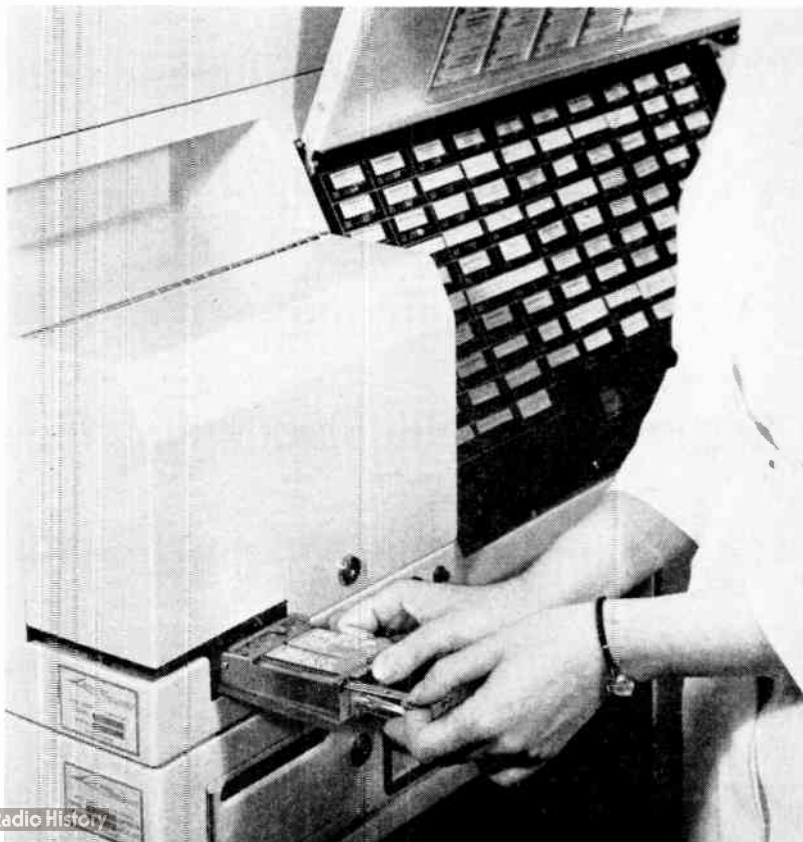
* Elliott Medical Automation Ltd.



Pre-packed stocks are loaded into the station which is then locked

A method of stock control which enables authorized persons only to obtain quick access to any desired item is described in this article. Originally designed for storing drugs in a hospital, it can be applied equally well for any small but valuable articles.

Embossed plate identifying required stock item is selected from panel on right. This plate, with plates identifying patient and nurse, is inserted into recording section





*Plates pushed into station with record voucher.
'Start' button is pressed*

Package delivered



three sections: drug storage bins; drug selection and issuing section; recording section.

The pharmacist has sole access to the drug storage bins which can hold 96 different drugs and up to eight boxes of each. Two or more bins could of course be used for a particular drug in heavy demand. After the pharmacist has loaded the boxes into the bins, he locks this section, so maintaining complete control over the ward stocks.

To obtain a box of a drug, it is necessary to put in information identifying the drug required, the patient for whom it has been ordered, and the nurse who is obtaining the supply. A package containing the required drug is then delivered, together with an automatically-printed label for the box. At the same time copies of the data are made for costing and stock-control purposes.

Data is stored in the equipment in the form of embossed plates; and three of these plates are required to operate the unit. The drug selection panel has 96 labelled slots each holding a plate. The nurse unlocks the door to this panel and selects the plate, which identifies the required drug. Removing the plate operates a micro-switch connected to the corresponding storage bin.

To complete the circuit, the drug plate is inserted in a shuttle in the recording section together with a patient plate and the nurse's personal identification bar.

When all three plates have been inserted together with a record voucher and the shuttle has been pushed home into the recorder, a 'start' button lights up to indicate that the station is ready to deliver the drug ordered by the doctor.

When the nurse presses the button, the required package is ejected from its bin, interrupts a beam falling on a photocell, and starts the printing cycle. The shuttle is locked in position until the information embossed on the plates has been printed, both on the record voucher and on a paper tape retained by the recorder. The voucher has a label portion which is attached to the drug box and duplicate copies for stock control and costing purposes.

If a bin is empty and no box is discharged, the printing cycle is not started and an 'empty' signal lights up.

After each transaction a 'replace plate' light indicates that the nurse must return the drug plate to its slot in the drug plate panel before removing another plate. If she does not do so, or inadvertently removes a second plate, an electronically-controlled alarm sounds.

The labelled box is transferred to the patient's individual drawer in the Brewer Medicine Trolley. This is designed to contain all the drug requirements of a ward. A patient's individual drugs are normally in his drawer. Medicines still required in stock bottles are kept in large drawers in the trolley. A separately-locked drawer accommodates dangerous drugs. The top of the trolley is used as a working area for the preparation of individual doses. It holds disposable medicine cups, syringe containers, forceps and swabs.

The nurse wheels the trolley to the patient's bedside, prepares an individual dose from the patient's supply and records the administration on a specially designed indexed card system.

By the simple procedure described taking 10-15 seconds, the nurse can obtain drugs from the drug station at any time. The drug container is legibly labelled, and control information is prepared for hospital management. At the same time each transaction is permanently recorded on tape within the recorder.

In the case of a branch hospital having no full-time pharmacist it is particularly useful to be able safely to increase drug stock in this way to cover 90% of the hospital's requirements. Division of responsibility for drugs

is clearly delineated; the smaller hospital's drugs can be supplied at bulk prices, and re-ordering procedure is simplified by the automatic recording of drugs used.

Industrial applications of the system are to be found where it is desirable to make components and material available at the point of use rather than in stores. At night, when the stores are shut, use of the system may have particular value.

Each foreman or charge hand authorised to use the system would be issued with a key to the stock-selection area, and an identification bar for which he would be absolutely responsible. To obtain an item from the unit, he would have to insert an embossed plate identifying the item required, a second plate for the process in which the item would be used, and his identification bar.

The data produced at the time of issue would be used for stock control and costing. Coded information may be embossed on the plates if this is required.

The industrial use of this system, designed originally for hospitals, will be an interesting reversal of the more usual adaption of industrial techniques for medical purposes.



Printed label is attached to package. Unit retains copy of data on tape

BY TV TO THE CONTINENT

This year well over 500,000 cars are expected to pass through the Dover car-ferry terminal en route to Calais, Ostend and Boulogne. Most of the drivers will be unaware that their progress through the terminal is being observed on television screens showing pictures from six cameras covering the area from the entrance to the ferry berths.

The Dover Harbour Board has installed closed-circuit television, supplied by Pye Telecommunications Ltd., to assist the control of traffic.

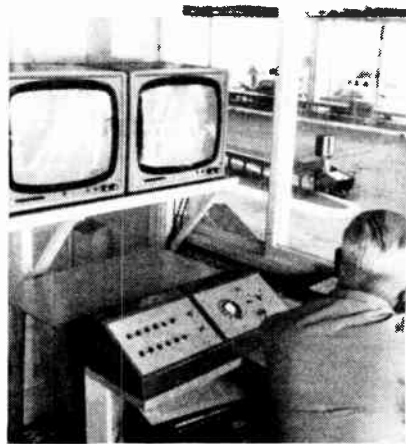
A control room with two 19-in television screens capable of showing pictures from six cameras enables the traffic

controller to spot any likely bottlenecks and to give instructions over the public-address system to maintain an easy flow of traffic.

The cameras are remotely controlled by a telephone dialling system, which automatically selects the required camera for focus, rotation and tilt action.

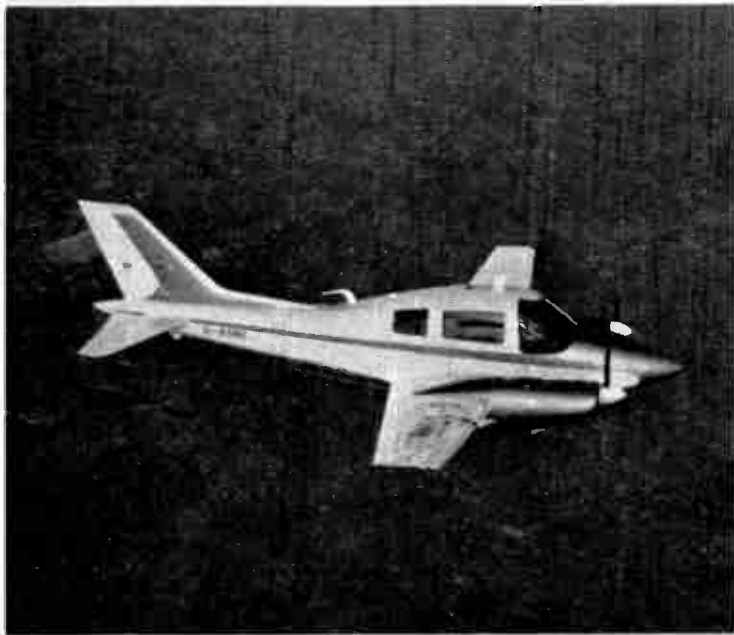
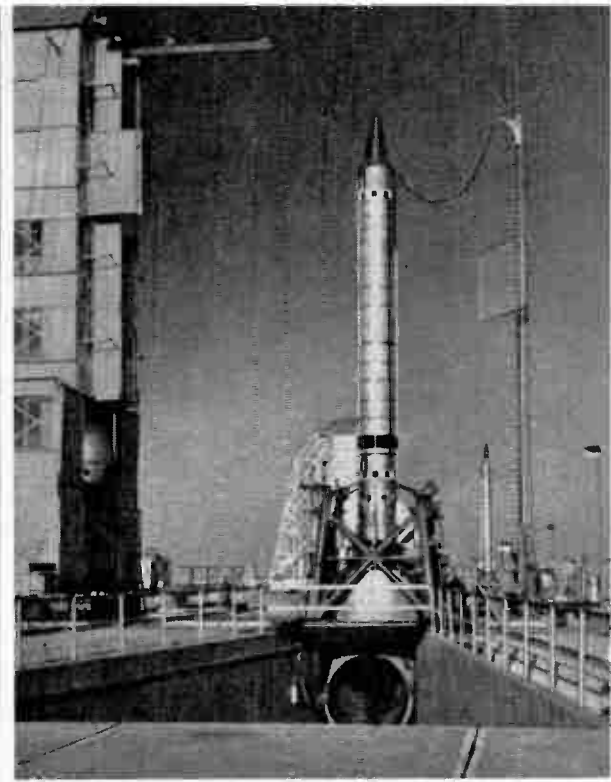
Drivers arriving at the waiting area are given visual instructions from a large illuminated sign. This shows sailing and loading times as well as destinations. The information board is operated by push buttons direct from the control room.

This picture shows one of the cameras overlooking the entrance to the terminal. Inset is an illustration of the control room where pictures from cameras installed by the ferry berths can be seen on the monitor screens





Farnborough



Air Show 1964



THE S.B.A.C. Flying Display and Exhibition at R.A.E. Farnborough is the British Aerospace Industry's shop window. This year's show of The Society of British Aerospace Companies, held from 7th to 13th September, was the twenty-fourth in the series.

Through the years the face of 'Farnborough' has been changed by the growing needs of modern craft. One of the most radical changes has been brought about by electronics. Now electronic equipment is as essential to aircraft as engines. And so, more than ever, this year the show reflects the increasing demand for electronics in aeronautics.

This review of the show deals with some of the electronic equipment, most of which, though designed specifically for the aerospace industry, is in principle applicable to other fields.

RADIO COMMUNICATIONS

Radio communication systems with output powers ranging from a few hundred milliwatts to hundreds of watts were to be seen everywhere. The main trends include transistorization, with the resulting reduction in weight and power consumption and 'modularization'. Modularization, a phrase we hear so often, indicates that the equipment is built up of a number of separate sections. However, in a great number of cases it is now intended to indicate that the modules of a system are compatible and can be assembled together in various combinations to provide different equipments from a standard range of units. The obvious advantage to the user is that 'tailor-made' equipments are possible at quantity-production prices.

The Cossor Communications mobile v.h.f. f.m. radiotelephones CC.301, 302, 303 and 304 (49), introduced at the show, typify this trend. Based on a number of interchangeable printed-circuit boards, these four basic robust and easy-to-service radiotelephones cover a very broad field of application. The 301 has an output power of 10 W and is recommended for use on motor-cycles, trains, tractors, etc. The 302 is a 25-W unit for under-dashboard mounting in cars and commercial vehicles. Somewhat similar, the 303

provides 25-W output and is intended for luggage-boot mounting with a separate control unit. The final unit of the series, the 304, provides an output of 40 W and is designed as two separate units like the 303. All operate in the 35 to 174 Mc/s band and are powered from a 6-12 V or 12-24 V d.c. supply. The latter three models can also be used as public-address amplifiers.

One of the smallest radiotelephones was shown for the first time by Amplivox. This is their 'Televox' pocket-sized v.h.f. transceiver (50). Housed in a $6\frac{1}{4} \times 3\frac{3}{4} \times 1\frac{1}{4}$ in. case, it provides a transmitter output power of 300 mW and a receiver sensitivity of 1 μ V. Special attention has been paid to the differing requirements of various industries. Each transceiver has its own internal speaker and microphone and is provided with switch selection of up to 4 crystal-controlled channels in the 156 to 174 Mc/s band. This makes possible communication between operators on the same frequency as well as the facility to allocate different channels to other personnel in the same area. In addition, small and large detachable battery compartments can be fitted to give respectively 6 and 12 hours' operation before recharging is necessary.

The 1964 S.B.A.C. Flying Display and Exhibition opened at Farnborough on Monday 7th September for six days. The static exhibition included the largest display of electronic devices of any of the 24 Shows. This report deals with some of those electronic devices. Particular attention has been paid to equipment with potential industrial application.

DATA DISPLAY

The traditional method of presenting individual items of data on separate meters may be considered satisfactory when an operation or process is a slow one, but when fast assimilation of complex data is necessary comprehensive data presentation becomes essential.

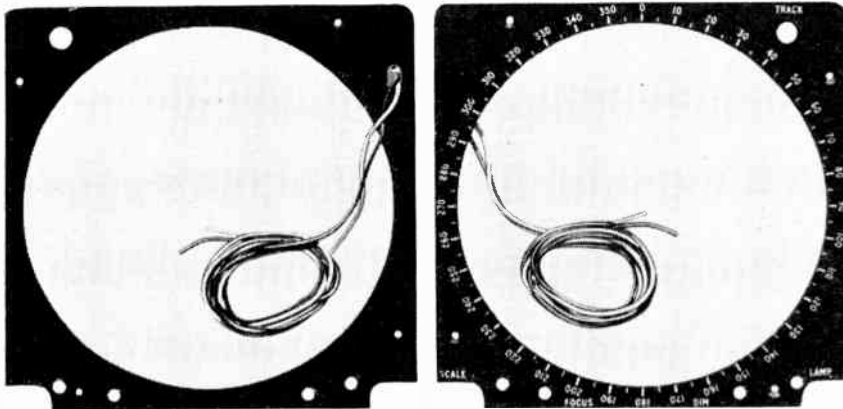
Many new forms of complex data display were demonstrated. Most are naturally orientated towards flying and ground control data presentation but in principle quite a number of the systems could be applied to industrial process control systems and operator training simulators.

Redifon's 'Iconorama' (51) is a new

way to co-ordinate several sets of data automatically and to display all related factors on a single viewing screen. With this any number of images may be slide projected as required to an accuracy of 0.1%. Basically the system comprises a number of slide projectors some of which are used to project static information, such as charts, maps and grids. The remaining projectors are XY plotting units. In the simplest form two projectors may be used, one for dynamic information and the other

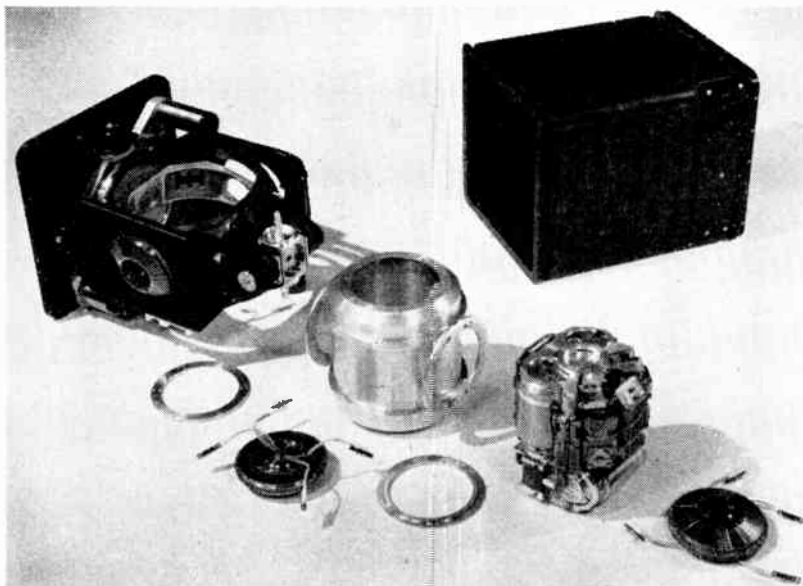
For further information about specific items circle the appropriate number, shown in brackets in this report, on the Service Card.

THE TITLE-BLOCK SHOWS — reading clockwise from top left — an artist's impression of the BAC/Sud Aviation Concord supersonic airliner, the Black Knight research rocket built by the Saunders-Roe Division of Westland, the BAC One-Eleven short-haul jet, the Westland Wasp 5/6-seat helicopter, the BAC VC10 long-range airliner, and the Beagle 206 executive aircraft



ELECTROLUMINESCENT PANEL LIGHTING—'Sierraglo' electroluminescent control panels, which were to be seen in operation on the Napier stand, have been ordered for BAC TSR2 low-level bomber, and passenger cabin signs employing the same principle will be used in the BAC One-Eleven. The panels simply consist of a thin plastic sandwich containing an electroluminescent phosphor. The legend, engraved through the opaque wear-resistant facing, glows uniformly when the panel is energized; its intensity can be controlled by a normal rheostat dimmer. Flying leads are seen on the reverse of the panel (left), although terminals may be fitted as an alternative. Since separate incandescent lamps are not required, this system represents an improvement in the reliability of control-panel lighting.—Circle 53

ULTRA-VIOLET OSCILLOGRAPH RECORDER—A range of well-styled equipment was exhibited by Southern Instruments. Among recent additions was the M.1300 10-channel, ultra-violet, direct-writing oscillograph recorder. This simplified low-cost instrument features optional paper widths of up to 6 in., datum traces and timing lines, a plug-in lamp unit, and writing speeds from d.c. to 10 kc/s.—Circle 52



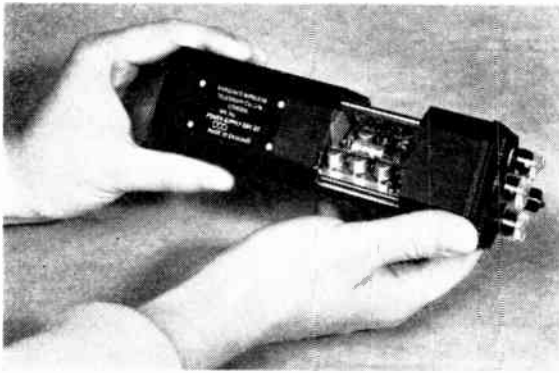
LIGHTWEIGHT INERTIAL PLATFORM—An exploded view of the Ferranti lightweight inertial platform. This is a 3-gyro, 4-gimbal platform with full inertial capability, complete aerobatic freedom and direct a.c. motor gimbal drive. The minimum operating life of the gyros is 3,000 hr.—Circle 55

FARNBOROUGH AIR SHOW 1964

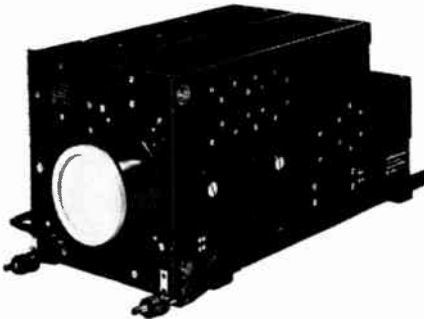
AUTOMATIC CRIMPING TOOL—This power-driven bench model of the 'UNIcrimp' automatic crimping tool was demonstrated by Plessey. Operated without effort or skill either by hand or foot-pedal, it makes perfect square-form crimped joints to any size of tag or wire up to 12 a.w.g.—Circle 54

BRUSHLESS A.C. GENERATOR—English Electric showed the AE 2100 brushless a.c. generator. This 200-V, 3-phase, 400-c/s machine is of homopolar construction with a continuous output of 40 kVA and an overload rating of 80 kVA for 5 sec.—Circle 56



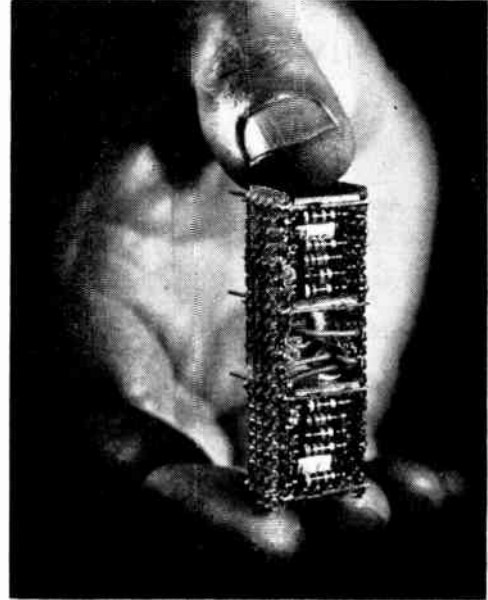


MICROMINIATURE MARKER BEACON RECEIVER— Described by the Marconi Company as 'a practical exercise in microminiaturization', this experimental 75-Mc/s marker beacon receiver conforms fully with all current operational requirements. The entire receiver is accommodated behind its display unit in a standard flight instrument case—less than a quarter of the size and weight of the present equipment. An even more important result of the use of microminiature techniques is the consequent increase in reliability: calculations based on the failure rates of individual components indicate that the complete receiver will eventually have a 'mean-time-between-failures' of about 30,500 hours. This unit is providing valuable information on microminiature circuit construction, which will almost certainly form the basis of the next generation of airborne radio and radar equipment.—Circle 58

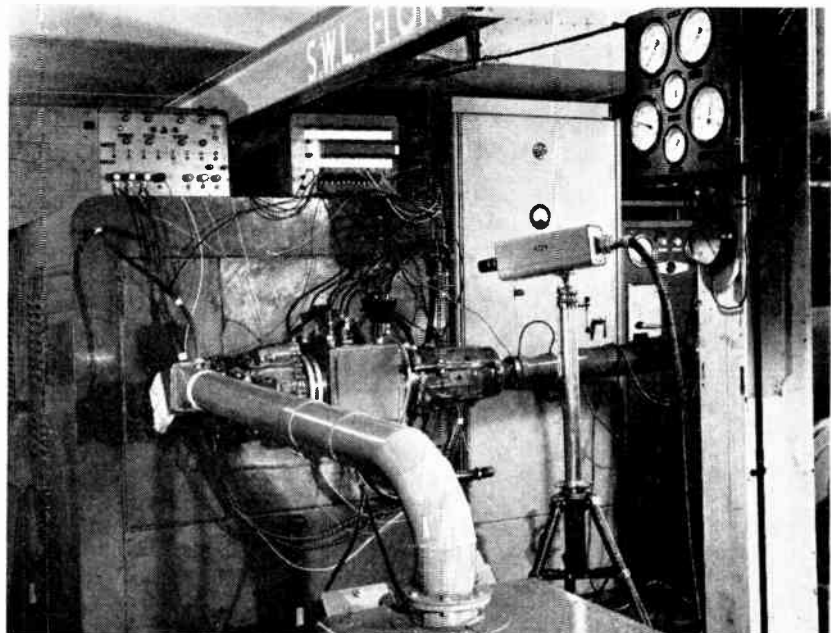


STATIC INVERTERS— Ekco showed a full range of static inverters for the generation of medium and low-power 400-c/s supplies for airborne applications. Features of the range (from 75 VA single-phase to 1 kVA 3-phase) include high efficiency, reliability, light weight, close voltage regulation and frequency tolerance with low harmonic content. A smaller single-phase 35-VA unit is suitable for many applications including driving small motors and synchro systems. The picture shows type E208 for 115 or 200-V single-phase 500-VA output.—Circle 59

HIGH-DENSITY PACKAGING OF ELECTRONIC COMPONENTS— An example of the 'Ministac' system of modular circuit construction, as used in aircraft and missile electronics. This STC system enables a large quantity of active and passive components, both discrete and hybrid, to be assembled in the minimum space. The inside conducting walls of the modules form pre-punched circuit paths.—Circle 57



LOW-COST CLOSED-CIRCUIT TELEVISION— The picture shows an A.E.I. closed-circuit television camera at work in a development laboratory. Two simple units form the basic television system—a 4-lb camera and a 14-in. control monitor, weighing 30 lb, which contain the minimum circuitry necessary for high definition. The system can be extended, as required, for multi-channel work. This low-cost equipment, which is fully transistorized and can be operated from two 12-V car batteries, has many applications in air traffic control, including the monitoring of runways and parking areas, up-dating of arrival and departure information, etc.—Circle 60



for static data. The dynamic information plotting projector incorporates a coated glass slide on which images are automatically scribed by a stylus. Input signals actuate X and Y servo-mechanisms which govern the movement of the stylus plate. There is no restriction on the type of input data. Information from digital or analogue sources, teleprinter tape, sonar or radar can all be fed in automatically.

A moving map display (61) for navigation was shown by Ferranti. This displays, continuously and automatically, the aircraft's present position and track against the background of a map, tracing the progress of the craft over the ground and showing surrounding features and future position. Essentially, the display unit is a film back-projector; the display is a ground-glass screen. The filmstrip, consisting of 35 mm reproduction of navigation charts, is driven through the projection gate along and across its longitudinal axis (representing E-W and N-S movement). The electro-mechanical drive is controlled by signals derived from the aircraft's navigation system. The aircraft's position appears under a marker and its track is shown by a radial line on the screen.

A realistic three-dimensional display for data processing radar (62) was featured by E.M.I. Electronics. This will obviously go a long way in solving the problems of presenting to an air traffic controller a three-dimensional celestial view of a volume of airspace. The actual display utilizes a flat-faced c.r.t. on which appears a synthetic picture in the form of the faint outline of a perspective view of a transparent cube, representing the airspace under consideration. Within this cube the aircraft appear as luminous spots in their correct relative positions. The aspect of the cube is under the control of the observer who can rotate and tilt the cube as required. Graticules make possible a quantitative assessment of a particular air traffic situation.

For instant photographic analysis by untrained observers, Marconi were demonstrating their 'Photographic Positive/Negative Viewer' (63). Based on closed-circuit television, pictures are displayed on t.v. monitors for analysis. The operator can instantly produce the effect of a wide variety of printing exposure times and can magnify selected areas of the photograph up to twenty times. A unique feature is the facility which provides the effect of complex masking in printing. This enables the operator to select any 20% of the grey scale in the t.v. picture information range and to

effectively expand this to constitute 60% of the total grey scale, the rest of the picture information being compressed to fill the remaining 40% of

INSTRUMENTATION

The requirements of the aerospace industry are so diverse and growing so rapidly that hundreds of new electronic instruments and systems must be developed each year. Suffice to say that, providing the capital is available, the electronics industry can and will make instruments to do almost anything.

Mechanism Ltd. illustrated the ubiquity of electronics with a prototype servo-operated precision aneroid barometer (64) which has digital read-out. In this a contact on the diaphragm of the aneroid makes with another which is connected via gearing to a servo motor. The servo-mechanism is hunting continuously. When the diaphragm moves and the contacts break, the servo motor is energized and moves to make the contacts; as soon as they are made the motor is reversed to break the contacts and so on. The shaft of the servo motor also operates a voltage decade switch, the outputs of which are connected to five separate decade numeral tubes. The position of the diaphragm therefore controls the voltage decade switch and the digital reading on the tubes. The complete equipment provides a frictionless precision barometer with remote readout facilities.

Smiths Aviation Division were showing a new altitude reporting equipment known as the digitized transmitting altimeter (65). It is designed automatically to signal the height at which an aircraft is flying to air traffic control officers on the ground. In place of the usual altimeter pointers, an optical digitizer is operated by the altimeter movement. An optical disc, printed with 10 channels of information according to the 'Gillham' altitude reporting code, is the main com-

COMPONENTS

New materials and components were to be seen on many stands. These were in the main aircraft devices made for a specific job of work. However, a number, such as the Westinghouse gate turn-off controlled rectifiers, have more widespread application.

The Westinghouse turn-off controlled rectifier (69) is a device similar to the thyristor. Unlike the thyristor, however, it can be turned off by applying a negative potential to the gate electrode. Two types are now avail-

able with current ratings of 3 and 5 A mean and voltage ratings up to 600 V.

Probably the smallest new potentiometer at the show was the HT250-2 'Mechatrim' (70) on the stand of Rotax. Without the lead this measures 0.312-in. long × 0.286-in. diameter. Using a metal-film track it is available in total resistance value from 100 Ω to 7.5 kΩ and it has a good h.f. characteristic.

Among the many working demonstrations of Elliott-Automation was their digital time base generator (66). This is driven by a shaft encoder from, say, the radar aerial. Twelve binary digits are used in sine and cosine channels to form sawtooth waveforms which will drive any conventional p.p.i. display. The equipment permits direct digital positioning of intertrace markers by the data-handling system and provides digital read-out of these markers for transmission to remote displays. Information can be transmitted virtually any distance over ordinary telephone lines and can be held to an accuracy of ±1 digit.

A production model of the low-cost compact data logger (67) was being demonstrated by Solartron. This is a small 20-channel digital data logging system having a maximum scanning speed of 3 points per second. It incorporates an integrating digital voltmeter with a sensitivity of 10 μV per digit and an accuracy of 0.05%. Plug-in modules are available to extend the capabilities of the equipment.

Ultra Electronics were demonstrating the Trix 32-track tape recorder (68). This is designed primarily for a public building announcement system and provides facilities for 32 pre-recorded messages of up to 6 min duration or 64 messages of 3 minutes each. In addition, this may be used for industrial operator training by recording a series of instructions which may be selected in any order.

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For further information about specific items circle the appropriate number, shown in brackets in this report, on the Service Card.

SOLVING INDUSTRY'S PROBLEMS



SPERRY PUTS THE TOE IN

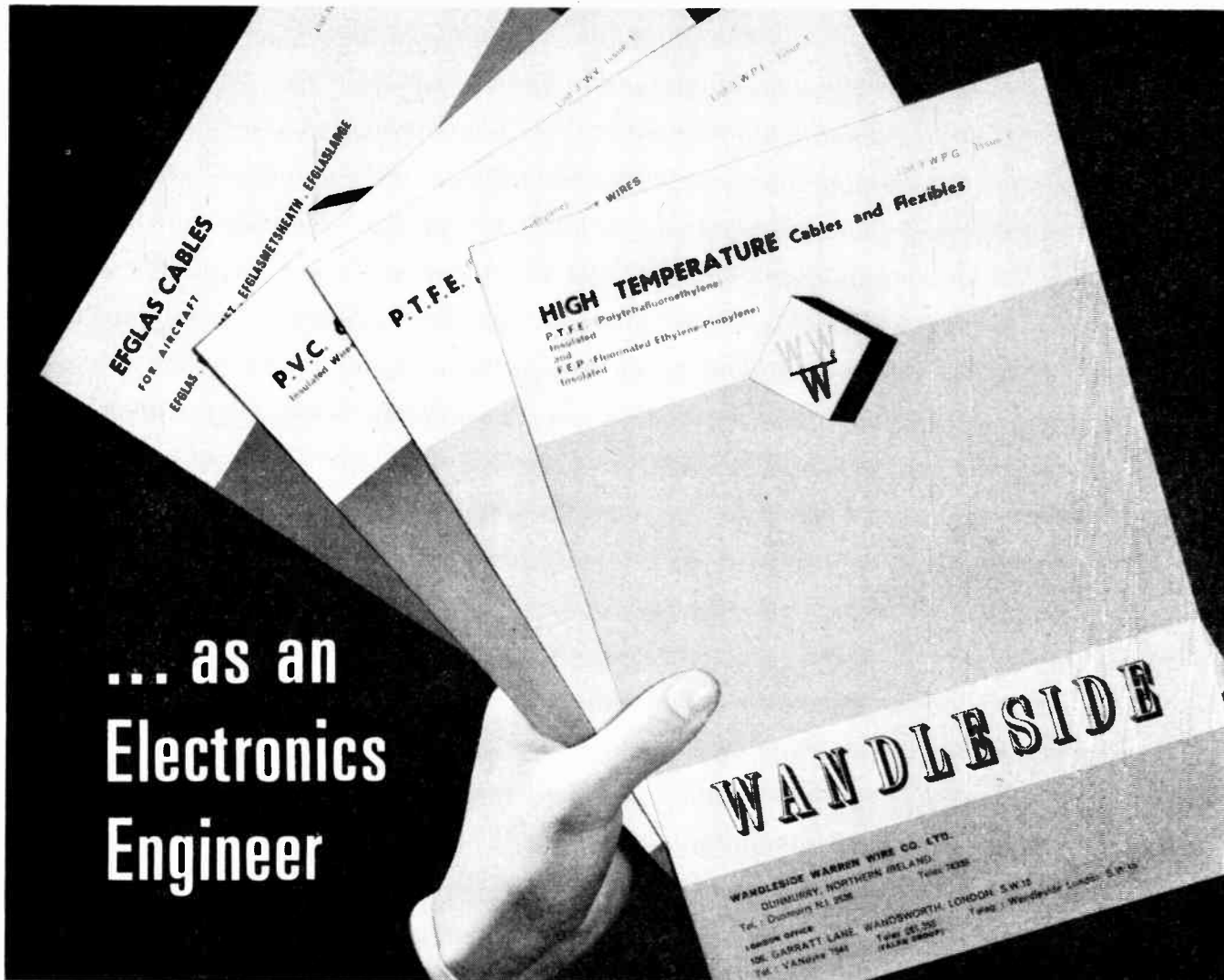
VAUXHALL MOTORS LTD. required a quick and extremely reliable flow-production gauging system which would enable them to set front-wheel "toe-in" on the car assembly line with unflinching precision.

A SPERRY GAUGING SYSTEM which electrically filters out tyre rotational irregularities and indicates the precise degree of "toe-in", provided the solution.



INDUSTRIAL CONTROL

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**Electronics
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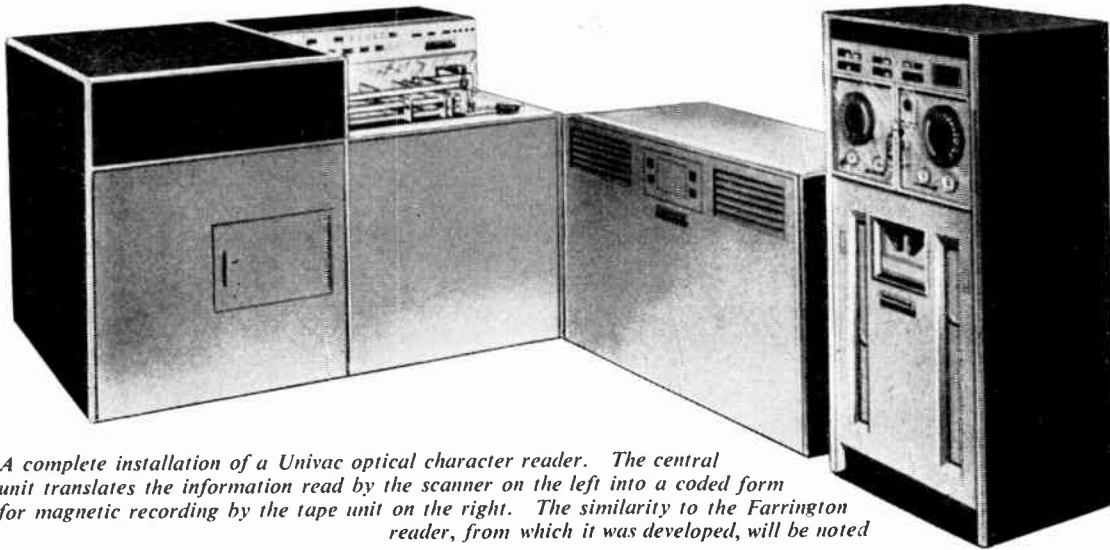
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A complete installation of a Univac optical character reader. The central unit translates the information read by the scanner on the left into a coded form for magnetic recording by the tape unit on the right. The similarity to the Farrington reader, from which it was developed, will be noted

THE ability of all practical readers being limited to certain stylized fonts, in the absence of any standardization a prime limitation is imposed on their use, namely the documents to be read must be originated in some manner under the control of the user. In business data processing this limitation does not prove nearly so severe as might be expected, and indeed much more than font standardization would be required if documents of outside origin were to be read—for example document size, field location, sequence of information, etc., would all need a degree of standardization. The curious aspect is that while the installation of reading machines for *business data processing* has made some headway in the United States, for industrial control purposes (where it might be considered that much more document origination is under the control of the user) the facilities seem to have been very little used. The present writer cannot find any specific reason for this, and it is assumed that the potential value of optical character recognition (o.c.r.) may not be widely appreciated. Hence it is intended to generalize the circumstances in which such systems may be of value, and in so doing to break down the usual arbitrary distinction between 'business data processing' and 'industrial control', for it is not always possible to determine where one ends and the other begins.

Types of Document

Broadly, there are two types of documents originated under the user's control which subsequently require to be read. The first is the turn-around document, which is sent from one point to another and back again, either once or repeatedly. One of the points may be an outside organization, as long as it is not the point of origin. The second type is made up of those documents from a number of different sources under the user's control and which have to be read so that the information on them can be merged, collated, analysed, and/or used to initiate direct controlling action.

Turn-Around Documents

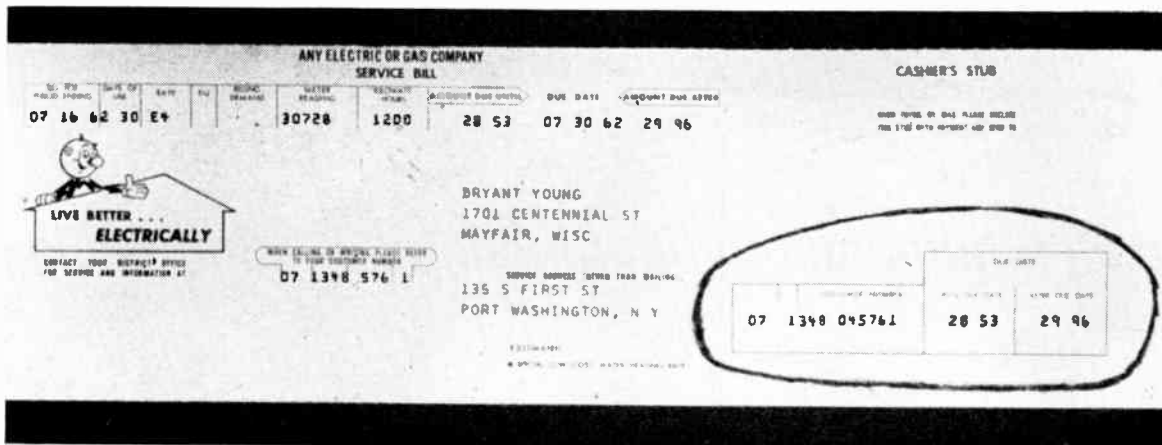
One of the principal fields in which turn-around documents have been used with o.c.r. is in customer billing. The bills sent out incorporate a tear-off stub bearing the customer's account code number, the amount of the bill,

DEVELOPMENTS IN ELECTRONIC READING MACHINES

By JOHN B. RUDKIN

3. Applications and Economics

In this concluding article on reading machines, the author deals with their applications. He also touches upon economics and points out that there are many indirect benefits which are not easy to assess in monetary terms.



An example of a turn-around document for use with an optical character recognition system. The tear-off stub on the right is intended to be returned by the consumer with the remittance but all the numerical data on the document is printed in a type suitable for automatic reading. In consequence the data can be analysed and recorded before the document is dispatched

and other relevant information, prepared on a machine with a suitably-styled type basket. This may in turn be a computer output printing device. On payment, the customer detaches the stub, sending it with the remittance. The only manual operation required is to check that the remittance agrees with the amount on the stub, after which the stubs can be read by o.c.r. machines, the information thus produced on cards or magnetic tape being used to update the customer's account, etc. This system has been used in the U.S.A. by power supply concerns, by insurance companies, by fuel oil suppliers (for credit cards) and so on.

There seems no reason why a system similar to this should not be highly beneficial for such tasks as production control. Whether production is for stock or against specific customer orders, there comes a point at which a written record of each productive demand must be made, either by an internal order (perhaps with a graded priority attached) or by an acknowledgment of a customer's order. In either case, the type fount used could well be suitable for o.c.r. and either the original or a carbon copy of the document could be used with a reader to prepare input for a production control computer. The output of such a computer routine, in turn, could well be printed in similar form, and the documents produced used as works orders on branch factories producing sub-assemblies, components, etc., who, in turn, would use them for direct input preparation in their own production control routine. On completion of each order or sub-order, the documents could come back as input media for updating the production control schedules.

The value of the technique lies in the dual nature of the type fount—the fact that it is intelligible both by machines and men. The limit to its value in this direction is set by the cost of readers: unless a reader is going to be fairly intensively used it will not justify its cost, hence the direct activation of individual production machines is likely to remain cheaper by the use of punched cards with a pre-printed interpretation. However, when it comes to the dynamic control of machine tools by a specification previously prepared on a computer, it may be that a print-out from such a computer to be subsequently read by an on-line o.c.r. device would prove economic as well as advantageous in having a manually-intelligible specification.

Multiple-Source Documents

A common application of o.c.r. in this field is the analysis of cash-register tally-rolls from a number of departments

or branches. The registers are fitted with type-wheels in the appropriate fount, the tally-rolls are gathered at one central point and then read by character readers. The data so produced can be analysed by computer (or even by punched-card sorters) to produce the gross revenue by departments, by areas, by days, or in one class of goods, or whatever is desired, limited only by the number of symbols which can be printed on the tally-roll.

The technique can be extended to any sort of organization with branches or departments originating their own documentary records, for it is possible to produce either the original documents or by-product tally-rolls in the necessary type fount with, again, the value of dual intelligibility. This technique is clearly an advance on that of producing punched paper tape as a by-product of hard-copy documentation. Moreover, it is cheaper, the substitution of one type fount for another is relatively inexpensive, but the addition of any kind of punching mechanism is quite costly.

The key to the application of this technique lies in a well-established truism; that preparation of data in machine-sensible form should be done as close to the point of origin of the data as possible. Wherever data arises at numerous points and is transcribed on any sort of typing or printing device, there is the possibility of rendering that data machine-sensible as well as man-sensible merely by changing the type fount to one suitable for o.c.r.

Economics

In considering the economics of techniques such as o.c.r. it is dangerously easy to look at direct cost savings only, and ignore the consequential effects which may be more difficult to assess. In 'pure' data-processing applications, such as the bill-stub turn-around system described above, speakers for the Sperry Rand Corporation have claimed that the break-even point in direct input-preparation costs falls at about 10,000 documents per day, though this figure would leave about six hours of o.c.r. machine time available each day for additional tasks and future expansion. The indirect economic benefits arise from such features as the ending of training of replacement key-punch operators, the end of delays due to sickness or other absenteeism, the lower error-rate, and possibly the psychological effect on the customer of a ready-made payment advice prompting quicker payment. (To be fair, a turn-around stub could be used just as well with manual key-punching to gain the psychological effect.)

When it comes to industrial control applications, it

seems to the writer that direct cost savings in input preparation are not the crux of the matter; indeed, such savings would not be the main object of a system. The savings to be achieved are in the fields of better production control, increased efficiency and functions of a like nature, all stemming from the dual intelligibility of the o.c.r. type fount. Being difficult to quantize in a

prognosis, these potential benefits are likely to be visualized and appreciated more by the practical engineer and the works manager than by the financial controller. In the subjective view of the writer, this unhappy state of affairs reflects the reason for much of the tardiness in applying modern techniques in British industry: namely the over-influence of purely-financial control in top management.

Rumanian Automatic Bakery Equipment

Two new automatic bread bakeries are being built in Rumania at Bucharest and Galati. They are to be equipped with bulk flour storage, handling and distribution systems designed, supplied and installed by Henry Simon Ltd., of Stockport.

The silo for flour storage at Bucharest will be the world's largest bakery silo with a capacity of 2,300 tons; Galati will have a 1,000-ton silo. Daily output of each bakery will be 150 and 80 tons of bread respectively.

Despite the difference in output, the flour handling and distribution systems in both bakeries are similar. At Bucharest there are 20 concrete storage silos which will be filled pneumatically from either sack intake or bulk wagons. Selection of bins is by means of an automatic multi-way valve system and pneumatic samplers fitted to the feeding lines will give opportunity for testing the quality of flour

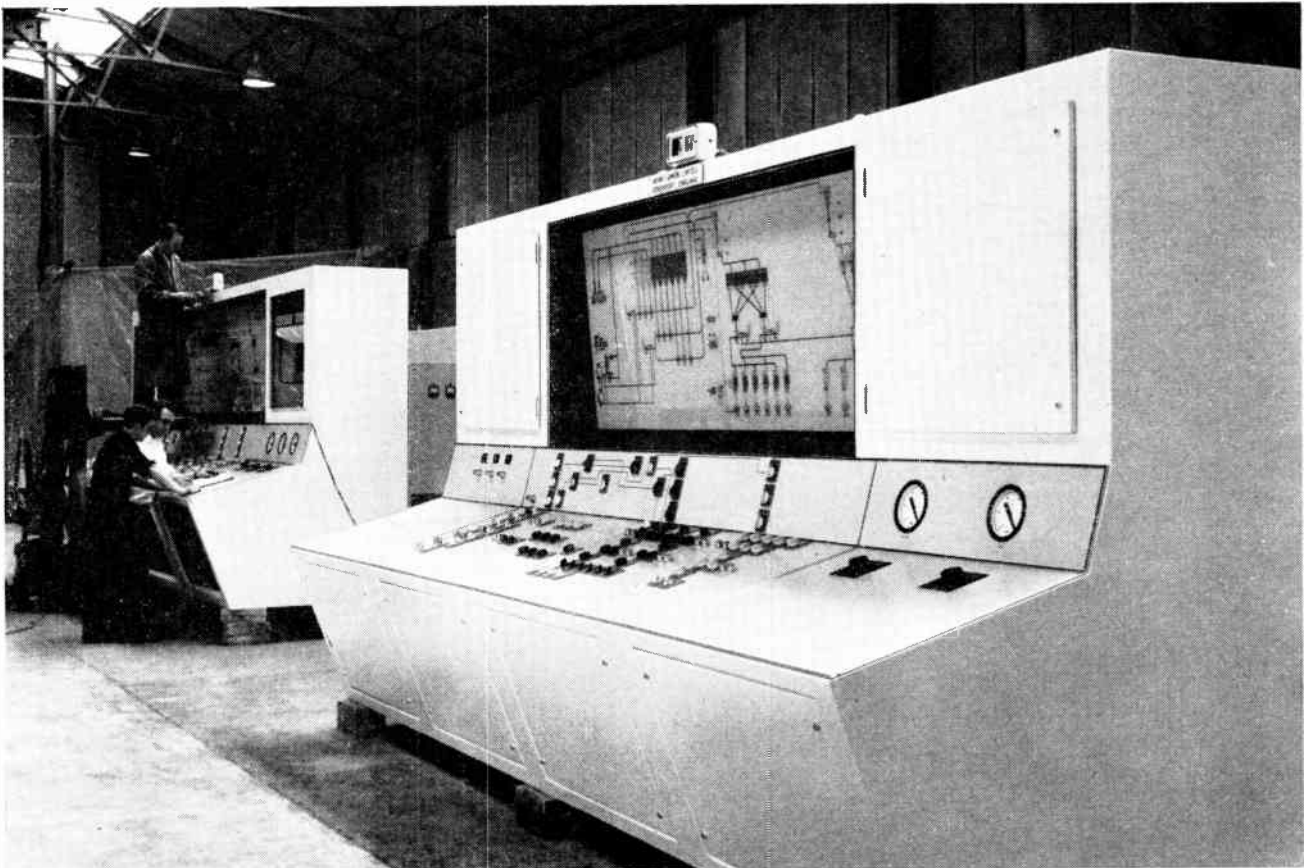
as it is received; provision will be made for returning flour to the intake point.

The whole intake, storage, handling and distribution system is controlled from a centrally situated panel at both plants.

Ericsson electroluminescent 'Phospholite' panels are being used as a means of lighting the mimic diagrams. These panels comprise wafer-thin sandwiches of glass and prepared phosphor between two conducting surfaces, one of which is transparent. Application of the appropriate voltage produces cold light of an even glow, in colours peculiar to the phosphor used.

The flow diagrams are of true colour and display equipment in its appropriate shape. Their surfaces are free of engravings and drillings so that they can be kept clean simply by wiping over.

Illustrated here are the two control consoles undergoing final assembly and testing before shipment to Rumania

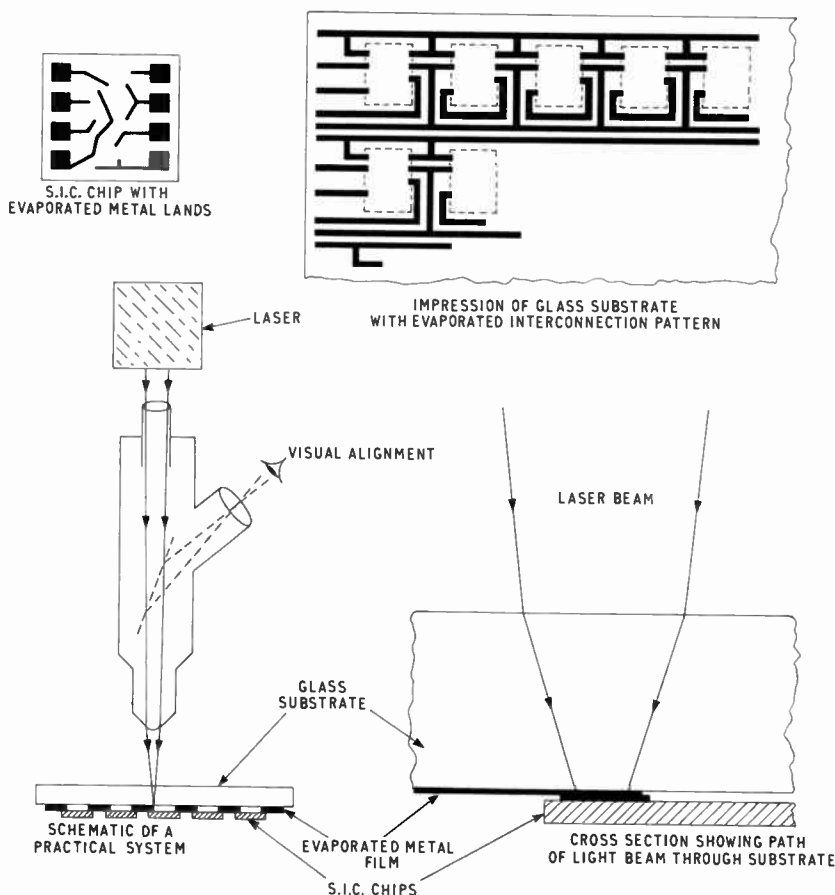


Laser Welding of Semiconductor

INTEGRATED CIRCUIT INTERCONNECTIONS

By T. E. PRICE, Ph.D., A.M.I.E.E.*

A method, still in the experimental stage, of making connections to sub-miniature components is described in this article. A welding technique is used with a laser as the source of energy.



THE reliability of semiconductor integrated circuits (s.i.c.) is being continually improved with the advances in technology. There is still the problem, however, of interconnecting s.i.c. into a system. This problem must be solved if the reliability of a complete system is to approach that of the individual s.i.c. functional unit. The reliability of the interconnections can be greatly improved if instead of packaging a single s.i.c. functional unit in a container a complete sub-system is interconnected and packaged in one can using the highly-controlled processes of the s.i.c. production line. There are two approaches; (a) to interconnect large arrays of circuits on a single slice and (b) to mount and interconnect individual circuit chips on a passive substrate. The former approach requires a high yield or 100% testing and a unique interconnection pattern for each slice; the second approach uses 100% testing but requires only one interconnection pattern. The two methods will converge in that the number of circuits interconnected on a single slice will be adjusted to give a usable yield, while the circuit complexity of the individual s.i.c. chips will increase. The second approach has the added advantage of circuit flexibility. This communication describes the unique method of mounting and interconnecting s.i.c. chips on a passive substrate that is being investigated at these laboratories. The idea has been made possible with the advent of the laser as a compact source of energy in the visible portion of the electromagnetic radiation spectrum. The use of fine wires for interconnecting is precluded on the grounds of complexity and reduced reliability.

The sequence of events is illustrated in the figure. Interconnection lands are evaporated on to the s.i.c. chips and an interconnection pattern for the proposed system of s.i.c. chips is evaporated on to a glass substrate. The substrate is placed in a jig with the evaporated metal film on the lower surface. The s.i.c. chips with the interconnection lands uppermost are placed underneath the substrate and aligned with the interconnection pattern on the substrate using micro-manipulators and microscope. Pressure contact is made between the chip and substrate and the microscope is then used to focus the laser beam through the glass and on to the contact area. The power from the laser is so adjusted that the metal on the substrate is welded to the metal on the s.i.c. chip. The complete substrate is finally packaged in a metal can.

* Royal Radar Establishment.

The advantages of the method are:—

- (a) Maximum circuit flexibility
- (b) High reliability of a welded joint
- (c) High packing density, approaching that of a single slice
- (d) No chip-to-substrate alloying stage.

Preliminary tests have been made using dummy chips and a borosilicate

glass substrate with chrome-gold inter-connection lands. A metallurgical microscope with trinocular head was used to focus the beam from a $2\frac{1}{2}$ -in. \times $\frac{1}{4}$ -in. ruby laser. A Variac attached to the power supply was used to vary the energy output of the laser, the maximum energy available being about 1 joule. The main problem encountered was the non-repeatability of the weld resulting from the poor

control of the energy output from the uncooled ruby laser. However, the tests were sufficient to demonstrate the feasibility of the method provided that the energy output of the laser could be controlled; e.g., by cooling. Outstanding problems related to the choice of glass for the substrate and metal or combination of metals for the inter-connections have, however, still to be solved.

High-Speed Electronic Checkweighing and Grading

Four electronic checkweighers are now in operation at The British Oxygen Company's Sparklets Division, checking the weight of soda-syphon bulbs, while simultaneously grading them into five weight categories, at a rate of more than two per second.

Before introducing them, Sparklets relied completely on mechanical devices which did the job at only 40 bulbs per minute. Increasing demand led them to search for equipment with a higher performance, but no machine existed, either at home or abroad, to meet their requirement for simultaneous checkweighing and grading at high speed.

After more than two years' research and development Telomex were able to produce an equipment (model MX 300) giving a weighing accuracy to within 0.05 gm, normally working at a rate of 130 bulbs a minute, and capable, if required, of handling up to 150 units a minute.

Empty bulbs are fed into pallets and a belt system supplies them individually at high speed to the weigh head of a battery of three checkweighers and graders, over which they are transported by a 'walking beam' system. They are classified by the machines into the five pallets representing these weight groups. The bulbs in each category are then filled with a specified weight of carbon dioxide gas.

The precise weight of each category, including the CO₂, is thus known at the time of storage. It is the function of the fourth checkweigher to ascertain whether the known weight of each category has been maintained after a three-week 'aging' period. Those bulbs which do not meet the original weight figure (due to leakage) are rejected.

An automatic record is kept by the

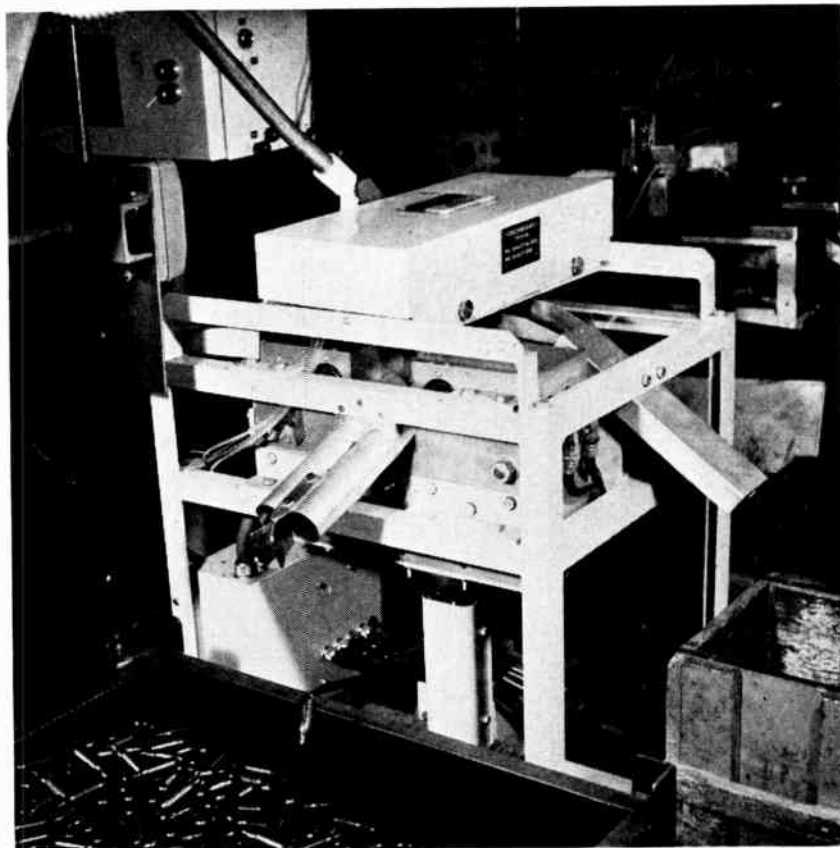
equipment of the number of empty bulbs handled in each weight category. These figures can be read off the machines' indicator panels and provide valuable information on production trends.

This high-speed checkweighing and

grading equipment is also suitable for similar applications involving components in the engineering field or for tubes and capsule-type packs in the pharmaceutical industry.

For further information circle 71 on Service Card

The fourth checkweigher in service at The British Oxygen Company's Sparklets Division is used to determine whether the filled soda-syphon bulbs have leaked during a three-week storage period. Sound bulbs are delivered to the pallet in the foreground



EQUIPMENT REVIEW

1. Metal-Ceramic Sealed Components

A wide range of metal-ceramic sealed components, which have considerable advantages in electronic, vacuum, high-temperature and nuclear-engineering applications, is now available from E.M.I. Electronics who also offer a service for the design and manufacture of special components and will undertake the sealing of customers' parts.

Where leak-tight high-vacuum components are required to withstand high temperatures, the glass parts of vacuum enclosures are the first to fail. The temperature must be kept below 500 °C, the softening point of the hardest glass. For many modern techniques higher temperature working is desirable and this has led to the use of ceramic components. Ceramic materials withstand very high temperatures, and possess excellent resistance to thermal shock.—*E.M.I. Electronics Ltd., Hayes, Middlesex.*

For further information circle 1 on Service Card

2. BNC Connectors

A range (L1637) of pattern-15 BNC coaxial connectors introduced by Belling-Lee, incorporates a cable grip strong enough to withstand pulls approaching the breaking strain of the cable. The gold-plated pin and socket inserts, although removable for wiring, are captive when assembled.

The connectors, designed for v.h.f. applications on Services and NATO equipment, operate efficiently up to 3 Gc/s and are interchangeable with their U.S. counterparts. The initial range comprises two fixed sockets, two bulkhead sockets (one-hole and flange-mounting), a free plug and a free socket.

The improved cable grip is achieved first by trapping the braid between silver-plated ferrules. Then the cable is held by a compression gland of silicone rubber, which also prevents moisture from entering the end of the cable. Finally, it is gripped by a split

collet which tightens as the locking nut is screwed in. There is thus no strain on the centre conductor.—*Belling & Lee Ltd., Great Cambridge Road, Enfield, Middlesex.*

For further information circle 2 on Service Card

3. Impulse Counter/Totalizer

Landis & Gyr are adding to their Sodeco series a predetermining counter with totalizer. This is a 4-digit TCE series counter and is available, with or without zero reset, for 10 or 25 impulses per sec.

The mechanism of the predetermining counter and of the totalizer are independent, each having its own counting coil. The zero-reset arrange-

ments are equally independent and can only be operated manually.

The predetermining counter has a changeover switch which is operated at the zero position. In normal models, without any special designation, the contact is operated by the drop-out of the armature. If the contact must close at the moment of attraction of the armature, a special type 'v' is available.

The zero reset contacts of the totalizer comprise a normally-open and a normally-closed contact, which are operated by depressing the zero-reset lever.—*Landis & Gyr Ltd., Victoria Road, Acton, London, W.3.*

For further information circle 3 on Service Card

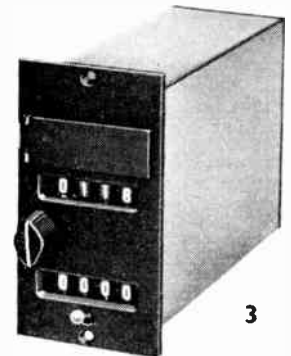
4. Gas Chromatograph

Pye have announced the series 104 chromatographs. These instruments are low-cost high-performance gas chromatographs of functional modern design.

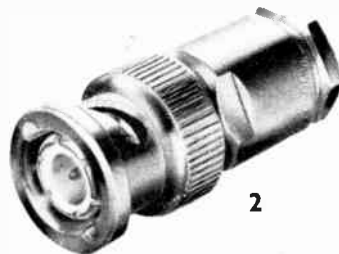
The basic instrument is available in three forms: with single-flame ionization detection, temperature-programmed dual-flame ionization detection, and katharometer detection. Special features include interchangeable heads with fitted detectors and columns, and a high-temperature oven



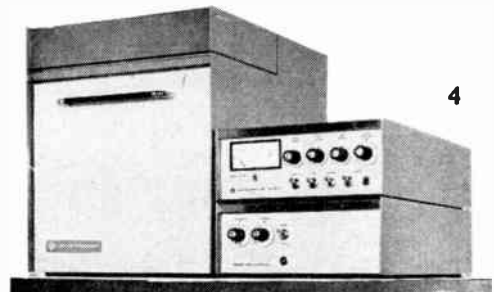
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(500 °C) which will accommodate a 20-ft preparative column. Ease of operation and ease of access to a large column oven are the key design features of this series.—*W. G. Pye & Co. Ltd., P.O. Box 60, Cambridge.*

For further information circle 4 on Service Card

5. Interdigital Diplexing Filter

A high-performance interdigital diplexing filter, especially suitable for C-band telemetry applications at high altitudes, has been introduced into this country by Roberts Electronics.

Model F-2089 is a 3-port device with a bandpass response between the common terminal and the two outputs. It has two 50-Mc/s pass bands centred 364 Mc/s apart, at 6,040 and 6,404 Mc/s. Insertion loss across each pass band is 1.5 dB maximum, and v.s.w.r. is 1.5 maximum. Centre-frequency separation may be reduced to 200 Mc/s without compromise of performance.

Isolation between outputs is 50 dB at any frequency, and this pressurized unit, which measures 15 cu in., will handle a peak power of 2 kW. Variations in size and performance are available.—*Roberts Electronics Ltd., 17 Hermitage Road, Hitchin, Herts.*

For further information circle 5 on Service Card

6. Miniature Transistor Amplifiers

Recently introduced by Micro State Electronics Corporation, the MTQ series of miniature transistor amplifiers includes five models, designed for use as low-noise i.f. and r.f. amplifiers covering all frequencies in the 30 to 300 Mc/s range.

Features include high gain, wide bandwidth, and rugged construction. Amplifiers are also available with built-in video detectors and a.g.c. circuitry.

Package size is 27 × 19.1 × 77.8 mm (less connectors); r.f. connectors are Omni Spectra OSM. The d.c. requirement is 20 V at 35 mA, and the operating temperature range is from -50 to +75 °C.—*Ad. Auriema Ltd., 125 Gunnersbury Lane, Acton, London, W.3.*

For further information circle 6 on Service Card

7. New Electrolube Grease Pack

Electrolube have announced the introduction of a collapsible metal tube to replace the previous card-mounted capsule for Electrolube grease 2G. The tube, which has an applicator nozzle, is packed in an attractive carton and contains the same quantity of grease as the old capsule. The price is unchanged.

2G grease, which increases conductivity, loosens tarnish, prevents oxidation and reduces arcing and contact burn, is suitable for use on all types of contacts, controllers, pick-up shoes and rails, relays, etc. It has a wide temperature range (-70° to +225 °C) and is also a good mechanical lubricant.—*Electrolube Ltd., Oxford Avenue, Slough, Bucks.*

For further information circle 7 on Service Card

8. Differential Amplifier

Now available from Fenlow Electronics is the AD103 d.c. differential amplifier on a printed-circuit board 3½ × 5 in. It requires power supplies of + and -24 V d.c. and the gain is variable up to 1,000 with bandwidths up to 20 kc/s. The price is £35.

The common-mode rejection is 100 dB at 50 c/s and 80 dB up to 2 kc/s for common-mode signals up to ±10 volts with 50 Ω out of balance. The common-mode input impedance is greater than 5 MΩ and differential input impedance is 1 MΩ. Noise is less than 15 μV peak-to-peak and drift is approximately 20 μV per °C.—*Fenlow Electronics Ltd., Springfield Lane, Weybridge, Surrey.*

For further information circle 8 on Service Card

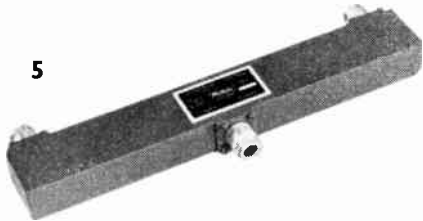
9. Lithium-Nickel Ferrite Cores

Lithium-nickel ferrite storage cores, now available from Mullard, are claimed to offer considerable advantages to the computer manufacturer in comparison with cores previously available. In particular, they can operate over a wide temperature range without the need for current compensation.

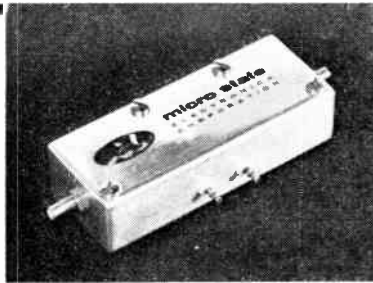
These cores can readily operate over a 60 °C temperature span with constant drive-current amplitude, so that neither temperature compensation of the drive current nor temperature stabilization of the matrix is required. The sense amplifiers of the core store can also be simplified because, over this range with a constant drive current, the peaking and switching times remain substantially constant and no compensation of strobing time is required.

The lithium-nickel ferrite cores have usable properties over the temperature range -20 to +100 °C. The magnetostrictive coefficient is very low, resulting in low stress sensitivity and negligible oscillation through magnetostrictive excitation.

At present two types of core made from this material are available: the FX2763 (0.03-in. o.d) is intended for use in high-speed stores with cycle



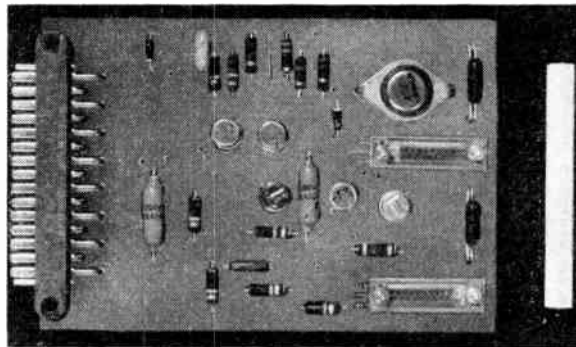
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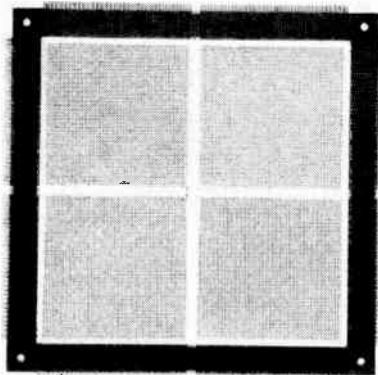


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EQUIPMENT REVIEW



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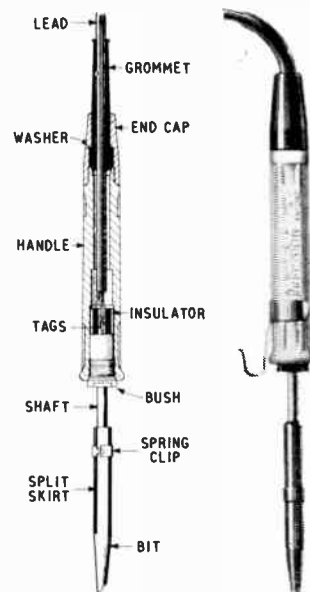
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times of less than $2 \mu\text{sec}$, whereas the FX2764 (0.05-in. o.d.) is for use in slower stores. Both cores are available assembled as single matrix planes or complete stacks.—*Mullard Ltd., Mullard House, Torrington Place, London, W.C.1.*

For further information circle 9 on Service Card

10. Digital Voltmeter/Ratiometer

Digital Measurements have recently added the DM2022 digital voltmeter to their range of digital instrumentation. This instrument is a development of the DM2020 voltmeter, but has a longer scale (39999) and built-in ratiometer facilities.

The accuracy is 0.0025% f.s.d., $\pm 0.01\%$ of reading and the resolution is 1 part in 40,000. There are 5 ranges covering from 0 to 2 kV, the sensitivity on the lowest range being $10 \mu\text{V}$. The display can be scaled externally to give direct readings in lb/in.², °C, etc., from voltage analogue inputs. 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 ratiometer facility is an important feature of the instrument in that it enables comparison measurements to be made between voltage ratios and external references; e.g., potentiometer calibration, analogue

computer measurements, etc. Also incorporated are the wide range of facilities featured in the earlier DM instruments: these include full-accuracy maximum and minimum operating modes, and decade outputs in any one of six codes to drive printers, punches, etc. — *Digital Measurements Ltd., 25 Salisbury Grove, Mytchett, Aldershot, Hants.*

For further information circle 10 on Service Card

11. Process Timer

Copley Haddon & Co. have announced an addition to the range of model KF electronic process timers, which is particularly suitable for use in the chemical laboratory.

The P series combine an inbuilt a.c. and d.c. continuously-variable current source with the standard KF timer. A double timer allows for the setting of 'on' and 'off' periods up to 220 sec in 1-sec intervals, with a timing accuracy of $\pm 0.5\%$. Special versions allow for a maximum period of 10 min.

Terminals on the front panel give any a.c. or d.c. voltage in the range 0 to 250 V at $\frac{1}{2}$ A. A calibrated knob selects the output required. According to the setting of links the output voltage may be switched 'on' or 'off' by the timer or maintained continuously.

Apart from the use of this instrument in electro-chemical processes, its

versatility as a combined timer and current source makes it suitable for sequence switching of solenoids and other electro-mechanical devices.—*Copley Haddon & Co. Ltd., Ferndale, Gipsy Lane, London, S.W.15.*

For further information circle 11 on Service Card

12. Gearheads

A series of size 08 gearheads with a length of $\frac{3}{4}$ in. are announced by Bowmar. Using precision ball races and stainless steel pinions, a maximum lost motion of 30 min is achieved in ratios of up to 2,000 : 1.

A starting torque of 0.005 in.-oz is achieved at room temperature, and the operating load torque is 5 in.-oz with maximum momentary overload torque of 25 in.-oz.

Mounting is either by means of four axial screws through the body or by clamp ring. 13-tooth splines or $\frac{1}{4}$ -in. diameter plain output shafts are available. A slip clutch can be incorporated on the output shaft with an increase in length of $\frac{1}{4}$ in.—*Bowmar Instrument Ltd., Sutherland Road, London, E.17.*

For further information circle 12 on Service Card

13. Miniature Soldering Iron

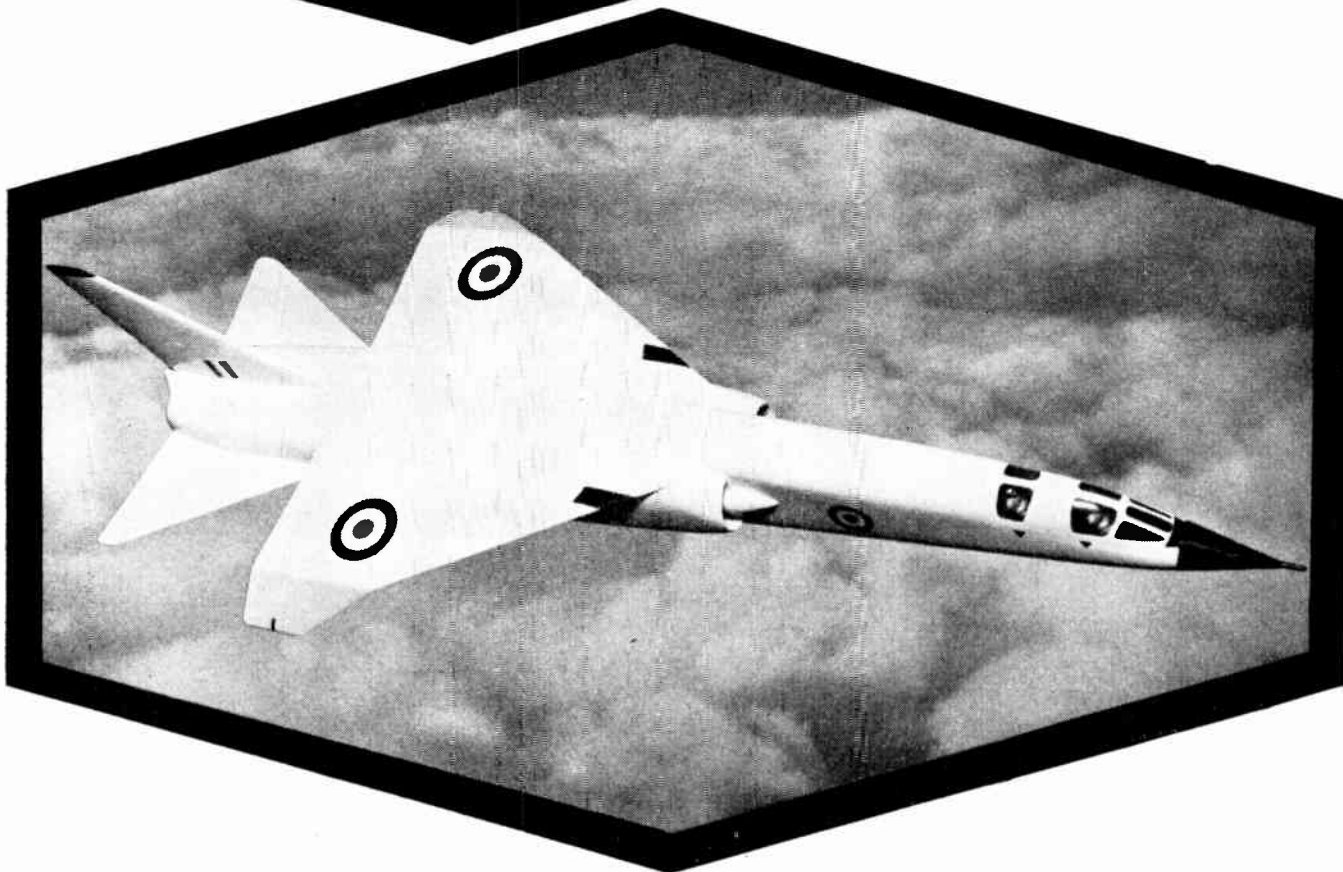
Antex have recently announced the addition to their range of soldering irons of model C240N. This is a lightweight and robust iron with a truly removable bit measuring $2\frac{1}{2}$ in.

(continued on page 483)

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supersonic jets

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The electronic components in a supersonic jet *must* work without failure. Their selection therefore is most critical as only components of the highest reliability and closest tolerances can be accepted. The electronic system in the British Aircraft Corporation TSR2 includes Kemet solid tantalum capacitors. Kemet capacitors are also used in the British Aircraft Corporation VC10, the Hawker Siddeley ship-to-air guided missile Sea Slug, and their air-to-ground guided bomb Blue Steel—fair proof of their reliability in performing vital functions in extreme conditions. But Kemet tantalum capacitors can be more down to earth too. They are best for all terrestrial electronic equipment including computers wherever accuracy and consistent reliability are essential.

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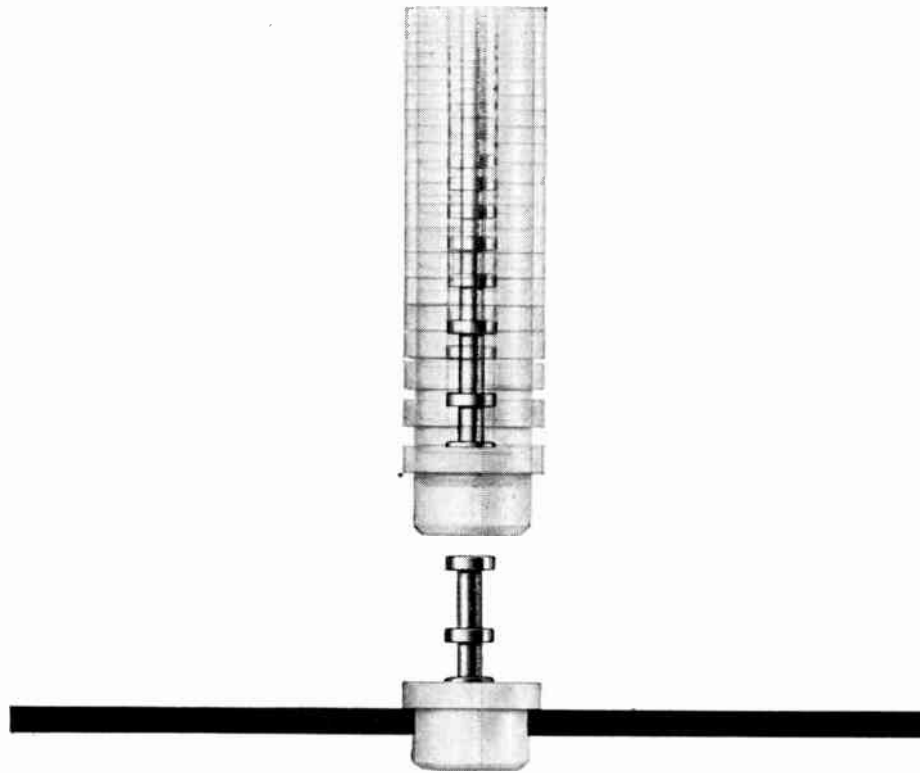
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long $\times \frac{1}{4}$ -in. maximum body diameter.

It is claimed that the 'Ferraclad' bit lasts at least five times longer than nickel-plated bits and provides greater heat capacity and retention. The split skirt of the bit, together with a circular clip, make removal of the bit very easy.

The basic model CN consumes 15 W and is available in different versions for 48-52, 110-120, 120-130, 200-210, 220-230 and 230-240 V operation.—*Antex Ltd., Grosvenor House, Croydon, Surrey.*

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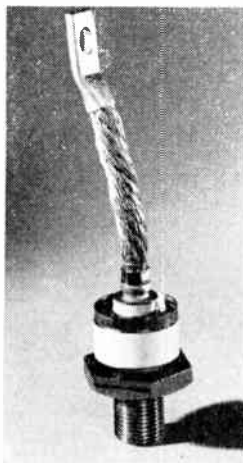
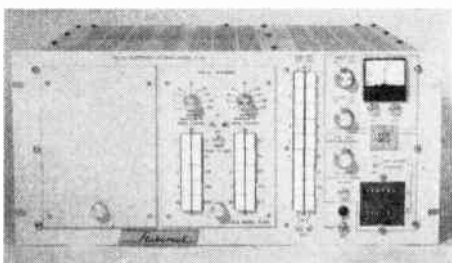
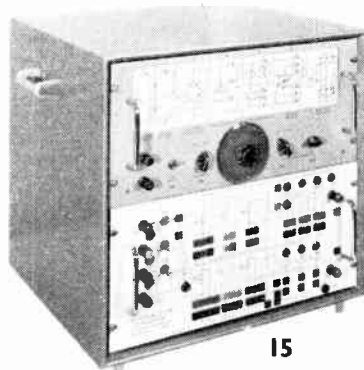
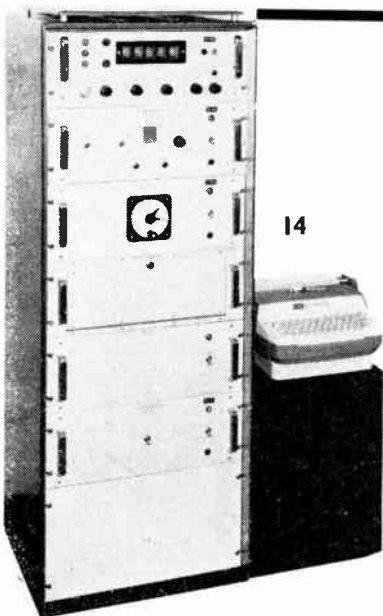
14. Special-Purpose Data Logger

Digital Measurements have recently supplied data-logging equipment to be used for the monitoring of the air-conditioning system installed at the Shell Centre in London. The equipment consists of temperature transducers (platinum resistance air-temperature thermometers) with their associated bridge circuits and a multi-

channel data logger producing a printed output from an automatic electric typewriter. Apart from the typewriter, the standard rack-mounting units are contained in a cabinet 20 in. wide by 18 in. deep by 35 in. high.

The data logger is in a centralized control room and the transducers are at widely spaced locations, necessitating very long cable runs. The equipment monitors temperature over a wide range and the accuracy between 50 and 90 °F is ± 0.5 °F, the resolution being 0.1 °F. The output, which is scaled to read directly in °F, is displayed on a digital voltmeter in the data logger, and is also printed out by the typewriter. The output of any transducer can be indicated on demand, and, in addition, a timing circuit commands the logger to produce a complete statement of all temperatures every half-hour.—*Digital Measurements Ltd., 25 Salisbury Grove, Mytchett, Aldershot, Hants.*

For further information circle 14 on Service Card



15. Universal S.C.R. Converter

With the development of semiconductor devices such as diodes and thyristors (silicon controlled rectifiers), there is a trend to replace conventional mercury-arc equipment. This must be reflected in electrical-engineering courses, and to meet this need F. C. Robinson & Partners have introduced the 'Universal S.C.R. Converter'.

This set is flexible enough to provide all the basic connections, which are obtained by connecting the appropriate sockets on a clearly-engraved front-panel mimic diagram: the student can thus easily trace the circuit he has made. Grid control switches complete the appropriate pulse circuits and illuminate the corresponding panels at the top of the instrument, showing the adopted connection.

The unit has been designed with good safety margins and for protection incorporates fuses at all strategic points. Suitable metering jacks and sockets are provided. The set has a full-range firing angle control and can, therefore, be operated as a rectifier or as an inverter. To represent a high-voltage d.c. transmission link, two sets can be operated together, one as a rectifier and the other as an inverter.—*F. C. Robinson & Partners Ltd., Davies House (2nd Floor), 181 Arthur Road, Wimbledon, London, S.W.19.*

For further information circle 15 on Service Card

16. Drift Stabilizer

Now available from High Volt Linear is the Special Electronic Systems model G.100 'Stabimat', a drift stabilizer for use with multi-channel pulse-height analysers. Gain drifts of detector, photomultiplier, e.h.t., preamplifier, linear amplifier and analogue-to-digital converter can be eliminated, and system gain can be stabilized to better than 0.1%. Also zero drift of the analyser can be eliminated.

Being digital in operation there is no inherent drift due to the stabilizer itself, and drift correction is entirely independent of counting rate. Use of an integral and differential scaler reduces unnecessary corrections due to statistical errors to negligible proportions, and there is no measurable loss of resolution.—*High Volt Linear Ltd., 1 Cardiff Road, Luton, Beds.*

For further information circle 16 on Service Card

17. High Voltage Silicon Diode

International Rectifier Co. has announced a 1,600-V, 200-A bulk avalanche silicon diode. These diodes are claimed as a major improvement in silicon power rectifiers, offering a

EQUIPMENT REVIEW

reduction in the number of series-operated diodes required.

The avalanche voltage increases by 0.1 % per °C, with increasing junction temperature, and substantial power can be dissipated in the reverse direction, e.g. 300 kW for 10 μ sec. Minimum bulk avalanche is 1,700 V at -65 °C.

These devices, classified 200 WAR 80 to 200 WAR 160, are available from 800 to 1,600 p.i.v. A surge rating of 3,000 A for 10 msec and a maximum operating junction temperature of 200 °C make them suitable for the most arduous applications.

Stud-mounted with a glazed ceramic all-welded encapsulation, the diodes are available in anode stud polarity only. Present r.m.s. to p.i.v. ratio can be reduced with improved reliability by inherent protection from transient over-voltages.—*International Rectifier Co., Hurst Green, Oxted, Surrey.*

For further information circle 17 on Service Card

18. Potentiometer Recorder

The Latronics Recordette-4, available from Wessex Electronics, is a portable, self-balancing potentiometer recorder, designed for a wide range of chart speeds, and both ink and inkless recording. Features include an accuracy of 0.5% f.s.d., a sensitivity of 0.25% f.s.d., and full servo performance with a full-scale balancing time of 0.75 sec.

The types 1 and 2 input units provide an adjustable f.s.d. between 10 and 100 mV. Type 3 provides an adjustable f.s.d. between 10 mV and 100 V. Type 4 is designed for thermocouple inputs, providing direct recording of temperature.

Chart speeds from $\frac{1}{4}$ in. per hr to 48 in. per min are available, and the 4-in. wide paper may be fed on to the take-up roll or may be allowed to feed out through a slot at the bottom of the door for immediate reference and tear-off. The panel-mounted version requires a panel cut-out of $6\frac{1}{2} \times 8\frac{1}{2}$ in.—*Wessex Electronics Ltd., Midsomer-Norton, Bath, Somerset.*

For further information circle 18 on Service Card

19. Valve Voltmeter

K.L.B. Electric have introduced the Paco V.70 valve voltmeter, a versatile and robust instrument for use in the workshop, school or laboratory. Its balanced valve bridge circuit assures maximum sensitivity and stability for all measurements.

This instrument has seven d.c. ranges from 0-1,500 V; seven a.c. ranges from 0-1,500 V r.m.s. and 0-4,000 V peak-to-peak; an ohmmeter range of

0-1,000 M Ω and a decibel range of -6 dB to +66 dB.

The V.70 is supplied with a detachable 3-way probe to permit rapid, accurate tests on all types of equipment. Also available are a high-frequency crystal probe and a high-voltage probe which permits direct reading of voltages up to 60 kV. The instrument is priced at £22 12s. or may be purchased in kit form at £20 8s.—*K.L.B. Electric Ltd., 335 Whitehorse Road, Croydon, Surrey.*

For further information circle 19 on Service Card

20. Automatic Feed Control

To obtain maximum efficiency in the processing of materials by milling, grinding, pulverizing or mixing, it is often vital that continuous regulation of the feed rate is maintained. To achieve this, Lancashire Dynamo Electronic Products has introduced a new model in the LDEP Vibrodyne series, the AFC.3 automatic vibrator feeder controller.

The unit is applied as the power source to any half-wave vibratory feeder requiring up to 6.4 A line current at 200/250 or 380/440 V a.c. This provides fully-automatic, self-regulat-

ing control of the feed rate to grinding and pulverizing mills, thereby eliminating the necessity for operator control of gates and manual gears.

A signal derived from the mill-drive motor current is fed via an integrating amplifier to regulate the power and hence the rate of feed from the vibrator. Controls are incorporated in the unit to set the fastest response, allow for time lag, protect against overrating the vibrator and to provide immediate stopping of the feed in event of mill overload. The control can also be applied where there are inherently severe fluctuating load conditions.—*Lancashire Dynamo Electronic Products Ltd., Rugeley, Staffs.*

For further information circle 20 on Service Card

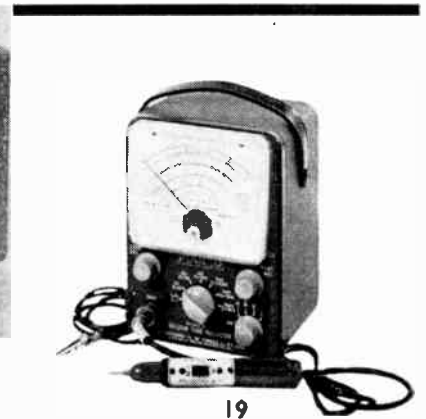
21. Miniature Multi-Pin Connectors

Belling-Lee has introduced additions to the range of miniature 'Unitors', which offer a large variety of small multi-pin connectors comprising from 2 to 36 poles. Maximum rating is 10 A per pole, and breakdown voltage greater than 10 kV.

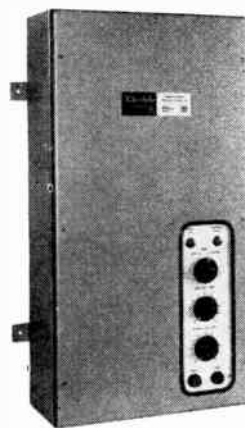
The units now added to the range are a cover and retainer which extend



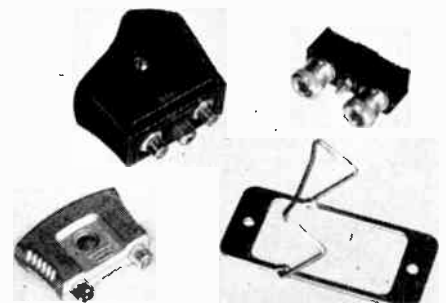
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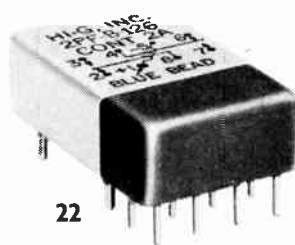
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the range of applications by allowing end-of-cable mounting of one member so that the connectors can be used as conventional plugs and sockets; an improved twin coaxial unit; and a coaxial shorting link.

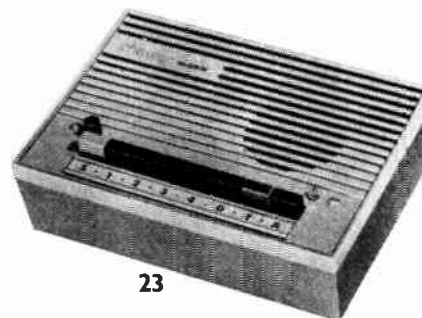
All members in the miniature Unitor series are based on a common module, different mouldings having the same mounting centres and occupying equal amounts of panel space, so that they are physically interchangeable. They also have a central earthing spigot which serves as a locating key for blind insertion and is polarized, giving alternative positionings.

With a single pair of connectors, four non-interchangeable arrangements are possible; with a group of three, using modules with different numbers of poles, there are thousands of possible variations. As inter-chassis connectors, the Unitors can be mounted directly on the chassis; alternatively, shrouds are available to accommodate one, two or three modules in a rectangular cut-out.—*Belling & Lee Ltd., Great Cambridge Road, Enfield, Middlesex.*

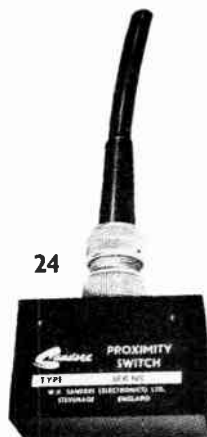
For further information circle 21 on Service Card



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22. P.C. Board Relays

A series of three relays, designed for use on printed-circuit boards, is now available from Hi-G Inc.

The 'Side-Step' relay features a low flat silhouette to improve the packaging factor of the p.c. board. A choice of three sensitivities is available: 250, 100 and 40 mW, all in crystal-can housings.

The dimensions are: 0.4 × 0.8 × 1.255 in. maximum. The relays are designed to meet the requirements of Mil-R-5757D and will operate without chatter while undergoing shocks as high as 50 g and vibrational forces of up to 20 g. Operate and release times are compatible with other Hi-G relays having the same sensitivity. — *Hi-G Inc., Spring Street & Route 75, Windsor Locks, Connecticut, U.S.A.*

For further information circle 22 on Service Card

23. Intercommunication System

Cass Electronics have announced an addition to the Dialog range of transistorized two-way intercommunication systems.

The 'Junior' master station can accommodate up to four sub-stations and has an effective operational range of up to 200 yd. Powered by four 1.5-V flash-lamp batteries which last for up to 12 months, the unit is suitable for both permanent and temporary installations.

A call is made from the master

station by pressing first the station button and then the speaker button. The unit is sufficiently sensitive for the person called to carry on a normal conversation up to 10 yd away from his station unit. — *Cass Electronics Ltd., White Hart Yard, Guildford Street, Chertsey, Surrey.*

For further information circle 23 on Service Card

24. Proximity Switches

W. H. Sanders (Electronics) announce the availability of two proximity switches. These units have been supplied to the U.K.A.E.A. for some time and are now available to industry generally.

The switch will operate when ferrous material is within 0.5 in. of the pick-up head, and the precise distance at which it operates can be adjusted by means of a sensitivity potentiometer. The pick-up head is completely impregnated and encapsulated in epoxy-resin and is unaffected by the conditions met with in most industrial processes.

The two versions available are the type FSPS/042 and the smaller model PDM/3173, which is suitable for use with a bistable transistor amplifier. The smaller unit is designed for assembly within existing transistor

logic systems, but can be used separately as a normal switching element.—*W. H. Sanders (Electronics) Ltd., Gunnels Wood Road, Stevenage, Herts.*

For further information circle 24 on Service Card

25. Biological Oxygen Meter

Electronic Instruments, in association with the Freshwater Biological Research Association and the Water Pollution Laboratory, have produced a portable, rugged and reliable biological oxygen meter for the direct measurement of oxygen in solution; e.g., in the study of pollution and in the treatment of sewage and waste waters.

The E.I.L. model 15A is based on a sensitive stable electrode system with a cathode small in size but having a large active surface. Oxygen reduced at the cathode produces a current proportional to the partial pressure of dissolved oxygen, the value of which can be read off directly from the meter. The electrode, which is designed for total immersion, can be dismantled and reassembled without affecting its calibration.

The model 15A is contained in a

EQUIPMENT REVIEW

sealed metal case which accommodates the oxygen electrode (model A15A) and its temperature compensator. Thus the instrument is ideal for use when measurements must be made in rivers, reservoirs or effluent plants and is equally suitable for laboratory use. —*Electronic Instruments Ltd., Lower Mortlake Road, Richmond, Surrey.*

For further information circle 25 on Service Card

26. Automatic Ultrasonic Cleaner

A fully-automatic ultrasonic cleaning machine, which requires no operators or supervision during the cleaning cycle and which lends itself to complete integration into manufacturing processes, is now available from L. & R. Ultrasonics.

This equipment is designed for general industrial applications ranging from small instrument or watch parts to large components in the automotive and other metal working industries. Components to be cleaned are automatically passed through the cleaning, rinsing and drying stages and a 5-gallon cleaning tank capacity is provided.

The machine is entirely self-contained and requires no special installation of any kind. Automatic cleaning machines without ultrasonic facility and smaller units operating on the same principle are also available. —*L. & R. Ultrasonics Ltd., 20 Northburgh Street, London, E.C.1.*

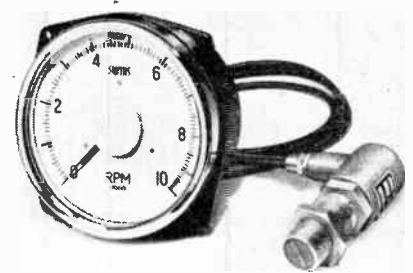
For further information circle 26 on Service Card

27. High-Speed Electronic Tachometer

A 6-in. industrial electronic tachometer is announced by Smiths Industrial Division. Two standard models with scale ranges 0–10,000 r.p.m. and 0–15,000 r.p.m. are available, but indicators with scale ranges of up to 100,000 r.p.m. can be made to order. The tachometer operates in conjunction with a magnetic pick-up, and is therefore suitable for applications where no mechanical take-off is available.

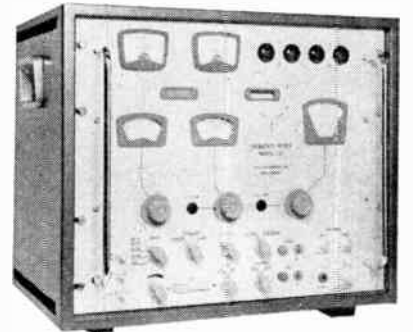
The instrument has a 270° circular-scale moving-coil indicator mounted in a case which also incorporates the transistorized drive circuit. Ferrous lobes on a rotating part of a machine passing in close proximity to the separately-mounted magnetic pick-up generate impulses which are converted into an output proportional to their frequency. Thus the position of the pointer is dependent on the speed of the shaft to which the lobes are attached.

This tachometer requires a 24-V d.c. supply, but as the maximum current consumption is only 100 mA, primary



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cells may be used. The ferrous lobes may be cast, machined or brazed on to a shaft, pulley, spur gear or fly-wheel. Pick-ups are available for use with lobes mounted around the periphery or an alternative head can sense the rotation of a slotted bolt screwed into the centre of an exposed shaft end. —*Smiths Industrial Division, Kelvin House, Wembley Park Drive, Wembley, Middlesex.*

For further information circle 27 on Service Card

28. Improved Frequency Meter

J.A.C. Electronics have announced that the frequency meter and generator type T.D.1 is now replaced by a model of improved layout and design. This is coded 331/C and has a standard 19-in. front panel making it suitable for rack mounting.

The general electrical characteristics of the instrument remain the same. Its range as a frequency meter is from 10 kc/s to 3,000 Mc/s, and its range as a frequency source is from d.c. to 3,000 Mc/s. The reference standard stability is ± 5 parts in 10^{10} at constant ambient temperature, with better than ± 1 part in 10^9 drift per day. Reading accuracy is ± 1 c/s and the sensitivity is 5 mV using magic-eye zero beat detection and 50 μ V using headphones.

Built-in facilities include automatic harmonic identification, direct

measurement of drift about any set frequency, provision of 37,000 standard frequencies (10-kc/s intervals) phase-locked to crystal accuracy, and the facility of amplitude-modulating the output at 1 kc/s.—*J.A.C. Electronics Ltd., No. 4 Station Estate, Blackwater, Camberley, Surrey.*

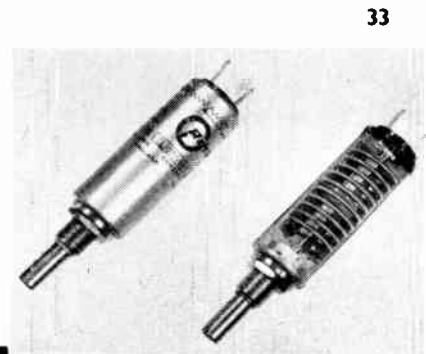
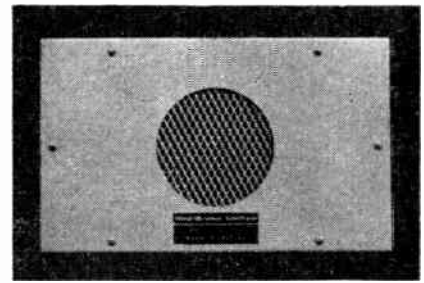
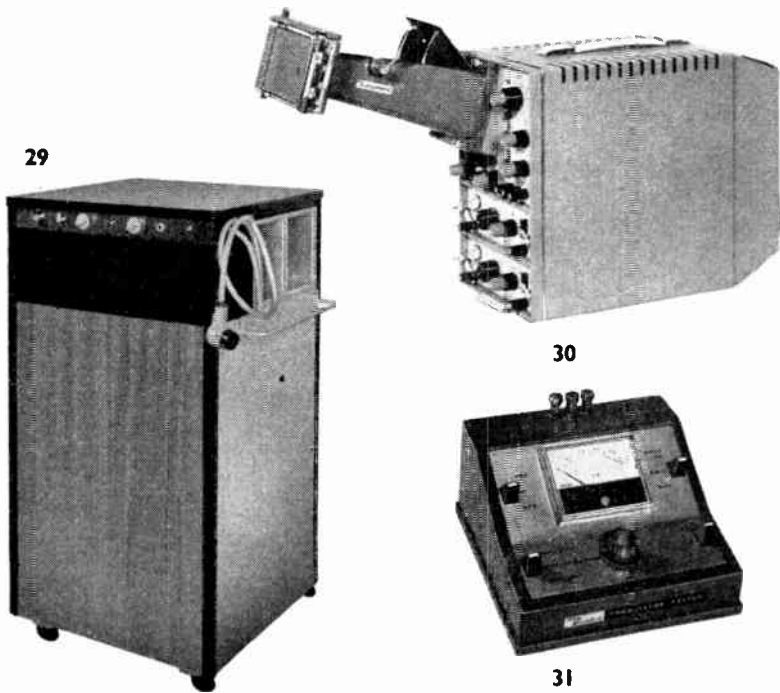
For further information circle 28 on Service Card

29. Bedside Locker Intercom

Two Yorkshire hospitals have ordered a new type of patient's bedside locker incorporating nurse-call communication and radio systems. The units have been designed in collaboration with Leeds Regional Hospital Board by Hadley Telephone and Sound Systems.

The assembly consists of an enamelled-steel chassis with a matt chromium-plated and lacquered brass panel giving a stainless-steel effect. Mounted on the panel, and within immediate reach of the patient, are a 'call nurse' button and a reset button, with a reassurance lamp which lights up to indicate that a call has been received and is being acted upon by the duty nurse.

There is a jack socket to take the patient's push-button remote control switch. Also at the patient's fingertips is a four-programme radio selection switch which can offer the B.B.C. Home and Light programmes and two



television sound transmissions. 'Silent' television is thus possible, with a set in the ward providing only the picture while patients receive the sound through bedside headphones—which can be of the ultra-lightweight stethoscope type.

An 18-core cable with a multi-pin plug enables the unit to be linked to appropriate points so that the lockers may be moved easily as the bed layout of a ward is changed.—*Hadley Telephone & Sound Systems Ltd., Cape Hill, Smethwick, Staffs.*

For further information circle 29 on Service Card

30. Polaroid Oscilloscope Camera

Telequipment have announced a relatively inexpensive oscilloscope camera, the type 'E', which employs Polaroid film up to 3,200 ASA and will produce oscillograms in 10 sec.

Designed for the smaller instrument, the type 'E' utilizes a maximum film size of $2\frac{1}{2} \times 3\frac{1}{4}$ in., and provides for viewing before exposure. A Dallmeyer lens is provided at a fixed object/image ratio of 1:0.7. No focusing is necessary and shutter operation is by simple lever action.

The camera is available with fittings for instant attachment to Telequipment oscilloscopes types S51, D43 and S43, as well as to all other oscilloscopes with Tektronix-type fitting (5-in. centres). Dimensions: length 11 in.,

width $7\frac{1}{4}$ in., height $4\frac{1}{2}$ in. Weight: 6 lb. Price: from £84.—*Telequipment Ltd., 313 Chase Road, Southgate, London, N.14.*

For further information circle 30 on Service Card

31. Compact Transistor Tester

The type 467 transistor tester, recently announced by Bendix Electronics, is compact, simple to operate and capable of measuring leakage and gain characteristics of p-n-p and n-p-n transistors with an accuracy of better than 5%.

Two leakage current ranges are provided: from 0 to 1 mA and from 0 to 10 mA. Gain can be measured from 0 to 200 at a collector current of either 1 or 10 mA. High resolution of each parameter is achieved by employing a 3-in. meter movement to indicate actual values.

The unit is battery or mains operated, and can also be used to check the back-to-front ratio of diodes.—*Bendix Electronics Ltd., High Church Street, New Basford, Nottingham.*

For further information circle 31 on Service Card

32. Continuous Alarm for Robotugs

Hird-Brown announce the availability of their oscillator alarm for driverless vehicles such as Robotugs.

One of the problems associated with the use of driverless tugs is that pedes-

trians do not hear their approach, especially under industrial noise conditions. Ordinary bells and hooters are liable to fail after a short time, because normally they are not designed for continuous operation.

The unit now available, the Mark III, is housed in a small sheet-steel case which holds all the necessary electronic circuitry and a loudspeaker to transmit a high-pitched and intensely audible signal. The unit is suitable for 24 V d.c. and is continuously rated, several thousand hours having been achieved with the prototype units.—*Hird-Brown Ltd., Flash Street, Bolton, Lancs.*

For further information circle 32 on Service Card

33. Helical Potentiometers

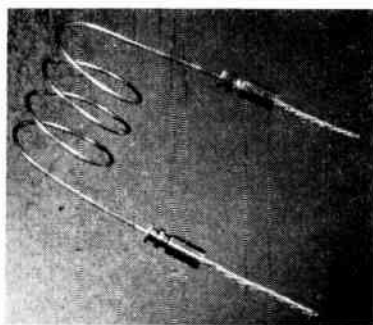
The $\frac{3}{4}$ -in. diameter helical potentiometers manufactured by Reliance Controls are now available in 5- and 10-turn versions with various improvements.

The end-stop torque has been increased to 5 lb in. and the end terminal is formed as a permanent clip with a two-point contact ensuring that any float would have no effect on the continuity of the instrument. A new method of bush mounting maintains rigidity throughout.

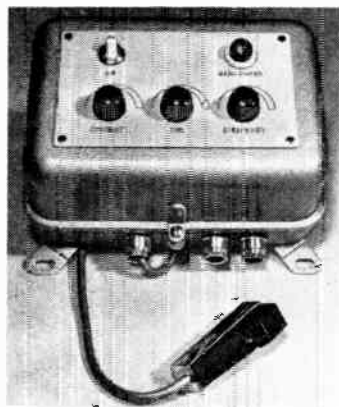
Both the 5- and 10-turn types are now in production with standard linearities of $\pm 1\%$ or $\pm 0.5\%$, and



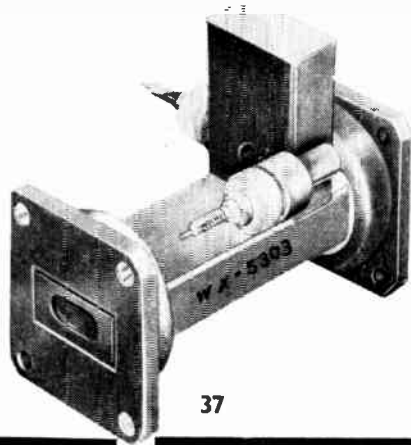
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$\pm 0.25\%$ to special order. The resistance range is from 10Ω to $50 \text{ k}\Omega$. Values up to 1.5Ω are possible as a slide-wire version. Fully sealed versions of all types are available.—*Reliance Controls Ltd., Relcon Works, Sutherland Road, London, E.17.*
For further information circle 33 on Service Card

34. High P.R.F. Laser

A high repetition-rate laser developed especially for industrial applications has been introduced by Raytheon. The model LE-1 laser features precisely-controlled reproducibility for use in repetitive manufacturing processes. It is expected to be used for micro-drilling, micro-welding, micro-metal removal, and precision hole drilling. Typical applications include balancing gyros and balance wheels, trimming resistors, and drilling filters and spinnerets for the textile industry.

This water-cooled device employs a $6\frac{1}{2} \times \frac{1}{8}$ -in. ruby rod and is capable of producing more than 10 joules of energy per pulse at a rate of one pulse

per second: pulse width is variable from 1 to 10 msec. The laser is capable of drilling holes less than 0.0002 in. in diameter, and when operated in a short pulse mode and fitted with a Q-switch, it can also serve as a transmitter for ranging and optical radar systems.—*Raytheon-ELSI, S.p.A., Villagrazia, Palermo, Italy.*
For further information circle 34 on Service Card

35. Photo-electric Scanning Device

A Visolux photo-electric device now available from Simmonds Relays is the RL.1, a photo-electric reflecting light gate for scanning printed edge marks on paper, plastic and other moving reeled materials without making physical contact. Equipped with an impulse amplifier, the RL.1 can initiate operations such as guillotining.

The equipment consists of a scanning head containing a projector lamp and receiver, the whole unit measuring 65 mm long \times 18 mm across and 30 mm maximum depth. The scanning head is joined to the mains ampli-

fier by a 2-metre cable lead. The impulse amplifier switch is fully transistorized and contains a built-in a.c. mains pack for 240 V 50 c/s and, in addition to an on/off switch and a mains warning light, is fitted with three controls for adjusting contrast sensitivity and time delay. The fall-off delay of the output relay is adjustable between 40 and 150 msec.

The amplifier is fitted with three fixing lugs and measures 190 mm \times 140 mm across. The relay switch is fitted with changeover contacts (2 A non-inductive at 240 V a.c.), and as a result can be operated either by a make or break current.—*Simmonds Relays Ltd., South Road, Edinburgh Place, Harlow, Essex.*

For further information circle 35 on Service Card

36. Mineral-Insulated Heaters

Spemby Technical Products have now extended their range of Thermocouple products to include mineral-insulated heaters. These heaters are basically Nichrome elements contained in an Inconel sheath with highly-compressed magnesia powder as insulation.

The ends of the cable are supplied with high-temperature sealed terminations capable of withstanding 500°C and fitted with flexible nickel leads. The heaters can be supplied to the customer's requirements in any length and configuration and in various diameters.

An experimental service is also available for heater and thermocouple rigs. If required, experimental heaters can be centrifugally cast into alloy shapes to increase the effective heat dissipation area.—*Spemby Technical Products Ltd., New Road Avenue, Chatham, Kent.*

For further information circle 36 on Service Card

37. Microwave Switching Valve

An externally-controlled microwave switching valve, called a 'tail-clipping tube', has been developed by Westinghouse for use on systems requiring clean and sharp transmitter pulses.

The WX-5303 reduces both the pulse fall time and the output pulse-width. The fall time of the transmitter pulse can be decreased to about 15 nsec. Since the valve is externally triggered, it can discharge at any selected time during the transmitter pulse.

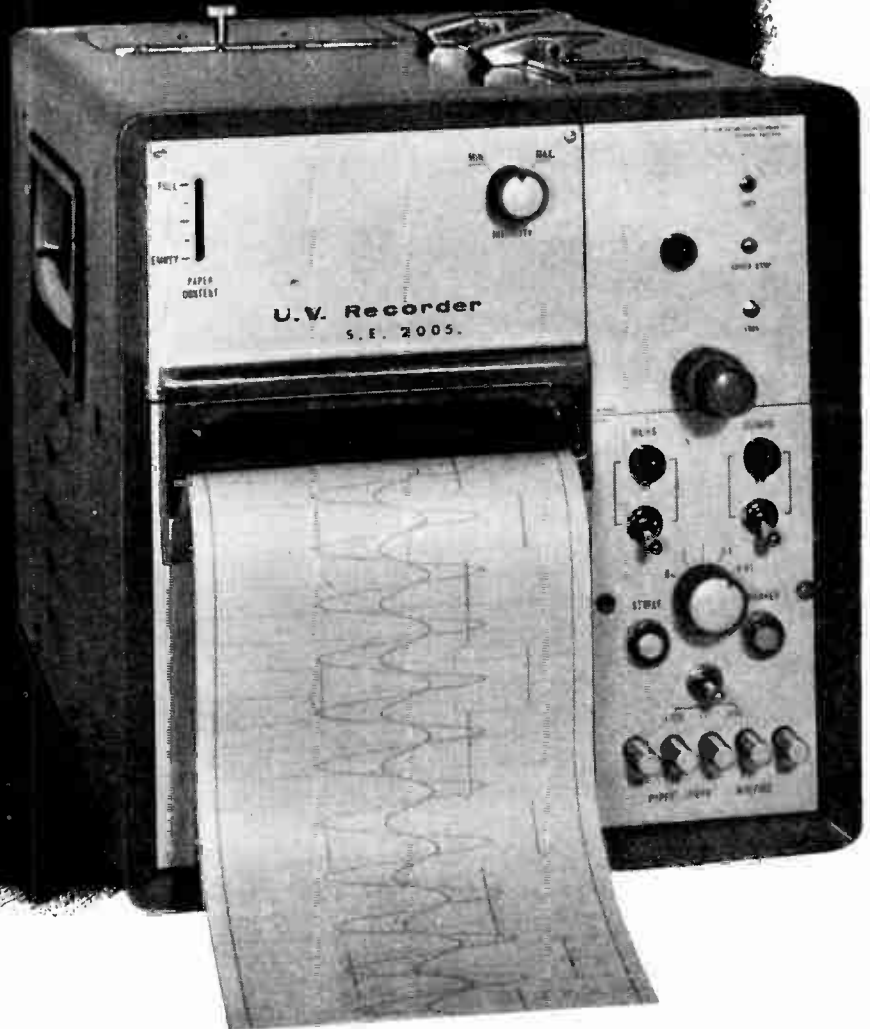
Designed for the 9.0 to 10.0 Gc/s frequency range, the valve operates over any 100-Mc/s band within this spectrum, as specified by the user, and provides 15-dB attenuation within 15

(Continued on page 489)

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COMPLETE INSTRUMENTATION SYSTEMS

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are chokes whose impedances may be varied by the flow of the direct current in the special winding. Fully tapped reactors are designed to vary the input voltage to any load between half and full rating of the reactor itself, from near zero to the full operating voltage, at mains voltages between 380/440v, 200/250v and 100/120v, A.C., 50 cycles, by the application of a small direct current on the control winding.

Correx reactors are available in standard ranges for powers up to 180 kVa per circuit on three phase operations. This refers to the 100% rating and not the possible uprating granted where reactors may be used on an intermittent rating i.e. furnace control where the rating utilization at control point may be as low

as 60%. In addition to the well known Correactor and A.C.R. reactor this range includes Toroidal reactors and Auto-excited transductors.

ABSENCE OF MOVING PARTS

No brushes, contacts, etc. to wear out. No maintenance is required.

CONSERVATIVE RATING

For intermittent use particularly where current is drawn for a short period, these reactors will stand large overloads. They can therefore be considerably uprated for those applications where these intermittent requirements obtain.

REMOTE CONTROL

As a small potentiometer only is required for the D.C. control, the reactor need not be mounted on the control panel, and may be installed elsewhere.

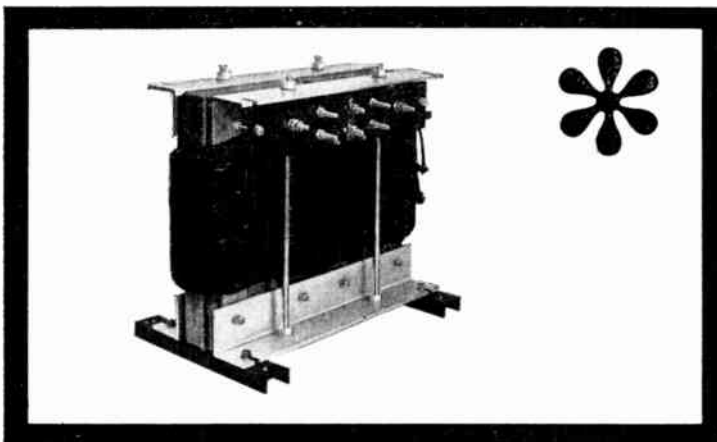
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nsec after the trigger voltage is applied. Other operating characteristics include: 0.4-dB insertion loss; 80-kW r.f. peak power; and a trigger spike of 2 kV.—*Westinghouse Electric International Company, Electronic Tube Division, 200 Park Avenue, New York, N.Y., U.S.A.*

For further information circle 37 on Service Card

38. Programmable Guillotine

William Crosland have recently introduced the Hydra 42 series guillotine, designed to meet the needs of printers and boxmakers for a highly versatile machine, which features provision for optional automatic programming which can either be supplied at the outset or added subsequently as the need for this facility arises.

The automatic programming unit, which can provide either semi-automatic or fully-automatic control, uses magnetic tape on which up to 24 programmes can be stored; any two adjacent programmes may be linked. The programmes are set by push-button, and the unit includes a programme correction device and provision for the checking of any

programme without cutting.—*William Crosland Ltd., Bredbury, Stockport, Cheshire.*

For further information circle 38 on Service Card

39. Swiss Connectors

Sealectro have been appointed sole U.K. agents for the Swiss Fischer range of coaxial and multi-pin connectors. Features include an improved latch which prevents accidental breakaway, ease of assembly and an interchangeable collet-type cable clamp which will accommodate a wide variation in cable diameter.

The range covers styles for cable-to-cable and cable-to-chassis connection, in up to 40 ways. Contacts may be specified for high voltage, high current or a combination of both. Sealed types are also available.—*Sealectro Ltd., Hersham Trading Estate, Walton-on-Thames, Surrey.*

For further information circle 39 on Service Card

40. Low-Noise P-N-P Transistor

Crystalonics Inc. have announced the availability of the 2N3059 high-gain low-leakage p-n-p silicon transistor.

A 2-dB noise figure at 1 kc/s with a 100-kΩ source impedance makes this device suitable for high-impedance low-noise amplifiers.

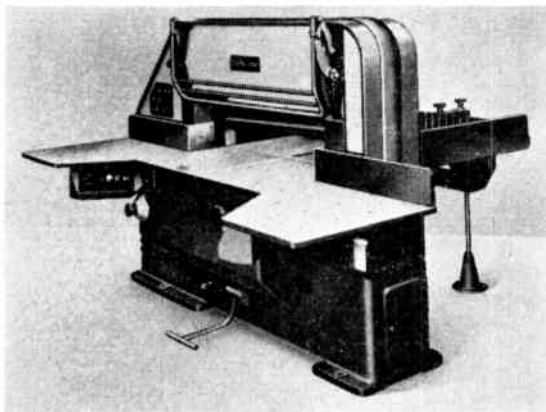
Beta is 100 to 300 at 10 μA collector current. Collector cut-off is 0.1 nA maximum. The 2N3059 is manufactured by an epitaxial junction process and is supplied in a TO-46 package.—*Crystalonics Inc, 147 Sherman Street, Cambridge 40, Mass., U.S.A.*

For further information circle 40 on Service Card

41. Thermocompression Bonder

Recently introduced by G. V. Planer is equipment designed for the production of thermocompression bonds, particularly for bonding leads to thin-film microcircuits and to semiconductor materials and devices, etc. Special features of the apparatus are precision micromanipulators with X, Y and Z motion and double-stem 'chessman' controls, independent thermostatic control of the bonding chisel and substage, and the flexible configuration of micromanipulator and substage positions on the work desk.

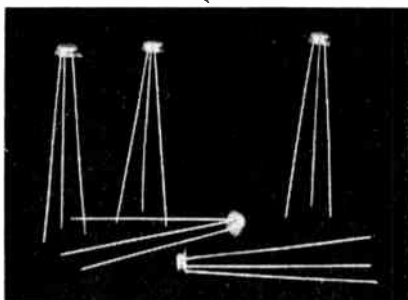
Two micromanipulators are included in the equipment, one carrying



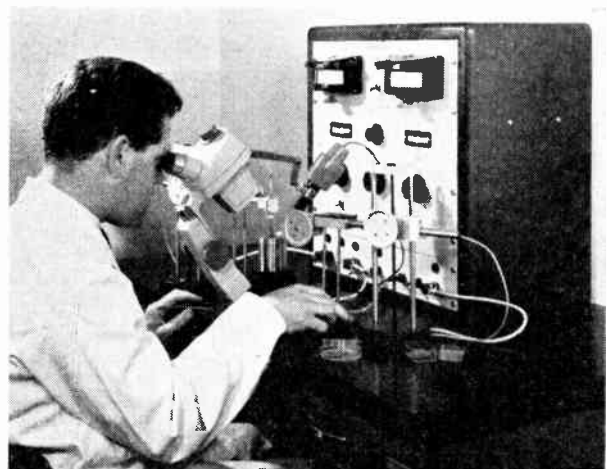
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EQUIPMENT REVIEW

the bonding chisel with variable load, the other the compressed-air assisted wire-feed appliance. The latter is designed to accept standard spools, being suitable for wires of between 0.0005 and 0.01 in. in diameter. A wire cutter is mounted at the nozzle of the feed mechanism. The bonding chisel and substage can be maintained at temperatures of up to 600 °C, with provision for the issue of inert gas over the working area, if required.

A stereo-zoom binocular microscope with continuously variable magnification of $\times 7$ – $\times 30$ or $\times 14$ – $\times 60$ and adjustable illumination is incorporated. The operating components and the control console are mounted on a steel desk with a surface area of 2 ft 6 in. \times 4 ft.—*G. V. Planer Ltd., Windmill Road, Sunbury-on-Thames, Middlesex.*

For further information circle 41 on Service Card

42. Modular Vacuum Unit

Torvac have announced a modular vacuum unit equipped with electron-beam equipment for metallurgical studies.

The unit illustrated incorporates two

standard 18-in. vacuum tanks, a 1,500 litre/sec diffusion pump, and accessories for welding, melting and evaporation.

A rotary manipulator is fitted which allows rotary movement to be fully controlled between 0 and 20 r.p.m.; a composite x-y manipulator is also supplied.—*Torvac Ltd., Histon, Cambridge.*

For further information circle 42 on Service Card

43. Electronic Beekeeping Device

Gauging Systems have introduced an electronic beekeeping device which is claimed to reduce labour costs, and increase honey production, by providing an early warning of swarming.

Normally each hive is taken apart every nine days in search of danger signs. With this device a filter amplifier is used to detect these signs from the outside of the hive through a crystal microphone, without disturbing the bees. The operator wears a pair of headphones and a visual indicator acts as an additional guide.

The 'Apidictor' consists of a high-

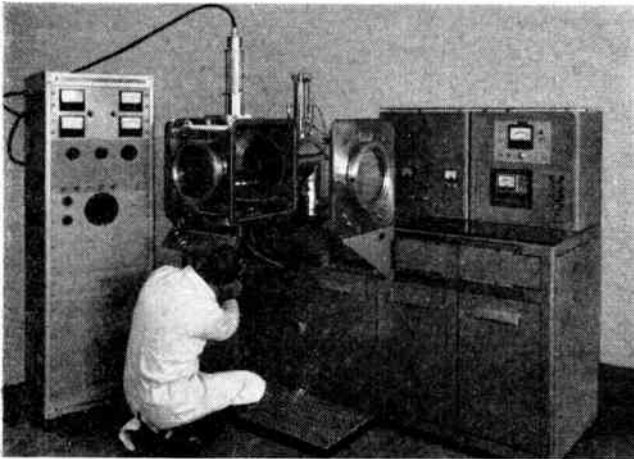
gain audio amplifier with three frequency bands: 80 c/s–10 kc/s, 1.6 kc/s–10 kc/s, and a narrow pass-band of 240–280 c/s. The amplifier and filter assemblies are mounted on printed-circuit boards, and the complete unit measures 5 \times 3 $\frac{1}{4}$ \times 1 in. Weight: 12 oz. Powered by a 9-V battery, running costs work out at about 2s a year. Price in the U.K.: £40.—*Gauging Systems Ltd., Royston Road, Baldock, Herts.*

For further information circle 43 on Service Card

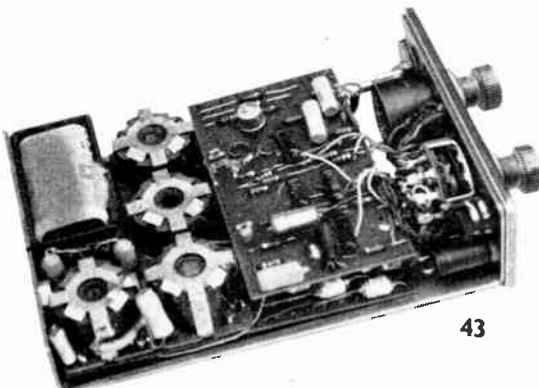
44. Under-Floor Heating Control

Findlay, Irvine have recently introduced a version of their 'Miniprobe' electronic thermostat, designed for the control of under-floor heating. Complete with a delayed-charge controller to take advantage of off-peak tariff systems, the unit costs £33.

Two remote sensing probes are used: one is located under the centre of the floor, and the other outside the house. The internal probe provides accurate control of the heat output, while the external probe compensates for outside weather conditions.



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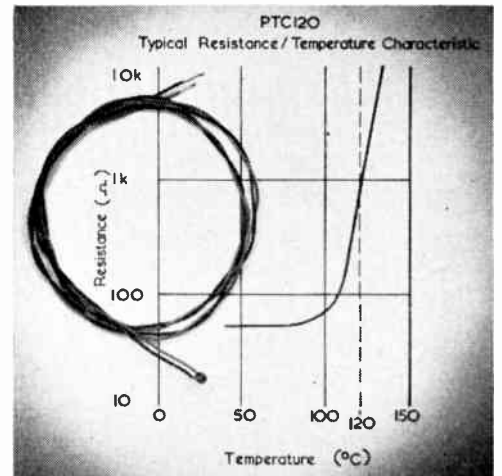


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Where off-peak electricity tariffs are available the compensating probe ensures that during very cold weather the necessary extra store of heat is obtained at low tariff. As a further refinement a delayed-charge controller is fitted: this delays the charge so that the desired temperature is reached at the end of the off-peak period, thus avoiding the waste of maintaining a high floor temperature while the building is empty.

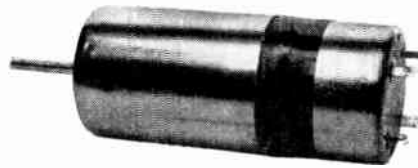
The desired temperature is selected by a calibrated switch, and the delayed-charge controller set to the time when the charge is to begin on a normal time switch. Once set, the controls need never be altered as all compensations are made automatically. The control box can be mounted up to 400 ft from the sensing probes alongside the mains, fuses and switches. All the electronic equipment is fully transistorized.—*Findlay, Irvine Ltd., Penicuik, Midlothian, Scotland.*

For further information circle 44 on Service Card

45. Thermistor

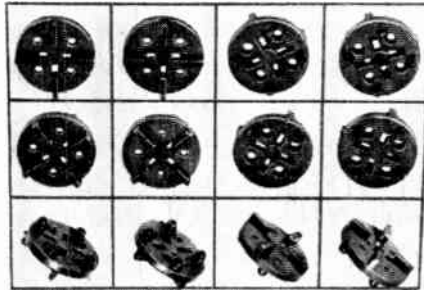
The first of a STC range of positive temperature-coefficient thermistors is announced. This is the PTC 120, which has been specifically designed for the protection of motors, generators, transformers and other equipment against excessive temperatures which might cause damage to the winding insulation. Nominal threshold temperature of the device is 120 °C.

The thermistor element is 0.186 in. in diameter, and the outer casing is



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tumbler de-burred so that it can be included in windings without any risk of removal of enamel insulation from the coils. The leads are arranged as a twisted pair and the standard length is 24 in. Other lengths can be supplied, and, for three-phase working, multiple arrangements of the PTC 120 are available.

The photograph shows the PTC 120 thermistor against a graph of its temperature/resistance characteristic.—*STC Semiconductor Division (Transistors), Footscray, Sidcup, Kent.*

For further information circle 45 on Service Card

46. Silicone Sealant

A silicone rubber sealant and adhesive which cures at room temperature has just been introduced by Midland Silicones under the trade name Silastoseal 'A'. This material is similar in performance to their existing silicone sealants Silastic RTV 731 and 732, but shows two significant advantages over these grades. Silastoseal 'A' is up to 35% cheaper than RTV 731 and up to 20% cheaper than RTV 732. In addition, it does not liberate acetic acid while curing.

Silastoseal 'A' is a one-component material with paste-like consistency. It can be readily extruded from the container and is easy to work. Once in place, however, it will not flow or slump, and it will cure on contact with atmospheric moisture to form a resilient heat-stable silicone rubber. Its moisture-resistance and heat-stability (up to 150 °C for extended periods and 250 °C for short periods)

make it suitable for a wide variety of adhesive, sealing and caulking applications.

Silastoseal 'A' is supplied in 2-oz and 5-oz tubes, in 6-oz and 12-oz polythene cartridges for use with a hand- or power-operated caulking gun and in 40-lb drums. A small free sample tube is available from the manufacturer.—*Midland Silicones Ltd., 68 Knightsbridge, London, S.W.1.*

For further information circle 46 on Service Card

47. F.H.P. Motors

Union Carbide are now marketing in the U.K. the complete range of f.h.p. motors produced by Dunker Motors of Bonndorf, West Germany.

Dunker has developed and is currently manufacturing the GK range of high-efficiency precision d.c. motors which feature low current drain, reliability and long life. They are designed for driving record players, tape recorders, oscillographs, cameras and similar instruments.

By utilizing an iron-free armature the motor iron losses are reduced to a very low level. The highest efficiency is of the order of 75% and the average efficiency over 60%. The smallest motor in the range, type GK.16, measures 1 $\frac{3}{8}$ in. long \times $\frac{3}{8}$ in. diameter and can develop a torque of 0.138 oz in. at approximately 2,000 r.p.m.—*Union Carbide Ltd., 8 Grafton Street, London, W.1.*

For further information circle 47 on Service Card

48. Universal Transistor Mounting Pad

A transistor mounting pad, type TO518-001, designed to accept both TO5 and TO18 transistors, has been announced by Jermyn Industries.

One side acts as a conventional TO5 mounting pad and the other acts as a TO18 to TO5 converter. Made in black nylon, the component is claimed to be the lowest priced nylon mounting pad available in the U.K. today, and large stocks are kept for 24-hour delivery.—*Jermyn Industries, Vestry Estate, Vestry Road, Otford Road, Sevenoaks, Kent.*

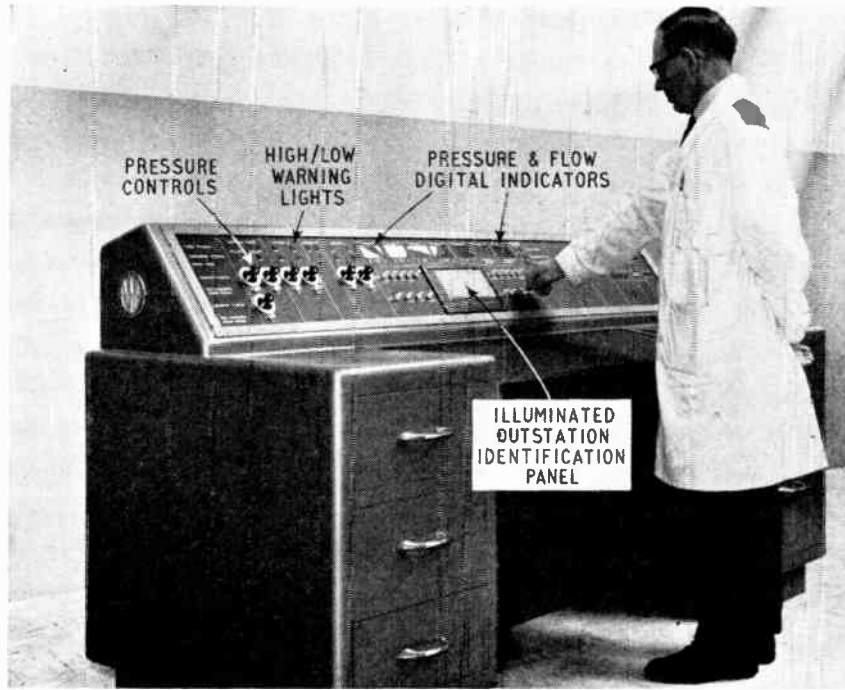
For further information circle 48 on Service Card

Price Reduction

In last month's Equipment Review (p. 432) we described the Visual Engineers FA 41 closed-circuit television camera and gave the price, less tube and lens, as £238. The manufacturers inform us that, as a result of a recent price revision, this camera now sells at £190, less tube and lens.

Illustrated here is the central control console with the various controls and displays indicated

EASTERN GAS TELEMETRY SYSTEM



THE Eastern Gas Board are having installed a remote control and telemetry system to provide central monitoring and control facilities for four outstations. In addition, the master-station equipment is designed to cater for a further 12 outstations.

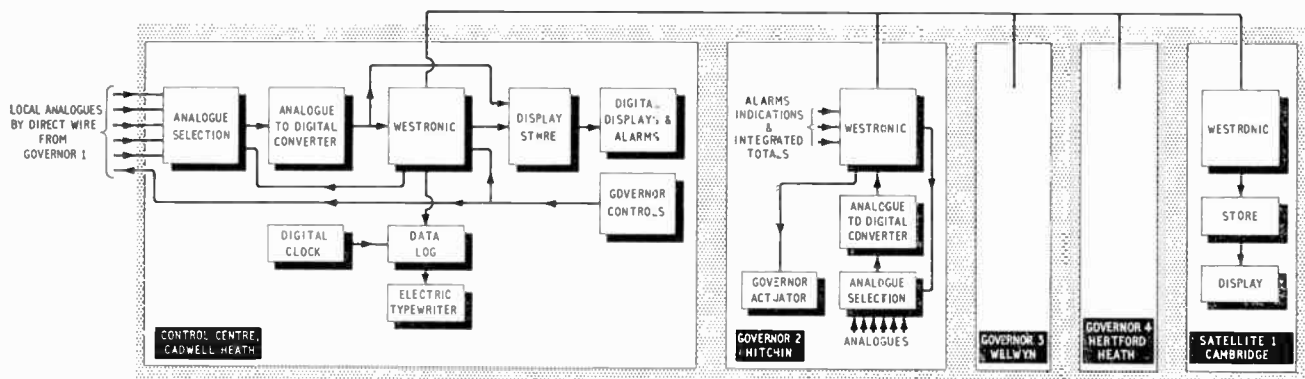
With this four-outstation installation, it will be possible to control from one central point at Cadwell Lane, Hitchin, the distribution of ordinary town gas from Hitchin to Hitchin 'A' station, Welwyn, Hertford Heath and Cambridge. At the same time the equipment provides facilities for monitoring pressure and flow at various points at the outstations along with automatic alarm-condition signalling for each station.

From the central control console an operator can press a switch and connect with any of the outstations. Immediately he does so, a panel identifying the station is illuminated, the seven pressure and flow indicators on the console are each set to zero and a switching or scanning cycle is initiated. During the scanning cycle, which lasts 80 sec, pressure at up to 5 points at the outstation is measured and transmitted to the control console indicators

and flow at up to 2 points is measured and also transmitted back to the console indicators. Thus, having interrogated an outstation the operator has before him, after 80 sec, actual readings of pressures and flow. Up to 2 volumetric governors are available to the operator to open and close remote control valves at the outstation in 5% incremental steps. While one station is being interrogated the others are still connected directly to the control console and should an alarm condition develop this will be automatically signalled on the control panel. Automatic logging and on-demand print-out facilities provide a permanent record of the distribution system throughout the day. Normally automatic hourly readings are made and printed out, but the operator can print-out readings at any time by pressing a switch.

The complete installation is based on the Westinghouse 'Westronic' electronic remote control and indication system. This is a transistor equipment capable of transmitting and receiving any number of controls and indications over a two-line wire or a radio link. In this particular installation, three outstations are connected to

A schematic of the complete Eastern Gas Board installation

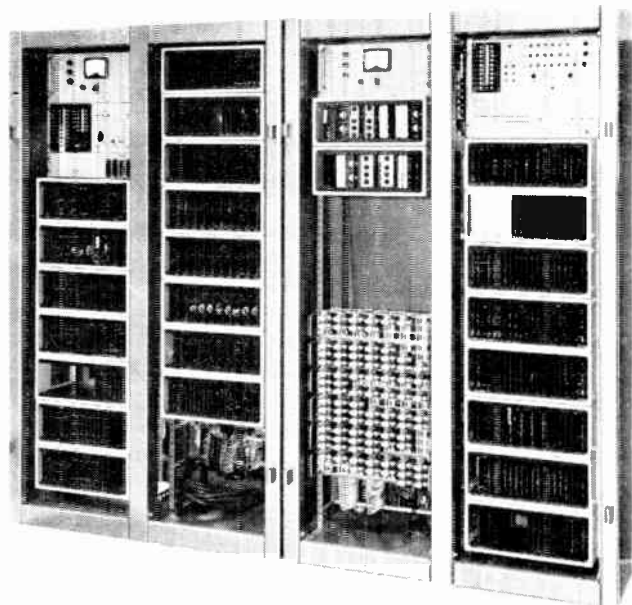


This shows the racks of units associated with central control

central control by G.P.O. telephone lines; the remaining outstation, being very close to the control console, is connected by multi-core cable. To achieve simultaneous telephone conversation and telemetry working, speech frequencies are limited to between 300 c/s and 2.1 kc/s and the band above 2.2 kc/s is used for the telemetry signals.

The equipment operates on a time-division multiplex principle, where the link is allocated successively to each of a number of channels for a brief period of time; there being as many channels as there are functions in the installation. During each period of time, information (pressure, flow etc.) is transmitted from one end and received and printed out or displayed at the other end. At the finish of that period of time the equipment moves to the next function and the process is repeated. By this means a number of functions is scanned successively, each piece of information being received at control as it is sent.

For further information circle 72 on Service Card



Theft, Fire or Flood Warning Equipment

Entry of thieves into an unattended building, or an outbreak of fire on the same premises, are two of the contingencies which can be made known almost immediately at a chosen control point hundreds of miles away by an automatic remote alarm system developed by E.M.I. Electronics.

This equipment will automatically announce any alarm condition, using the public telephone network. It can be used independently or, when specific measurements are to be transmitted, in conjunction with a telemetry system.

The basis of the equipment is a magnetic tape recorder, which is switched on by the alarm condition and which then performs the operations required to institute a telephone call. When the telephone connection is established and the receiving station acknowledges it, the transmitter passes over a verbal message giving the state of the installation which it is monitoring. The system can either dial, on an automatic exchange, or ask for two alternative telephone numbers, and pass several messages.

How it Works

When an event occurs which amounts to an alarm condition, the tape deck is automatically started. On an automatic telephone exchange, it dials a telephone number recorded on the first track of the tape. If the number is unobtainable or does not answer after several seconds, the equipment dials a second number, recorded on the second track of the tape. If it cannot get through on this number, it tries the first again. After some more alternative trials, if it still cannot get through it will pause for several minutes, then try again and again until it makes contact.

When the telephone call is established, the alarm system announces itself by a verbal message recorded on the third track of the tape. When this message is acknowledged by the receiving station, which is merely a telephone set with a small code generator added, an appropriate message is passed giving details of the alarm condition. Suitable

messages are recorded on several tracks of the tape. After passing the message, the alarm system shuts down.

A further facility built into the system is the ability to interrogate the transmitter from the authorized receiver. This confirms that a long silence is really due to the fact that no alarm conditions have occurred and not to a breakdown in the installation. All the messages are verbal messages recorded on the magnetic tape. If the installation happens to be on a manual exchange, verbal messages asking for the receiving station numbers are recorded on the first two tracks of the tape.

The equipment can be used in conjunction with a telemetering system. In this case, not only verbal messages but actual measurements can be transmitted. When an alarm condition occurs, the alarm system dials the receiving station or asks for its number, and the actual state of the guarded installation is transmitted as measurements to the receiver. When the transmitter is interrogated, actual measurements are also transmitted instead of verbal messages.

There are various possible combinations between the alarm and telemetering systems, from a simple system giving verbal messages to a complete system giving measurements over the public telephone system.

For further information circle 73 on Service Card

INFORMATION WANTED ?

If you require further details of products or processes described or advertised in INDUSTRIAL ELECTRONICS you will find it convenient to use the enquiry cards which will be found in the back of the journal. The sheet of cards can be folded out to enable you to make entries while studying the editorial and advertisement pages.



Personal and Company News

Aero Electronics Ltd. have taken over the complete production capacity of G3SJ Quartz Crystals Resonators Ltd. and M. H. Nicholas, a director of Aero Electronics has joined the board. The Plymouth factory is now known as Aero Electronics (Crystals) Ltd., Scoba Works, Stonehouse Street, Plymouth, S. Devon. Administration and sales will be handled through the head office at Gatwick House, Horley, Surrey. Telephone: Horley 5353. Telex: 87116. Cables: Aerocon, Horley.

The appointment of two new directors has been announced by **AEI Automation Ltd.** They are L. Drucquer, divisional director and general manager, Heavy Plant Division, AEI Industrial Group; and C. H. Flursheim, director of engineering, AEI Power Group.

The Industrial Electronics and X-Ray Division of **Livingston Laboratories Ltd.** has been appointed exclusive representative in the U.K. by Instrument Development Laboratories, Inc., for the sales and service of their colour measuring equipment.

International Telephone and Telegraph Corporation of New York has formed a new company in the United Kingdom under the name of **ITT Industries Ltd.** The new company has broad interests in the fields of heating, air-conditioning and automatic controls. The chairman is Rex B. Grey, managing director of STC Ltd., an ITT affiliate.

Vactric Control Equipment Ltd. announce that they have acquired the whole of the issued share capital of A. P. Besson & Partner Ltd., designers and manufacturers of miniature microphones, earpieces, transformers, electro-mechanical and industrial electronic equipment.

The Transatron Electronic Corporation of Wakefield, Massachusetts, U.S.A., has announced the appointment of Dennis O'Connell as director and general manager of the company's U.K. subsidiary, **Transatron Electronic Ltd.**

Wayne Kerr announce that J. A. Enwright has been appointed general manager of the Laboratory Company and G. L. Ball, general manager of the Instrument Company, in charge of production and sales.

To meet the increasing data-processing needs of merchant banks, stockbrokers, unit trusts, building societies, and hire purchase finance companies, **IBM United Kingdom Ltd.** has opened a new finance branch office, its fourth branch in the City of London. Located at Lee House, London Wall, this branch is managed by R. S. Sayers, a member of the Institute of Bankers.

Dr. J. E. Hughes has been appointed general manager, research and development, to **Johnson, Matthey & Co. Ltd.**

Erg Industrial Corporation Ltd. have appointed Gothic Electrical Supplies Ltd. of Gothic House, Henrietta Street, Birmingham 19, as Midland distributors for their range of vitreous wirewound resistors types RWV4J, RWV4K and RWV4L.

Major-General E. S. Cole, C.B., C.B.E., formerly director of telecommunications at the War Office, has been appointed managing director of **Granger Associates Ltd.** of Weybridge, Surrey. This company, which specializes in the field of h.f. radio communication, is the wholly-owned subsidiary of Granger Associates of Palo Alto, California.

The M.E.I. Equipment Co. Ltd. are to extend their factory and office facilities at Manor Royal, Crawley, Sussex. An additional factory block of just over 100,000 sq ft is to be erected, and a new six-storey office building with a total floor area of 40,000 sq ft. The buildings are expected to be completed in the autumn of 1965.



ENVIRONMENTAL TESTING OF COMPONENTS—A member of the engineering staff of the Plessey environmental test laboratory at Titchfield places relays in one of the laboratory's chambers. Practically any natural or extreme condition of temperature or humidity can be reproduced by the equipment, which is now extensively used for quality testing of professional components

E.M.I. Electronics Ltd. and Ing. C. Olivetti & Co. S.p.A., of Ivrea, Italy, have recently concluded an agreement under which E.M.I. will assume responsibility for the marketing and maintenance of the Olivetti continuous-path machine tool control system in the United Kingdom, EFTA (except Switzerland), British Commonwealth countries (except Canada) and a number of other areas. E.M.I. will also provide a computer programming bureau.

Polymer Consultants Ltd., High Church Street, New Basford, Nottingham, announce that they have been appointed sole distributors of equipment manufactured by Yarsley Testing Laboratories Ltd. This equipment is designed mostly to comply with the requirements of various standards for testing the physical properties of plastics, rubber, synthetic resins, etc.

Aircraft-Marine Products (G.B.) Ltd. have moved to new and larger offices at Terminal House, Stanmore, Middlesex. Telephone: Stonegrove 6341.

James McG. Sowerby has joined the board of **English Electric-Leo Computers** as technical director.

C. F. Dietrichsen, M.A., A.M.I.E.E., has joined the board of **Radiovisor Parent Ltd.**

Erie Resistor Ltd. have announced the formation of a European subsidiary company to promote sales of the company's products in Benelux, Western Germany and neighbouring countries. The name of the company is Erie Continental S.A., and it is located at 140 Avenue Eugene Plasky, Brussels 4, Belgium. The Sales Manager will be J. P. Neckebroek.

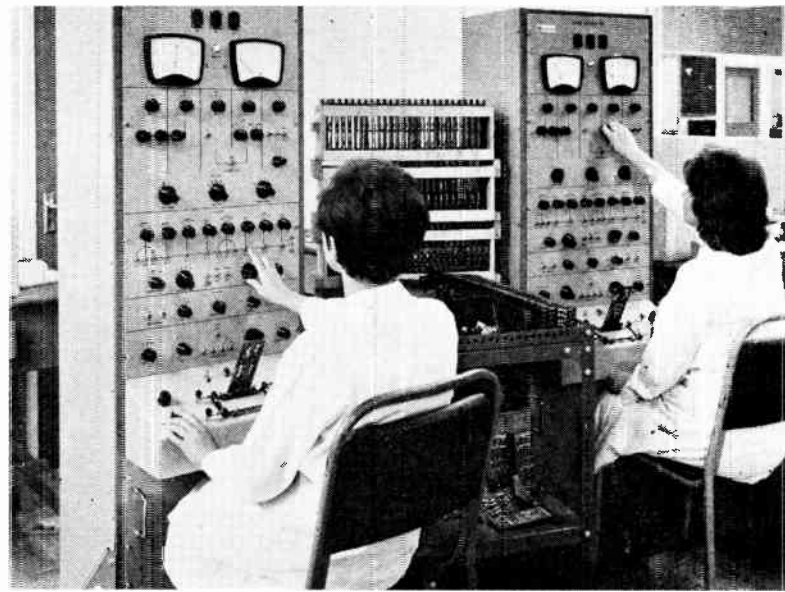
W. H. Sanders (Electronics) Ltd. announce that an agreement has been concluded with Associated Electrical Maintenance Ltd. to provide a comprehensive maintenance service for the Sanders Language Laboratories. This service covers the whole of England, Wales and Northern Ireland. An agreement has also been reached with North British Relay to provide similar facilities for users in Scotland.

Centralab Ltd. announce the appointment of J. B. Hodgson as general manager. Mr. Hodgson was formerly with Elliott Automation as chief engineer of the Minilog Division. Centralab are to market and manufacture a comprehensive range of ceramic capacitors and packaged electronic circuits.

S. G. Brown Ltd., a Hawker Siddeley company, have finalized an agreement with the Wayne-George Corporation, U.S.A., for the sole British distribution rights of the Corporation's complete range of optical shaft encoders and gyro test tables.

L. Rushforth has been appointed manager at Lincoln for the **English Electric Valve Co. Ltd.** R. E. Lake, manager of the Gas Tube Division at Chelmsford, has been transferred to Lincoln as deputy manager; Mr. Lake will also head and enlarge the Industrial Gas Tube Department. C. Z. Muskus is appointed assistant manager (duplexers). He will take over the manufacture of T.R. cells at present in production at Lincoln and enlarge the existing range.

International Rectifier Co. (Great Britain) has appointed Harmsworth, Townley & Co., Harehill, Todmorden, Yorkshire, as its authorized industrial distributor for North-West England.



TELEMETRY FOR ALGERIAN PIPELINE—The complete telemetering system for a new Algerian oil pipeline is to be supplied by Serck Controls. Solid-state digital techniques will provide fully-integrated supervisory control from a master station—four remote pumping stations being involved initially, with a further three planned for the future. Both telemetering and telecontrol signals are carried by a single circuit between the stations, a total communication channel bandwidth of 3 kc/s being utilized with a coaxial cable line. The picture shows card-mounted solid-state logic elements undergoing production tests

A. C. Cossor Ltd. announce the appointment of Air Commodore A. G. P. Brightmore, M.I.E.R.E., to the newly-created position of consultant to the managing director.

Aveley Electric Ltd. announce their acceptance of the Essex Electronic/Nytronic of America and Canada Agency for a range of delay lines, r.f. inductors, miniature r.f. chokes, sub-miniature ceramic capacitors, and miniature variable inductors, to Mil. specs.

Negotiations are in progress for the acquisition by **Elliott-Automation** of part of the Rank Cintel Division of the Rank Organization. The negotiations involve the aircraft instrument and head-up display section.

Ferranti Ltd. have moved their London office from Kern House, 36 Kingsway, London, W.C.2. to Millbank Tower, Millbank, London, S.W.1. Telephone: Victoria 6611.

The London office of **George Kent Ltd.** has been moved to Kingsway House, 103 Kingsway, London, W.C.2. Telephone (unchanged): Holborn 8211. Telex: 263301.

The Insuloid Manufacturing Co. Ltd. have announced that Robert Gow has been appointed a director.

J. F. Hitchcock has been appointed general manager of the telephone switching division of **Standard Telephones and Cables Ltd.**

A.S.E.E. 1966

The 1966 Electrical Engineers (A.S.E.E.) Exhibition will be held at Earls Court, London, from 23rd to the 30th March 1966. The opening times will be 10.00 a.m. to 7.00 p.m. daily, except Thursday, the 24th March, when it will be extended to 9.00 p.m. On the final day, the 30th March, the Exhibition will close at 6.00 p.m.

Application forms for space will be mailed to all previous exhibitors and new inquirers at the beginning of 1965.

Doubling Radiotelephone Channels

New radiotelephone equipment, designed to help solve the shortage of usable channels in the v.h.f. waveband, was recently demonstrated in London by Pye Telecommunications.

The equipment will enable twice as many channels, using the same amount of the spectrum, to be allocated to radiotelephone schemes. Radiotelephone systems will be spaced as close as 12.5 kc/s compared to current standards of 25 kc/s in Britain and 30 kc/s in the U.S.A.

The practical demonstration, carried out in a car touring the centre of London, showed that with a 12½-kc/s channel spacing the adjacent-channel interference was maintained at an acceptably low level.

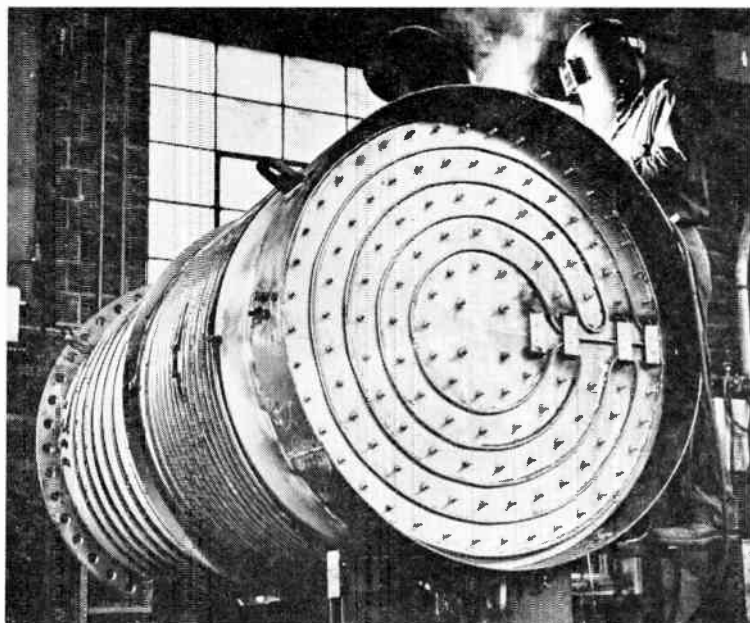
For further information circle 74 on Service Card

Noise and Vibration Reduction Exhibition

The first Noise and Vibration Reduction Exhibition—NAVREX—is to be held at Earls Court, London, from 5th to 19th June, 1965.

The exhibition, which will be sponsored by Trade & Technical Press Ltd. and organized by Iliffe Exhibitions Ltd., will be the first to deal objectively and exclusively with the increasing problems associated with the reduction and control of noise and vibration.

In conjunction with NAVREX a conference will be held within Earls Court at which technical papers will be presented.



GIANT DIFFUSION PUMP—This vacuum pump, 4 ft in diameter and 8 ft 9 in. tall, shown under construction at NRC Equipment Corporation in the U.S., has been designed specifically for a large space simulator chamber used to test complete spacecraft. These fractionating diffusion pumps operate from 2×10^{-4} to 10^{-9} torr (lower when used with a liquid-nitrogen-cooled baffle) and have a pumping rate of 140,000 litres per second for hydrogen and helium



RADIATION TESTING OF INSULATED MATERIALS—When insulated materials are liable to be exposed to nuclear radiation during service it is necessary to have prior knowledge of the amount of radiation which they will withstand before they become unsuitable for further use. In the research organization of BICC materials are subjected to electron bombardment from a 2-MeV particle accelerator while enclosed in a specially-designed vacuum cell

Colour Camera for TSR-2 Flight Simulator

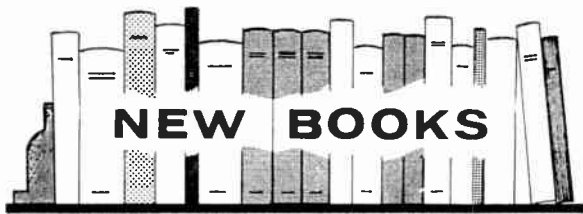
The pilots who will fly Britain's newest supersonic fighter, the TSR-2, will learn to handle the aircraft, without leaving the ground, with the aid of colour-television equipment. The Marconi Company has received a contract for the colour camera intended to provide the 'view from the cockpit' in the TSR-2 flight simulator which has been ordered by the Ministry of Aviation from General Precision Systems Ltd.

The television camera in this simulator will be mounted above a model of the countryside surrounding a typical airfield. The model is built on a continuous moving belt, which can be driven at a speed corresponding to that of the aircraft. At the same time, the camera itself is linked to the aircraft controls and will take up any 'flying' attitude in relation to the ground model. Full colour pictures from this camera will therefore correspond with the view that a pilot would have in an actual flying situation on a landing approach.

The Marconi camera intended for this equipment will be a slightly modified three-tube camera, type V3310.

Ferranti Logical Circuit Element Symposia

Due to the increasing interest in the ranges of logical circuit elements manufactured by Ferranti Ltd., Edinburgh, it has been decided to hold three symposia at the following locations: 26th October at Edinburgh (Crewe Toll Factory); 28th October at the 'Grand Hotel', Aytoun Street, Manchester; 29th October at the 'Mount Royal Hotel', Marble Arch, London, W.1. Engineers interested in these symposia may apply to Ferranti Ltd., Ferry Road, Edinburgh 5 (Phone: DEAn 1211), for an invitation.



Transistor Applications

By RICHARD F. SHEA. Pp. 273 + xiii. John Wiley & Sons Ltd., Glen House, Stag Place, London, S.W.1. Price 60s.

The first ten of the 23 chapters comprising this book deal with the fundamentals of transistor amplifiers and their analysis. The starting point is matrix algebra and the first four (short) chapters explain this and its application to circuits. We then come to transistor characteristic curves, equivalent circuits, bias, the characteristics of a single-stage amplifier, cascaded stages and feedback networks, the last being based upon matrix transformation.

The following chapters cover d.c. amplifiers, class A amplifiers, class B amplifiers, high-frequency parameters, high-frequency tuned amplifiers, wideband amplifiers, sinusoidal oscillators, relaxation oscillators, transient response, negative-resistance and switching devices, field-effect transistors, logic circuits, and integrated circuits. In these chapters the mathematics is much less obvious than the earlier ones would lead one to expect. This is sometimes a little deceptive, however, for an apparently innocent looking equation may contain terms which require one to turn back to the early chapters for their evaluation.

Generally speaking the treatment is good, but rather abbreviated. This is only to be expected in view of the ground covered in a limited number of pages. It does make the book one which is hardly suited to the beginner, however.

The International System (SI) Units

British Standard 3763 : 1964. Pp. 16. The British Standards Institution, 2 Park Street, London, W.1. Price 6s.

In view of the widespread consideration now being given to the possibility of adopting the metric system in this country, the publication of this British Standard will command great interest, particularly perhaps among educational authorities, lecturers and the authors of text books and of technical literature.

The SI units were adopted by the Conférence Générale des Poids et Mesures (C.G.P.M.) in 1954 and subsequently endorsed by the International Organization for Standardization. In both these bodies the United Kingdom voted formally in favour of their adoption.

The system has now been introduced as the only legal one in France, and it seems likely that it will also be adopted in several other Common Market Countries and, probably, in Russia. It will, therefore, become common, if not obligatory, in many Continental commercial transactions.

With the publication of the British Standard, authoritative definitions of the new units are made available in English for the first time.

The SI turns its back on many familiar U.K. units of measurement such as the 'acre', the 'mile', the 'ounce' and 'pound-force'. The English concept of 'weight' finds no place in the international system.

In fact, there are only six basic SI units with their associated symbols: metre (m) to express length, kilo-

gramme (kg) to express mass, second (s) to express time, ampere (A) to express electric current, degree Kelvin ($^{\circ}\text{K}$) to express thermodynamic temperature, and candela (cd) to express luminous intensity.

As well as defining these basic units, the Standard deals with a number of derived SI units, including the 'newton' to express force and the 'lux' to express illumination. In addition, the values of units of measurement commonly used in the United Kingdom are given in terms of SI units.

Sasco Radio and Electronic Master Catalogue

Pp. 1607. Published under the title 'The Radio Electronic Master: 28th Edition' by United Catalog Publishers, Inc., and available in the U.K. from Stewart Aeronautical Supply Co. Ltd., Gatwick Road, Crawley, Sussex. Price 42s.

This catalogue provides a comprehensive guide to the American electronic components industry. It lists over 175,000 components, gives a brief specification for each, includes the U.S. prices and shows the name and address of each component company. As component importers and distributors Sasco offer their importing facilities for any of the components listed in this catalogue.

Basic Pulse Circuits

By RICHARD BLITZER. Pp. 436 + xi. McGraw-Hill Publishing Co. Ltd., Shoppenhangers Road, Maidenhead, Berkshire. Price 68s.

The first chapter is devoted to the various ways of solving the mesh equations of a circuit, the circuits being more or less complicated arrangements of resistances and batteries. The second chapter covers pulse amplifiers and these are treated in terms of frequency and phase response. Only in Chapter 3, 'Linear Wave Shaping', do we come to a discussion of the effect of RC and RL circuits upon the waveform of a few simple excitations, such as steps, rectangular pulses and ramp voltages. This is followed by a chapter on non-linear wave shaping in which the effects of various limiters, mainly diode limiters, are described.

Chapters follow on multivibrators, timebase oscillators and generators, binary and octal systems and electronic counters, and gates. Some applications of pulse circuits are then discussed as well as miscellaneous circuits, and the book concludes with a chapter on transient analysis.

Throughout the book the modes of operation of the circuits are described in physical terms without the aid of any true mathematical development. Simple algebra and arithmetic are in constant use, however, for in the main the descriptions are carried out in terms of specific circuit values. The currents and voltages which exist, and the changes which occur in them, are calculated.

The treatment is thus somewhat unusual and, because of it, the book should prove exceptionally useful to the newcomer to pulse circuits.

Telecommunication Facilities in Buildings Part 3: Sound Distribution Systems

Publication CP327 : Part 3 : 1964. Pp. 72. The British Standards Institution, 2 Park Street, London, W.1. Price 20s.

One of a number of British Standards Codes of Practice dealing with electrical installations in buildings, CP 327, is currently being revised and work has now been completed on Part 3 for sound distribution systems. This part was originally numbered CP 327 : 300 and the numbering of the other sub-codes which make up the CP 327 series will be changed as they are revised.

Part 3 deals with sound distribution systems in buildings which are not designed primarily for sound reproduction.

Some guidance is also given on installations in open spaces. The aim of the code is to establish basic criteria for good performance and quality of reproduction. Seventy pages of detailed guidance are provided on materials, appliance, components, design considerations, structural accommodation, wiring, inspection, testing and maintenance.

Automatic Voltage Regulators and Stabilizers

By G. N. PATCHETT, Ph.D., B.Sc.(Hons.Lond.), M.I.E.E.E., M.I.R.E., M.I.E.R.E. 2nd Ed. Pp. 468 + x. Sir Isaac Pitman & Sons Ltd., Pitman House, Parker Street, Kingsway, London, W.C.2. Price 65s.

The first edition of this book appeared in 1954 and it was revised in 1958. Considerable changes have been made in this second edition. In particular, Zener diodes and transistor stabilizers are now included. Tap changes for power transformers and electronic voltage regulators for alternators are also treated.

The book provides a very thorough discussion of the subject and deals not only with principles but also with very many practical methods. References to the literature are given throughout and the bibliography of 1301 references occupies 55 pages.

Recommendations on Semiconductor Rectifiers (Mono-Crystalline)

British Standard 3771:1964. Pp. 15. The British Standards Institution, 2 Park Street, London, W.1. Price 10s.

Guidance on the minimum data to be quoted by a manufacturer of semiconductor devices in describing his products for general sale is given in this new British Standard.

B.S. 3771 is divided into three main sections covering essential rating and characteristics; methods of measurement of electrical characteristics; and assessment of working conditions.

The data quoted serves two main purposes: it makes easier the comparison of semiconductor devices of the same general class, offered by different manufacturers; and it defines the ratings and characteristics sufficiently to enable users to determine the suitability of particular types for circuit design purposes.

Physics of Failure in Electronics

Edited by M. F. GOLDBERG and JOSEPH VACCARO. Pp. 255. Cleaver-Hume Press Ltd., 10-15 St. Martin's Street, London, W.C.2. Price 60s.

The book comprises the Proceedings of the Symposium and the Physics of Failure in Electronics which was held on 26th and 27th September 1962 in Chicago.

Manufacturers' Literature

Baldwin Differential Gauge for Coating Measurement. This 6-page Leaflet No. 136 describes a gauge which measures the thickness or weight-per-unit-area of a coating on a sheet material during continuous production.

Baldwin Industrial Controls (Instrument Division), Dartford, Kent.

For further information circle 75 on Service Card

Improved Performance Levels for Mumetals. A single-sheet leaflet which lists the latest up-graded minimum permeability levels for Telcon mumetal.

Telcon Metals Ltd., Manor Royal, Crawley, Sussex.

For further information circle 76 on Service Card

Multi-Purpose Potentiometer. In this 2-page publication, List 2/3, a potentiometer designed primarily for on-site testing and calibration of thermocouples and associated indicators and recorders is described. It has a single range of 0.01 to 101 mV.

Cambridge Instrument Co. Ltd., 13 Grosvenor Place, London, S.W.1.

For further information circle 77 on Service Card

Ferranti 'Multilin'. An approach to microminiaturization of electronic circuits is detailed in this 23-page booklet. 'Multilin' packaged units are constructed with thin-film circuits and silicon integrated circuits.

Ferranti Ltd., Aircraft Equipment Dept., Western Road, Bracknell, Berks.

For further information circle 78 on Service Card

Rotary Solenoids Type C. Six different basic types of rotary solenoids are described in this publication Bulletin E43K/64a. Each basic type has many variants with different coils and rotary movement. Altogether 210 different types are specified.

H. Kuhnke Ltd., 163 Stanwell Road, Ashford, Middlesex.

For further information circle 79 on Service Card

The G.E.C. Fuse Catalogue. All G.E.C. industrial type fuses are listed in this 30-page publication SP901. Besides containing fuse dimensions, weights and prices, this brochure includes details of fuse carriers and bases.

G.E.C. (Engineering) Ltd., Electrical Engineering Works, Witton, Birmingham, 6.

For further information circle 80 on Service Card

P.E.S.—A Comprehensive Service for Industry. Set out in this 16-page, five-language booklet are the P.E.S. technical services. P.E.S. offer industry a service from initial study to final commissioning in air conditioning, heating and ventilating, civil, structural, chemical, electrical and mechanical engineering projects.

Petro Engineering Services Ltd., Uxbridge Road, Ealing, W.5.

For further information circle 81 on Service Card

Delco Radio Power Semiconductors. In a convenient, tabulated form, this 4-page leaflet lists details and prices of AC-Delco transistors, rectifiers and heat sinks. These include 3 to 50 A p-n-p transistors, silicon rectifiers and cadmium-sulphide photocells.

AC-Delco Division of General Motors Ltd., Dunstable, Beds.

For further information circle 82 on Service Card

Cable-Glands and Housings for Under-Water Electronic Applications. This 6-page leaflet outlines the principal features of some of the latest under-water cable-glands produced by

Submarine Cables Ltd., Greenwich, London, S.E.10.

For further information circle 83 on Service Card

How to Specify Permanent Magnets. A 6-page leaflet which is intended to assist anyone buying permanent magnets. It sets out how to provide clear and concise information to magnet manufacturers.

Permanent Magnet Association, 301 Glossop Road, Sheffield, 10.

For further information circle 84 on Service Card

STC High Frequency Crystal Filters. Twenty-two types of h.f. crystal filter, designed for use in mobile radio equipment, are described in this 48-page booklet No. MQ/108. The characteristics of each device are given in tabular and graphic form. Filters are listed for 12.5, 20, 25 and 50 kc/s channel spacing.

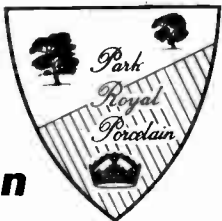
Standard Telephones & Cables Ltd., Component Group, Footscray, Sidcup, Kent.

For further information circle 85 on Service Card

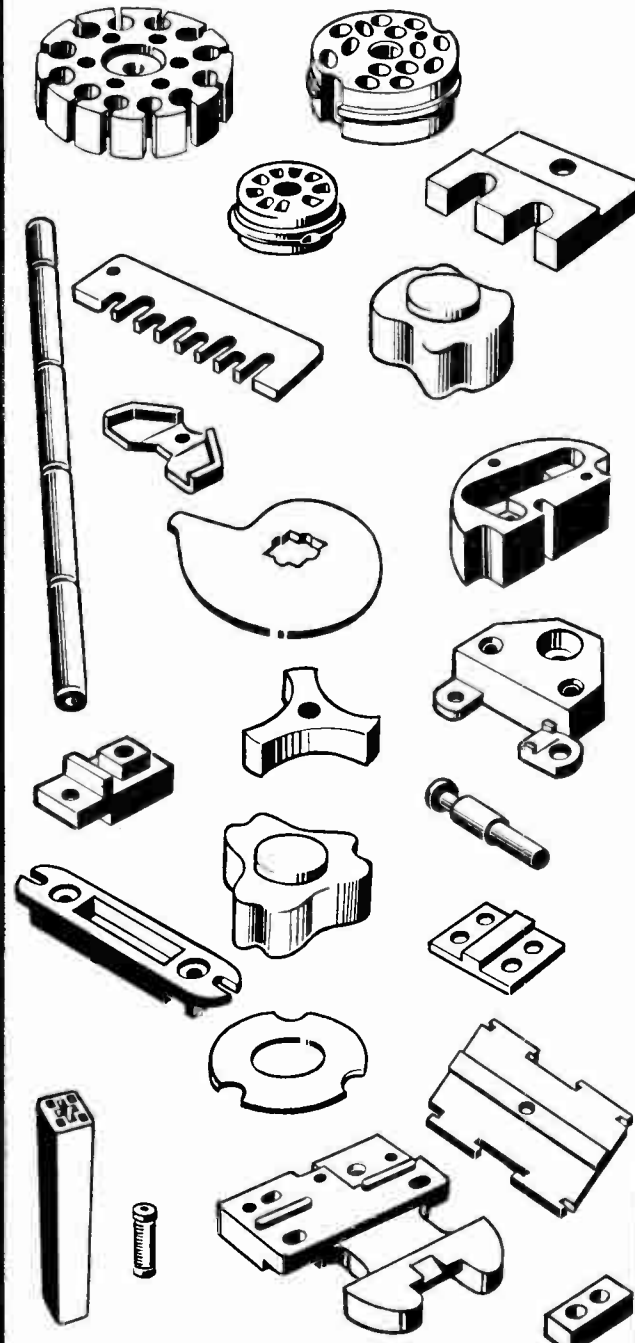
A Low Voltage Electrometer. Number 8 in the Mullard Educational Series, this 4-page leaflet gives constructional details for a low-voltage electrometer. This instrument is particularly suitable for pH measurements.

Mullard Educational Service, Mullard House, Torrington Place, London, W.C.1.

For further information circle 86 on Service Card



Porcelain
Steatite



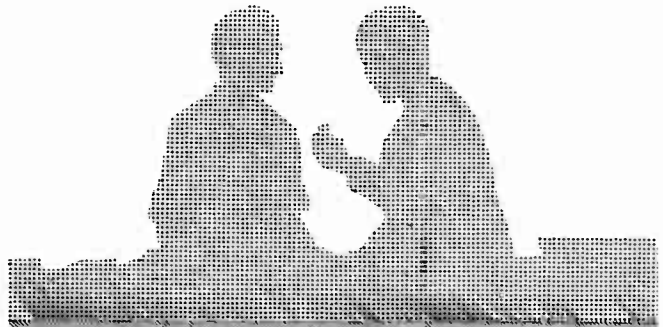
**V. G. PORCELAIN CO
LTD**

GORST ROAD
PARK ROYAL
LONDON, N.W.10

Telephones:
ELGAR 1411/7
Telex:
London 25589

WHITELEY

Epoxy Resin Mouldings

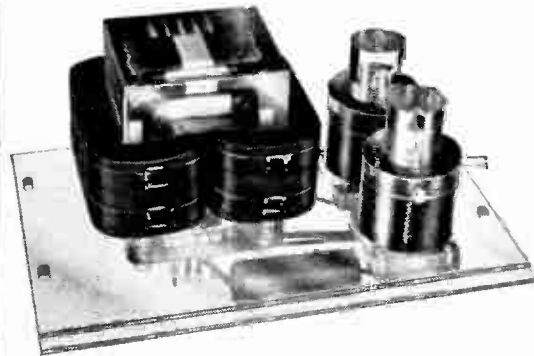


Great mechanical strength, excellent electrical insulation and complete climatic protection are ensured in Whiteley Epoxy Resin mouldings. Low shrinkage and strong adhesion to components and leads renders these Resins particularly suitable for encapsulation. Full details will be gladly sent on request.



Line Isolating Transformer

Transformer Y.17525 is a low loss audio frequency transformer, for use as an isolating transformer on circuits employing 17 c/s signalling, i.e. Post Office telephones. The insulation of the 'line' winding provides isolation against voltage surges of up to 25 KV rms. and continuously applied voltages of 14 KV rms. Please write for full details.



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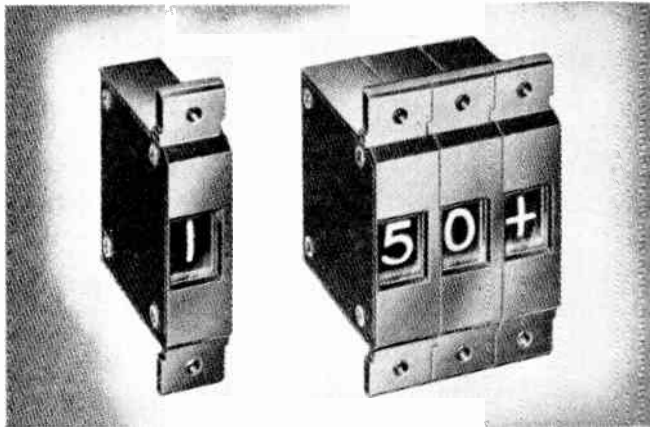
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This is essentially a long-life device. The only moving part is the magnet/drum assembly. This assembly weighs only a fraction of an ounce and bearing wear is negligible.

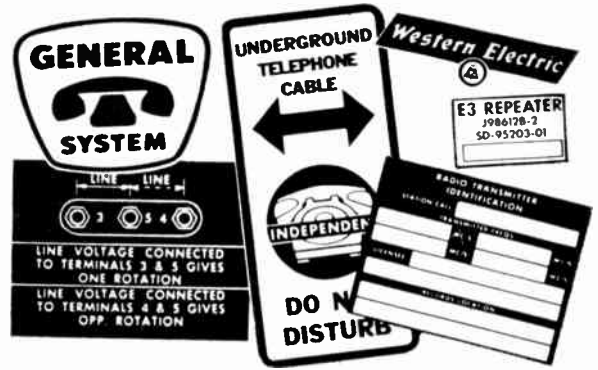


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 Voltages : available in 6, 12, 24, 28 or 36 volt versions
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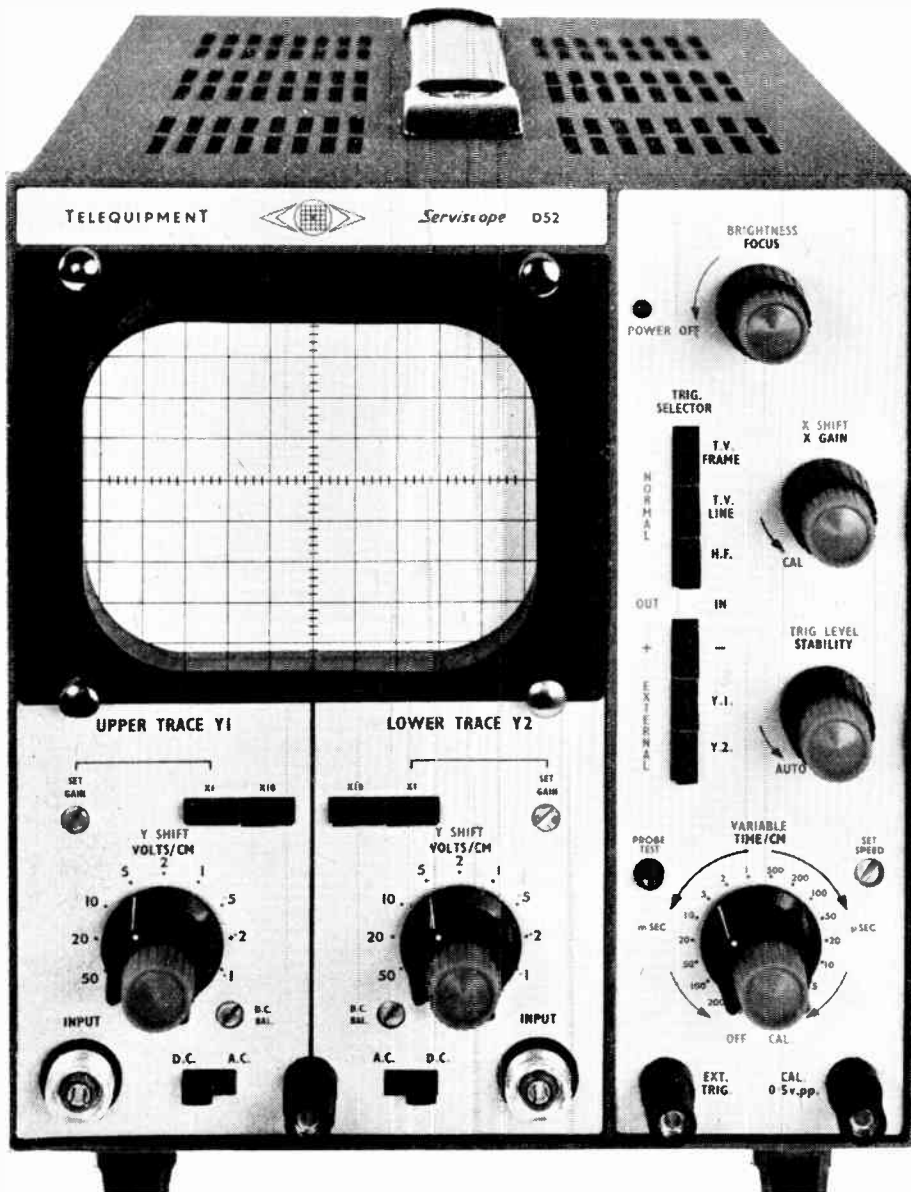
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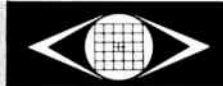
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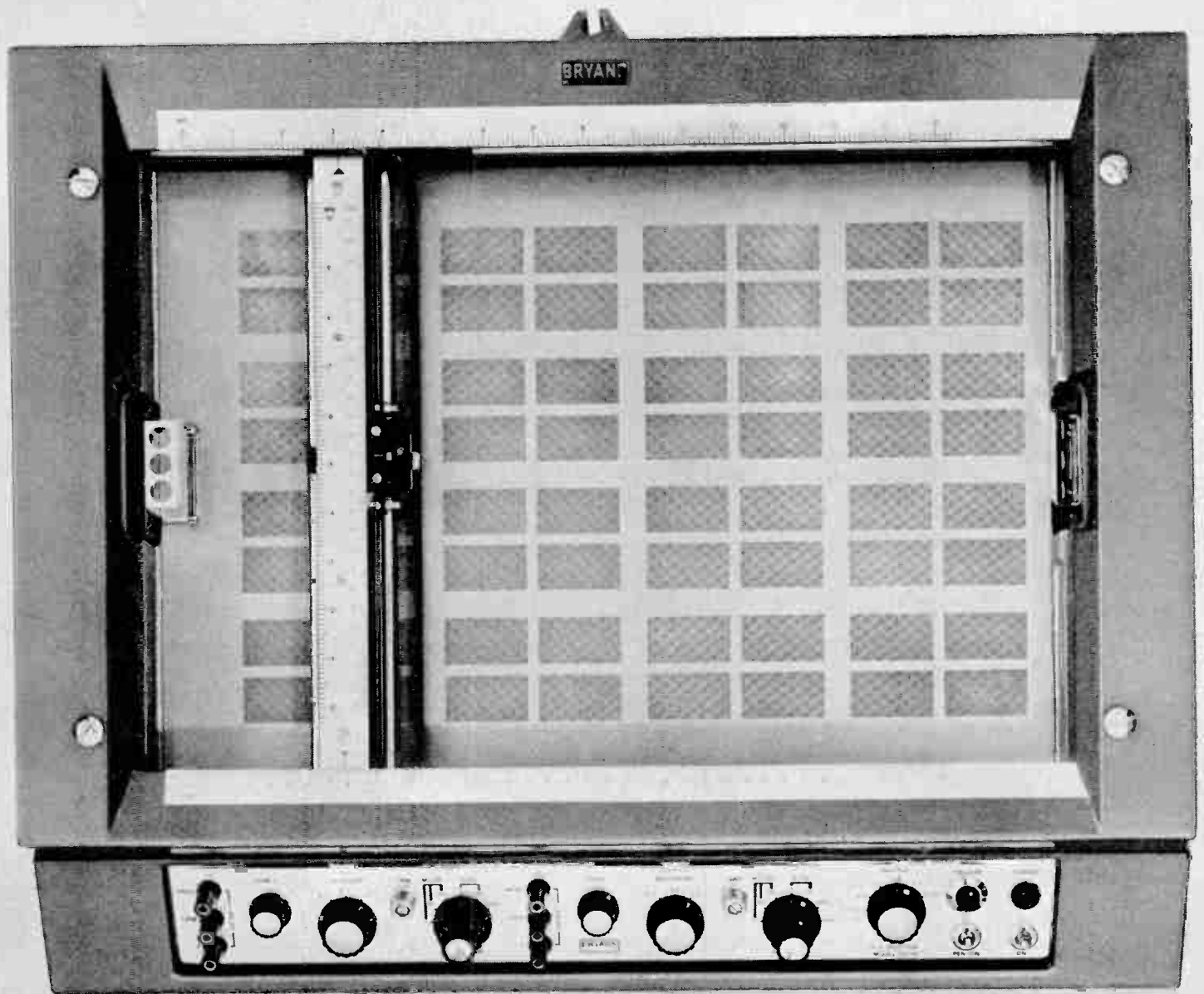
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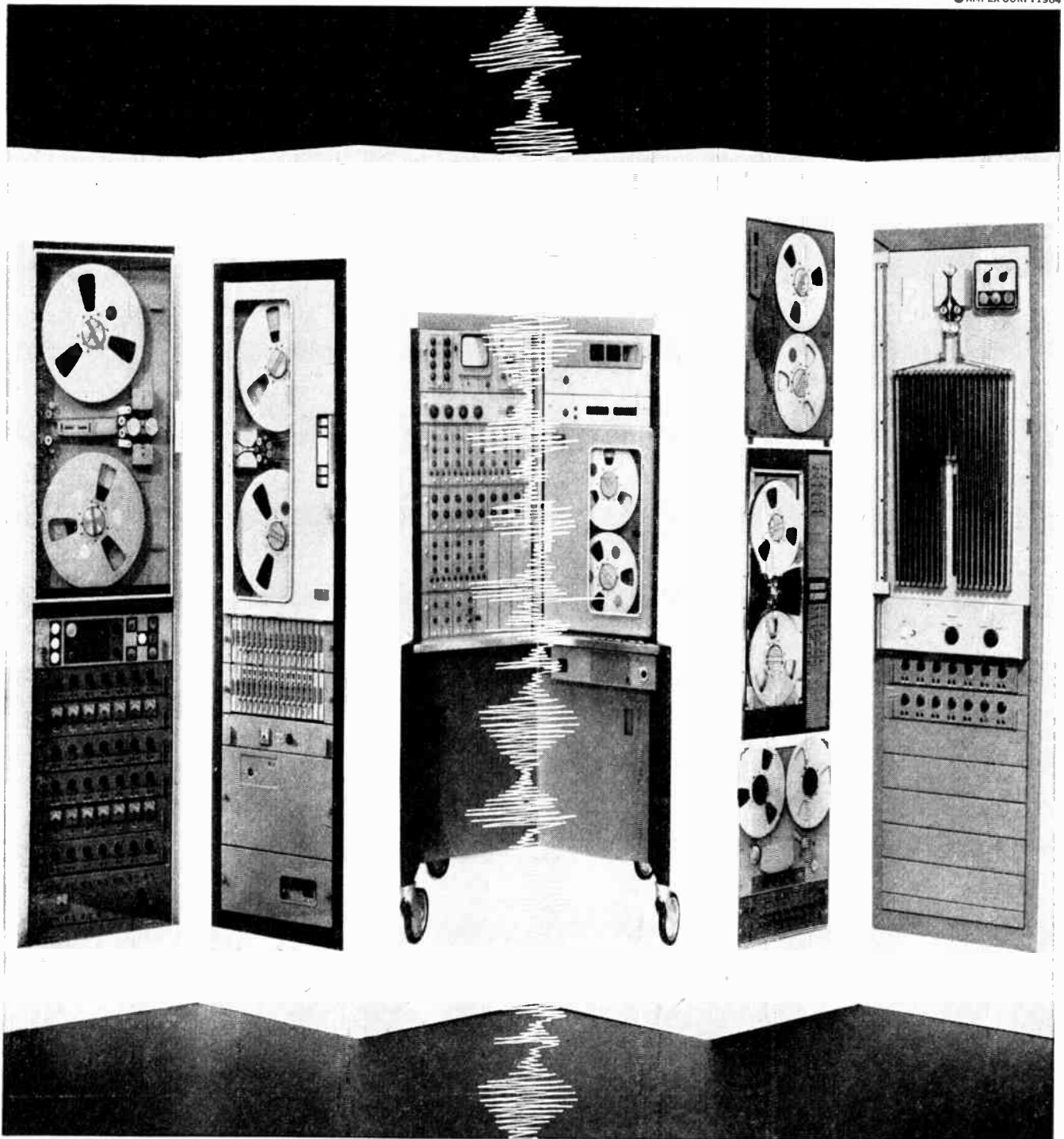
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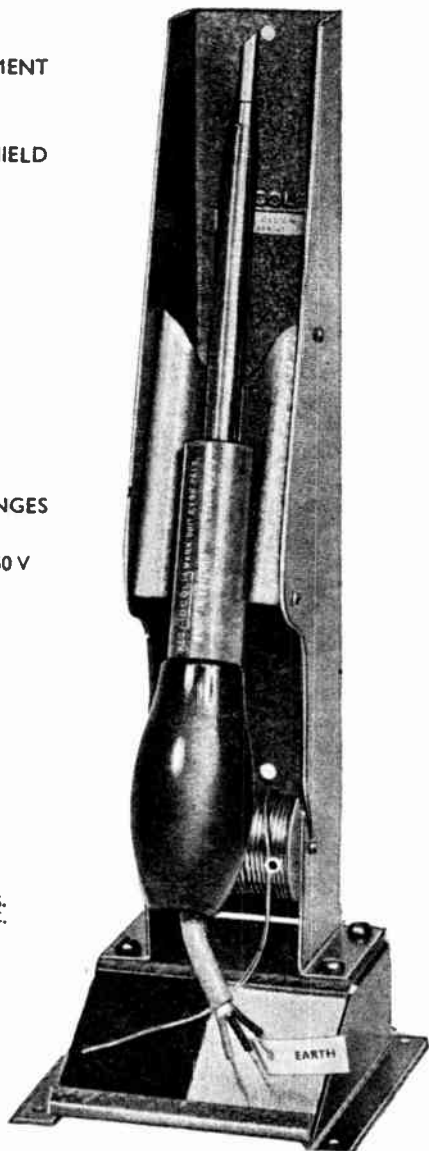
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Industrial Electronics October 1964

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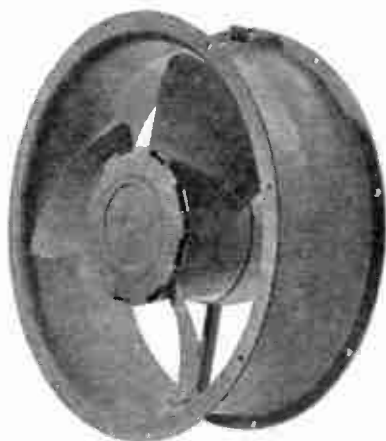
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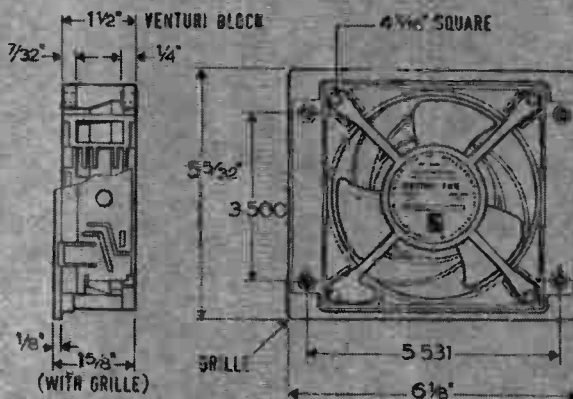
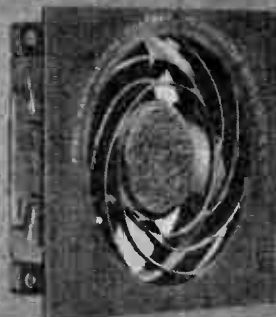
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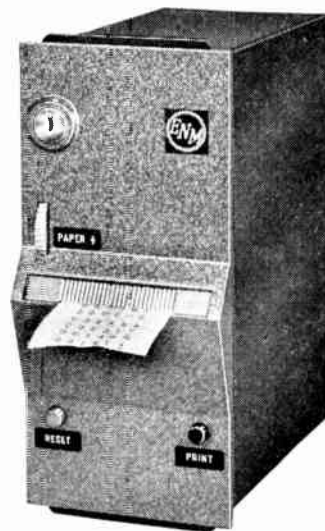
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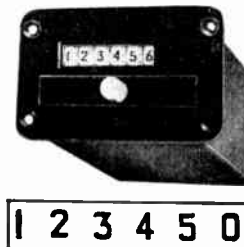
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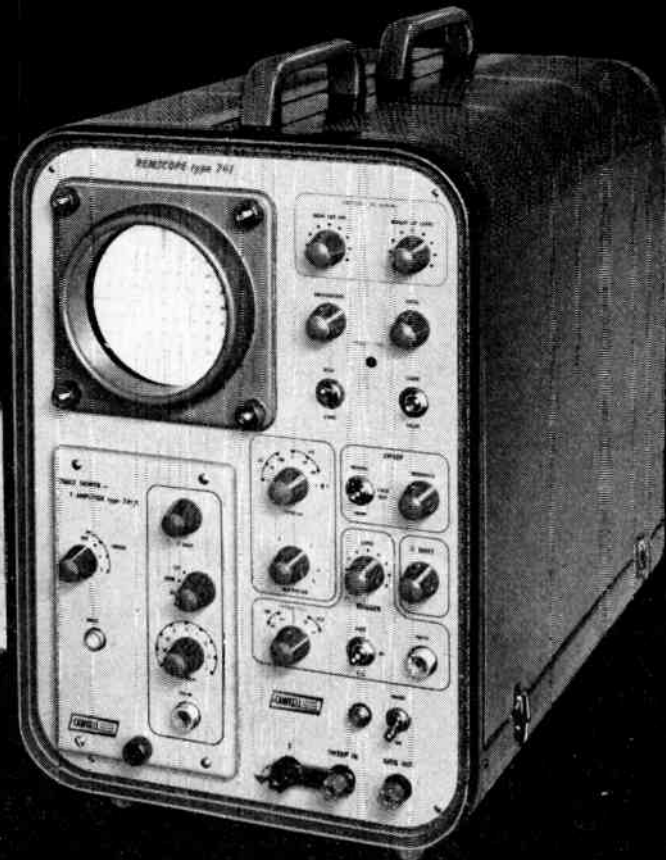
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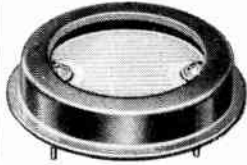
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CDS-9 (actual size)



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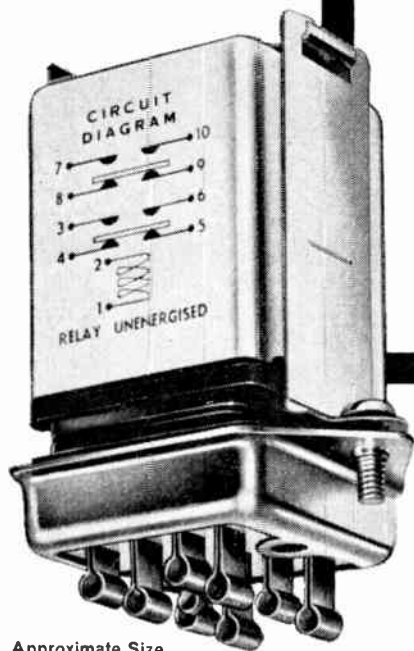
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20—500 °C	6.2	8.0	11.7	9.6	9.2	9.6	10.0
Inflection Temperature °C	435	350	330	480	460	510	540
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Nickel	29%	42.0%	42.0%	49.0%	48.0%	50.0%	51.0%
Cobalt	17%						
Chromium			6.0%				
Iron	Balance	Balance	Balance	Balance	Balance	Balance	Balance
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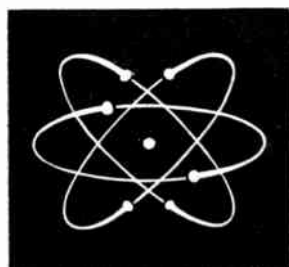
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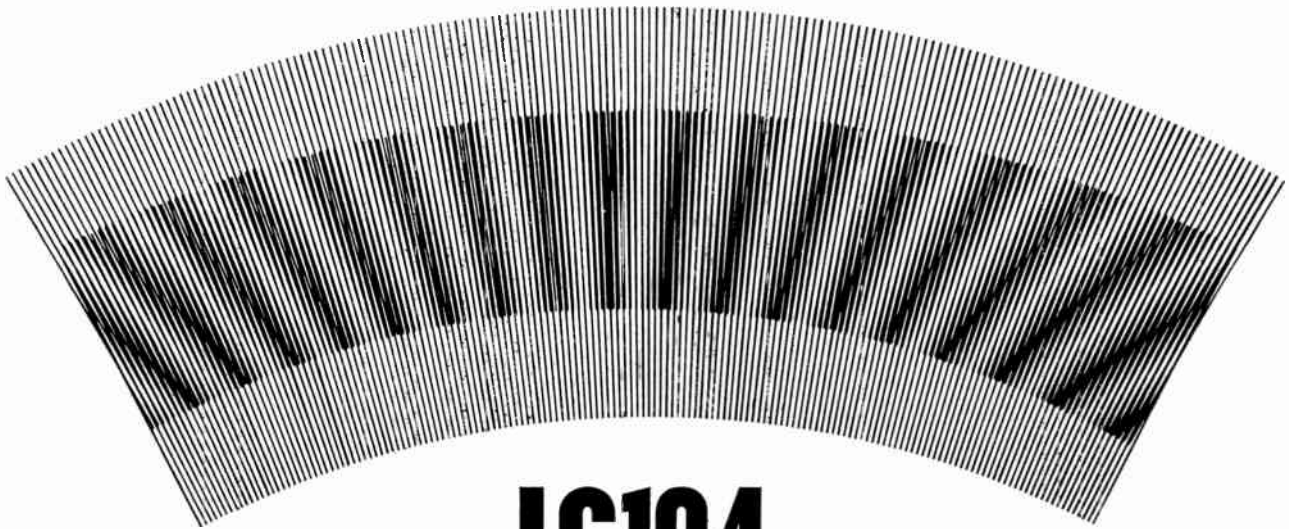
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