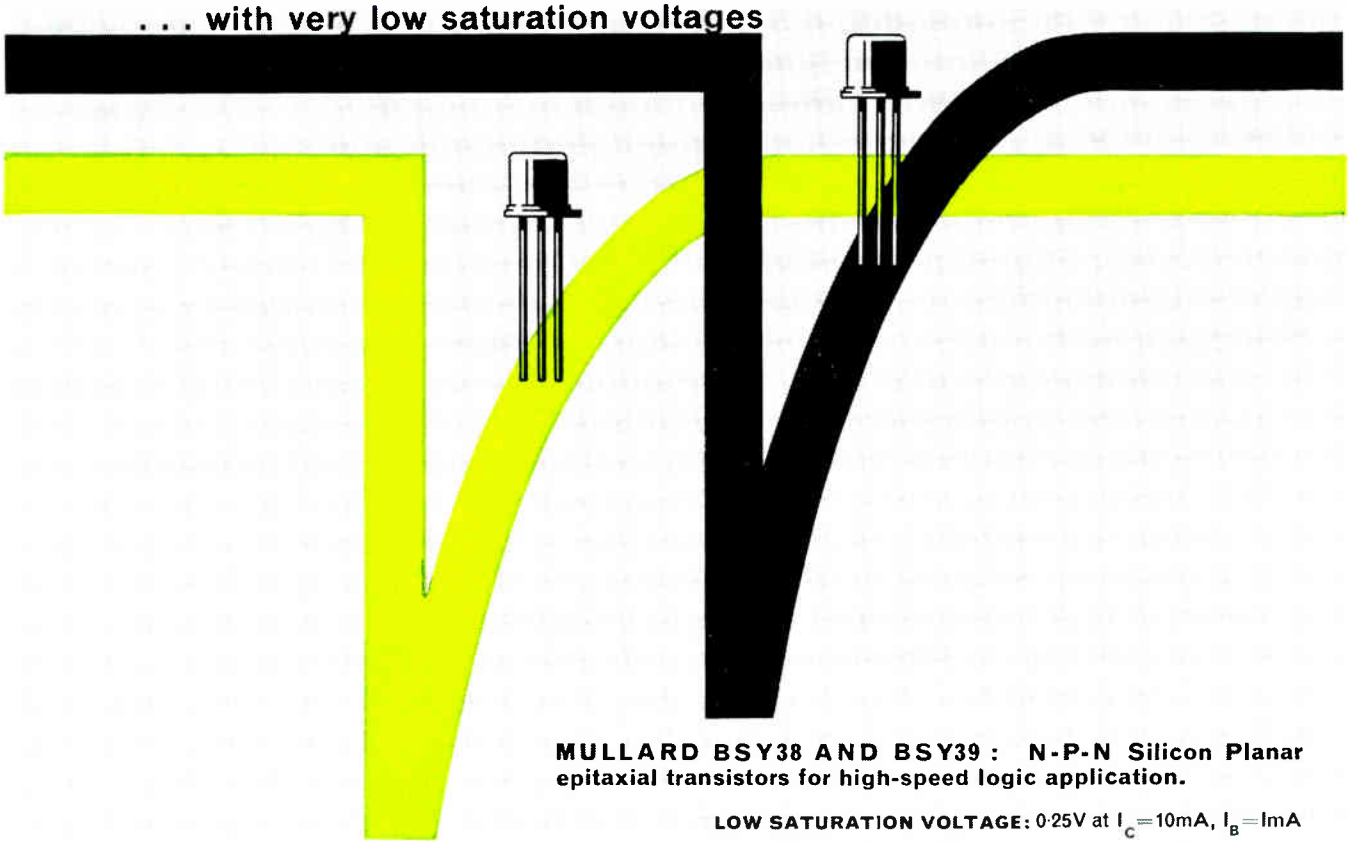
INDUSTRIAL ELECTRONICS

MARCH 1964 5s 0d

TWO NEW PLANAR TRANSISTORS

. . . with very low saturation voltages



MULLARD BSY38 AND BSY39 : N-P-N Silicon Planar epitaxial transistors for high-speed logic application.

LOW SATURATION VOLTAGE: 0·25V at I_C=10mA, I_B=1mA

DESATURATION TIME CONSTANT:
16 nanoseconds maximum (I_C=I_{B1}=I_{B2}=10mA)

	BSY38	BSY39	
h_{FE} at I_C=10mA	30-60	40-120	
$f_T$min. at V_{CB}=2V, I_C=10mA	200	200	Mc/s
V_{CB} max.	+20	+20	V
V_{CE} max.	+15	+15	V
V_{EB} max.	+ 5	+ 5	V
I_{CM} max.	200	200	mA
T_j max.	175	175	°C
θ_{j-amb}	0·5	0·5	°C/mW
Encapsulation	TO-18	TO-18	

Mullard
semiconductors
for industry

MULLARD LIMITED
Industrial Semiconductor Division,
Mullard House, Torrington Place, London, W.C.1.
LANgham: 6633

INDUSTRIAL ELECTRONICS

incorporating *ELECTRONIC TECHNOLOGY*

Volume 2 Number 3 March 1964

contents

Editor **W. T. COCKING, M.I.E.E.**

Assistant Editor **T. J. BURTON**

Advertisement Manager **G. H. GALLOWAY**

continued overleof

Published on the first Thursday after the 5th of each month by

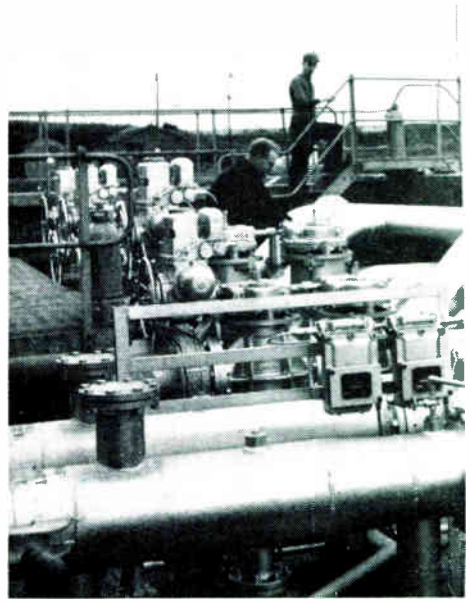
ILIFFE ELECTRICAL PUBLICATIONS LTD.
Managing Director: W. E. Miller, M.A., M.Brit.I.R.E.
Dorset House, Stamford Street, London, S.E.1.
Telephone: Waterloo 3333.
Telegrams: Wirenger, London, Telex
Cables: Wirenger, London, S.E.1.

ANNUAL SUBSCRIPTION, HOME £3 0s. 0d.
OVERSEAS £3 10s. 0d.
CANADA and U.S.A. $10.00.

contents

continued

FEATURES



OUR COVER

This month's picture, taken at the Esso Tynemouth Terminal, shows two Burndept proximity switches for the control of 'pigs' in the oil pipelines. An article in this issue describes the function and operation of the 'pigs' and the proximity switches.

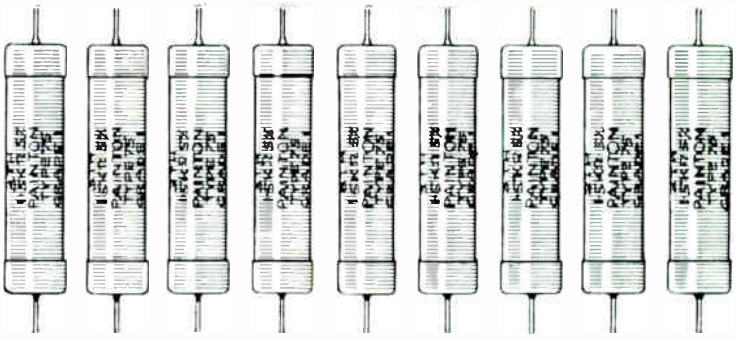
Next Month

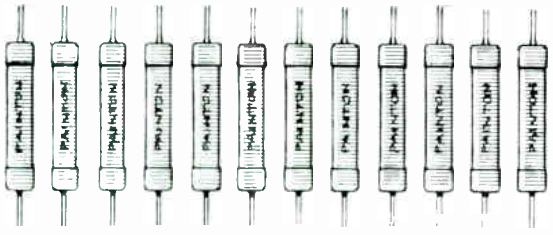
Details of the telemetering system used by the Central Electricity Generating Board are given in an article in next month's issue. Other articles will deal with electronic counters and with logical control.

TO SAVE YOUR TIME

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

Where

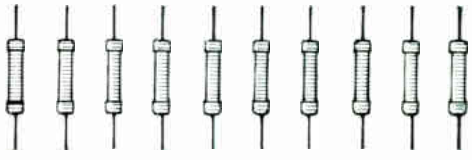


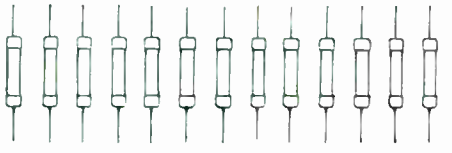


high stability

carbon resistors

are specified





you need

PAINTON RELIABILITY

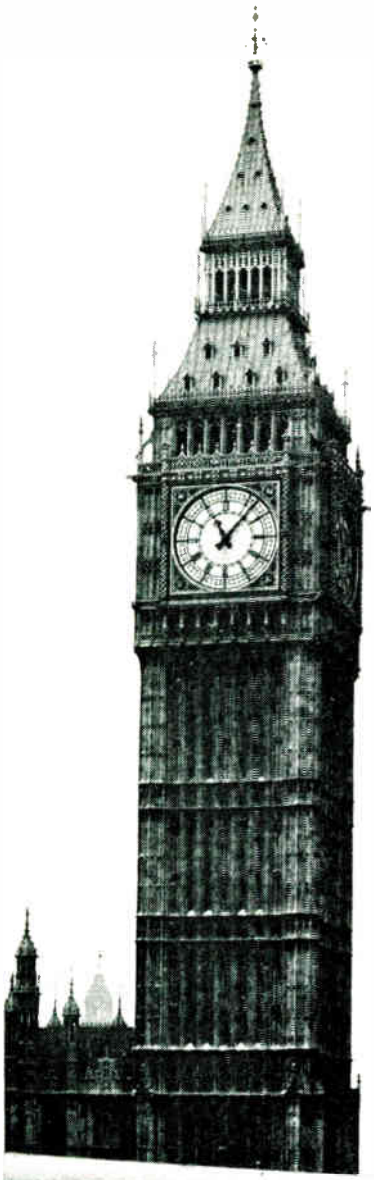
PAINTON

Painton
& CO LIMITED
KINGSTHORPE · NORTHAMPTON
Tel: 34251 (10 lines) · Grams: 'Ceil' Northampton · Telex: 31576

Australia Painton (Australia) Pty. Ltd. · **Benelux** Painton S. A. · **Sweden** Svenska Painton A. B. · **U.S.A.** Painton Inc.

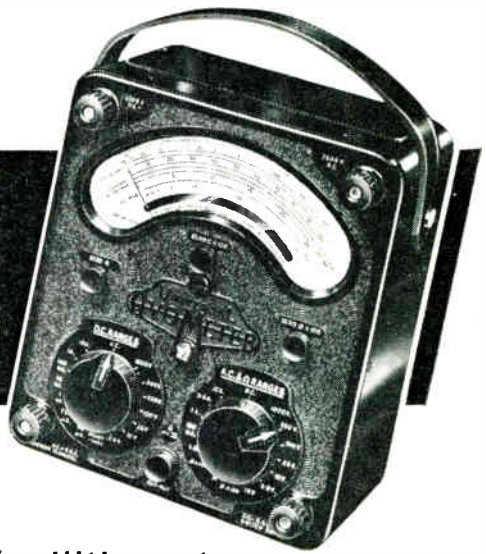
NOW....

PROMPT DELIVERY



of

Model 8 AvoMeter



thanks to

new production facilities at

DOVER *and* **LONDON**

The compulsion of continually increasing demand has urged us to achieve a more than corresponding increase in output of Model 8 AvoMeters. The combined facilities of our factories at Westminster and Dover are now such that deliveries can be effected promptly.

If you have urgent need of AvoMeters, please telephone. For forward deliveries, we, with the help of our Distributors, will deliver promptly to your time requirements.

● *Fully descriptive literature available free on request.*

A.S.E.E. Exhibition
Stand N.6
Earls Court, March 18-25

AVO LTD AVOCET HOUSE · 92-96 VAUXHALL BRIDGE ROAD · LONDON S.W.1 *Telephone: VICtoria 3404 (12 lines)* M GROUP

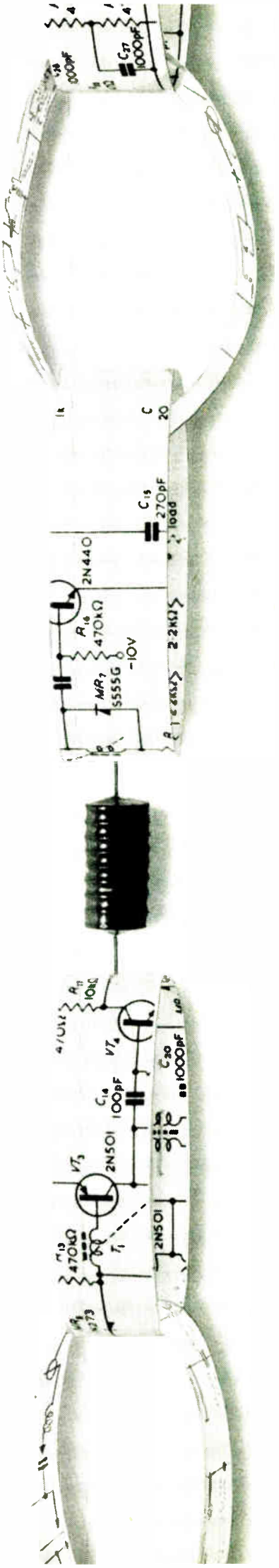
G 28

vital link

M.E.C. type P resistors ▯ the vital link in a precision circuit ▯ The miniature wire-wound resistors with full Type Approval (Types P12, P34 & P56) ▯ 16 types, with axial lead, radial lug or printed circuit mounting ▯ Resistance ranges up to 4.5MΩ and ratings up to 1.2 watts ▯ Tolerances from 1% to 0.1% are standard, tolerances to 0.01% available for special applications ▯ Wound with alternate sections reversed, to minimise inductance ▯ Bobbins of epoxy resin encapsulated in the same resin to give stability over the range —65°C to +150°C ▯ Reliability trials under typical conditions are yielding results to satisfy the most exacting designer.

Send for full specification, Type Approval details and stability data ▯ Miniature Electronic Components Ltd., St. Johns, Woking, Surrey. Tel. Woking 5211.

m-e-c



'Beyond the capabilities of any other system'

—assessment of Mullard magnet by head of Harvard Physics Department

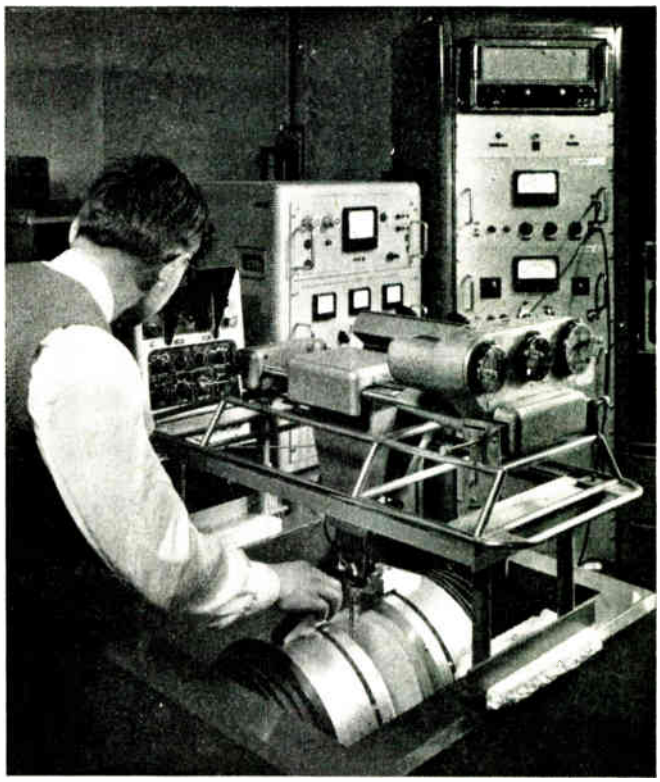
A permanent magnet for proton resonance work designed and manufactured by Mullard for the Physics Department of Harvard University was chosen because it is, in the words of the head of the department, 'beyond the capabilities of any other system we have investigated'. The magnet will be used in the Lyman Laboratory of Physics in experiments with an atomic hydrogen maser to redetermine the ratio of the magnetic moment of the proton to that of the electron.

HIGH DEGREE OF UNIFORMITY

The high degree of uniformity of the field in the gap of this magnet extends over a greater volume than in any other magnet yet built. The field is uniform to within 1 part in 10^7 over a volume equivalent to a sphere of 2cm diameter —about four times the volume normally attained in magnets of this type with a comparable degree of uniformity. To maintain this uniformity, the magnet is surrounded by a thermostatically controlled thermal enclosure which maintains the temperature of the magnet constant to within a few thousandths of a degree Celsius. The field strength is 3300 gauss in a 2in gap between 10in diameter pole pieces.

Many other university and industrial research laboratories have installed Mullard special-purpose magnets, both for general research work and for highly specialised investigations. Permanent magnets, electromagnets, and electro-permanent magnets can be designed and manufactured to individual specifications, and there is a growing range of standard assemblies based on previous successful designs. These standard assemblies are particularly useful in the cases where the specification of the required magnet assembly is similar to one in the existing range. By accepting an existing type, advantage is taken of the shorter delivery time compared with that of assemblies that have to be individually designed.

The applications in which Mullard special-purpose magnets have been used include microwave valves and vacuum measurement devices, nuclear magnetic resonance and electron spin resonance equipment, laboratory standards, atomic particle beam deflection, and general research laboratory use. A booklet has been prepared giving details of the Mullard design and manufacturing service for special-purpose magnets. For a copy of this booklet and data on the standard range of special magnet assemblies, please use the reader reply card of this journal (see reference number opposite).

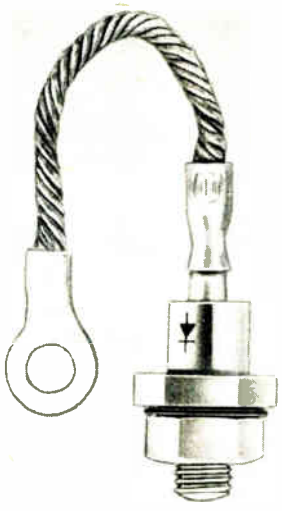


Testing the Harvard magnet in a specially screened area under carefully controlled conditions of temperature and humidity

What's new from **Mullard**

power-control devices on show at A.S.E.E.

The wide range of Mullard power-control devices will be displayed on stand MM12 at the forthcoming Association of Supervisory Electrical Engineers exhibition at Earls Court from March 18 to 25, 1964. The devices on show will include the latest developments in avalanche diodes, thyristors (silicon controlled rectifiers) and their associated heat sinks and stacks, ignitrons, thyratrons and high-voltage rectifiers.



20A SILICON RECTIFIERS EMPLOY LATEST HIGH-VOLTAGE TECHNIQUES

A new series of silicon rectifiers has been added to the extensive Mullard range of power rectification devices. The new series has the type number BYX13 and comes between the 10A rating of the BYY22 series and the 40A rating of the BYZ14 series.

The BYX13 series has the same envelope as the BYY22, that is, a 17mm hexagon. Besides having an average current rating of 20A, the maximum repetitive forward current rating is 100A. Two voltage ranges are available: one having a minimum breakdown voltage in excess of 1200V and a recommended maximum crest working voltage of 600V, and the other with a minimum breakdown voltage of 1600V and a recommended maximum crest working voltage of 800V. These rectifiers represent the very latest in high-voltage techniques and are undoubtedly highly economic.

A new type numbering system is used for devices in the BYX13 series. In this, the basic type number is followed by a group of figures indicating the maximum repetitive reverse voltage. Thus the BYX13-1200 is a device with a maximum reverse voltage of 1200V, the cathode being connected to the mounting stud. A reverse-polarity device with the anode connected to the mounting stud is indicated by the letter R following the type number.

Frequency range of low-power quick-heating valves extended to 470 Mc/s

The introduction of the YL1130 quick-heating double-tetrode extends the range of low-power quick-heating valves to include the 470Mc/s band. The YL1130 complements the QQZ03-20 which is a high-power valve for use in this band.

The YL1130 is intended for use as an amplifier or frequency multiplier in mobile and fixed transmitters working at frequencies up to 500Mc/s. A frame grid is used to produce the required power gain at these frequencies, and the low capacitances resulting from the push-pull construction allow efficient operation at ultra-high frequencies. The high gain is particularly useful when the valve is used in transmitters where the early stages are transistorised.

The quick-heating filament enables 70% of the output power to be obtained in less than half a second. When used as a class C amplifier, the valve has an output power of 15W at 200Mc/s, and 8W at 500Mc/s. When used as a frequency trebler at 500Mc/s, the output power is 3·5W.

An applications report describing a 6W transmitter operating at 480Mc/s is available.

New piezoelectric material

Four grades cover wide range of applications

A new piezoelectric material which combines high permittivity, a high coupling factor and good mechanical strength is now available for applications as varied as ignition systems, photoflash equipment, accelerometers, and gramophone pick-ups.

Four Grades

This new material is based on lead zirconate-titanate. It is available in four grades covering the two main modes of operation—wideband operation away from resonance which requires a high coupling factor and low mechanical Q-value, and operation at resonance which requires a high mechanical Q-value. These two modes of operation require a wide range of material properties and this range of properties is provided by the four grades.

Grade PXE1 has been developed for transducer applications at resonance—for example, ultrasonic generators and narrow-band filters. It has a high mechanical Q-value but low coupling factor.

For applications requiring maximum sensitivity for mechanical-to-electrical conversion, such as delay lines or ignition applications, grade PXE3 has been developed.

For high-quality resonance applications, grade PXE4 is most suitable. Typical applications of this grade include transmitters in fluids, such as sonar, asdic, and echo-sounding equipment.

The fourth grade, PXE5, has a low mechanical Q-value but a high sensitivity. It is ideal for gramophone pick-ups, feedback plates and ignition applications.

Reader Information Service

Further details of the Mullard products described in this advertisement can be obtained through the Reader Information Service of Industrial Electronics, using the appropriate code number shown below.

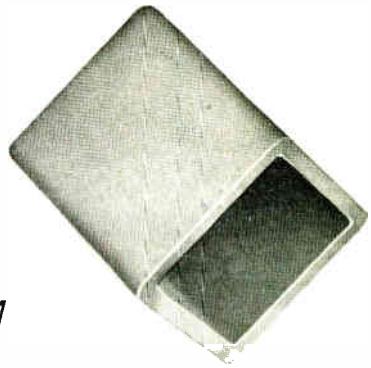
Special-purpose Magnets	206
Piezoelectric material	207
Silicon rectifier BYX13	208
Low-power quick-heating valves	209

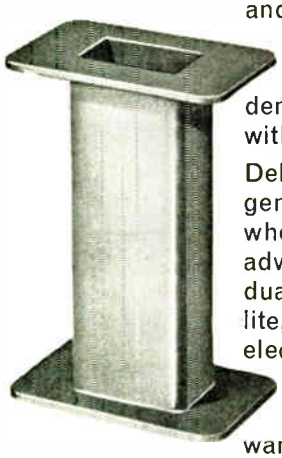
Mullard **Mullard Limited,** Mullard House, Torrington Place, London, W.C.1. Telephone: LANgham 6633

CAM9

The Materials with the 101 Applications

Ask the Delanco BAKELITE TUBE DIVISION TO ANSWER YOUR PROBLEM





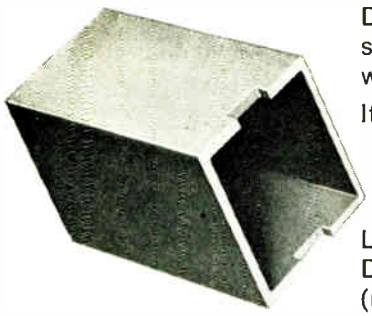
You'll be surprised at the number of applications for Delanco S.R.B.P. and S.R.B.F. tube, both in the electrical and mechanical sections of industry.

In the radio and T.V. worlds they are extensively used for coil formers, sleeves and stand-off insulators and for internally threaded tuning coils to take iron dust cores, as Transformer Bobbins.

In the Condenser trade they are used as condenser casings, from $\frac{5}{8}$" up to 8" internal diameters, with wall thicknesses up to $\frac{1}{2}$".

Delanco S.R.B.F. material has a host of uses in general engineering, for example as pump sleeves, where its resistance to corrosion is a definite advantage over metal. Fuse holders made from a dual material Vulcanized fibre and Delanco Bakelite, giving on the one hand the highest degree of electrical insulation and on the inner tube (vulcanized fibre) the best insurance against arcing.

These are only a few of the many uses, but we want to know of YOUR special problems wherein a bakelite tube might well be a cheaper and more efficient medium.

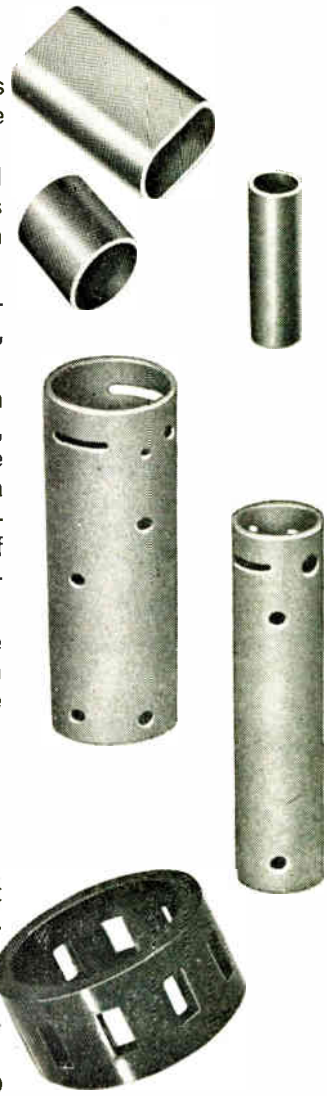


Delanco tube can be threaded, drilled, tapped, slotted and metal insertions can be incorporated where necessary and desirable.

It is made in round, square and rectangular sections, and we will gladly send your design department an actual sample with technical data, on request.

It conforms to British Standards specs S.B.AC LPT 59, 40, 42, and 58. BS 1314. Types A and C DEF. 500. S.E.S. 12 and BS 1885 Grades 1 and 2. (rectangular).

For reliability and quality use only DELANCO S.R.B.P. Tubes.

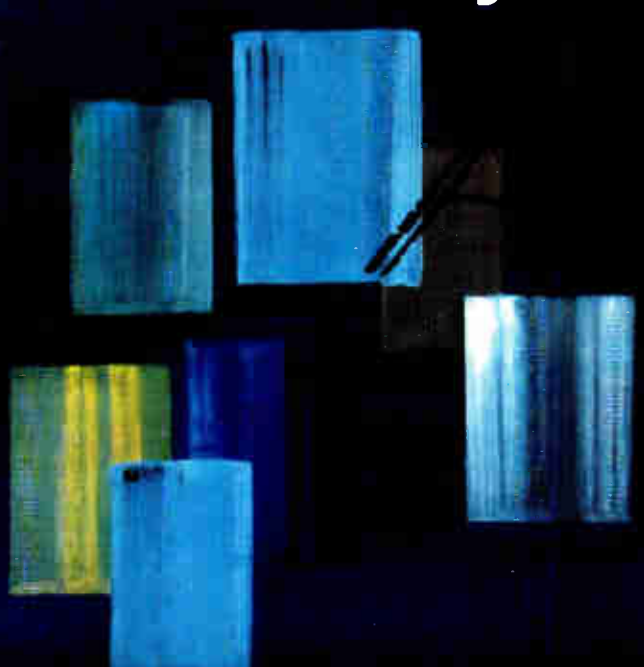


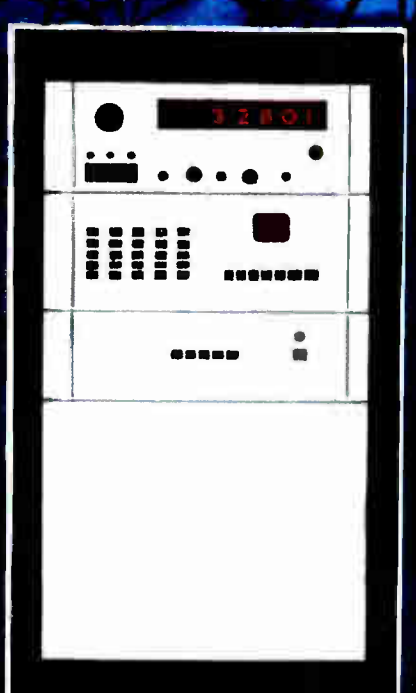
ANGLO-AMERICAN VULCANIZED FIBRE CO LTD

CAYTON WORKS · BATH STREET · LONDON E.C.1

CLE 8484 (20 LINES) GRAMS: PROMPSERV, CENT, LONDON

data systems

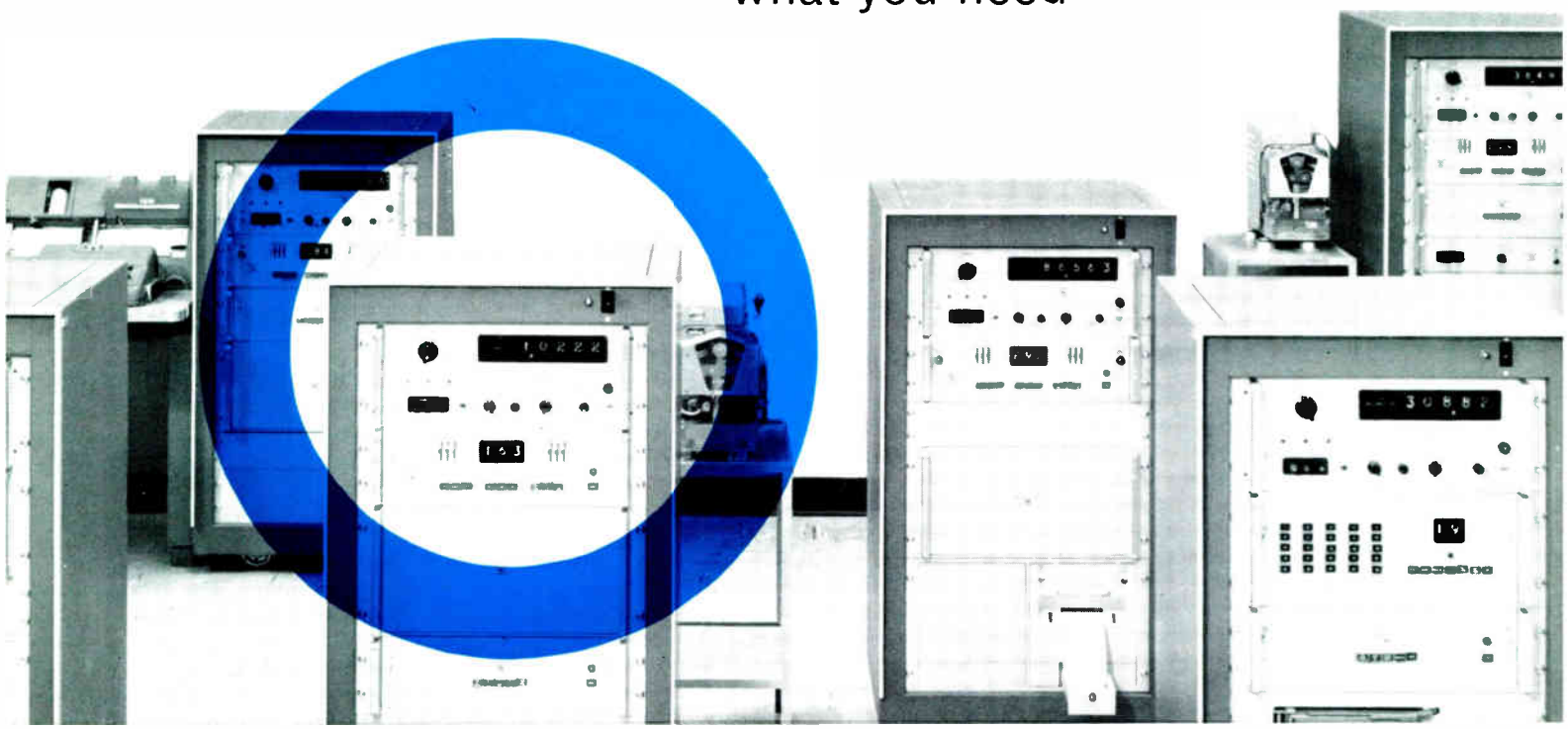




* DATA ACQUISITION FOR COMPUTER PROCESSING,
* WIND TUNNEL INSTRUMENTATION,
* ENVIRONMENTAL TESTING,
* AUTOMATIC CHECK-OUT OF COMPLEX SYSTEMS,
* DATA LOGGING FOR PROCESS CONTROL,
* COMPONENT TESTING.

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., ± 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 hp, 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

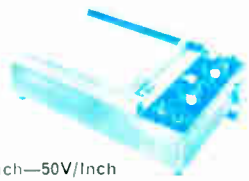
Servo response

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

hp 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.

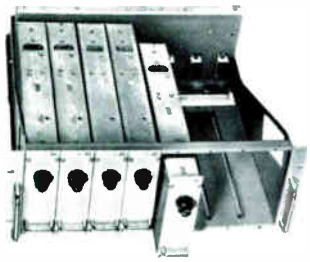
Dymec Data Plotting Systems DY-2030A, B, C and D are available to provide graphical displays of digital information stored on punched cards or perforated tape.

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)	10μV/div.	2μV/div.	10μV/div.	10μV/div.
Overall Linearity	1%	< 0.4%	< 0.4%	< 0.5%
Common Mode Rejection	60db	160db	160db	140db
Drift Referred to Input at Constant Temperature	5μV/hr.	2μV/day	2μV/day	20μV/day
Noise Referred to Input	1% of Input Signal	< 2μV p-p	< 3μV p-p	< 5μV 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	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	±0.1% of 10V f.s. at DC	±0.01% of 10V f.s. at DC	±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 - 300μs to 1% of full scale output	Less than 300 μs	For ±10V, 200 ms to within 25mV of original output
Drift	±2μV ref. to input. ± 0.01% of f.s. at output at constant ambient for 40 hours	±0.02% of f.s. at constant ambient for 40 hours	±2μV ref. to input. ± 0.1mV ref. to output for constant ambient for 40 hours
Noise	5μV rms, DC - 10 Kc/s (ref. to input at gain of 1000)	7μV rms, DC-50 Kc/s (ref. to input)	1μV 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. ±10V at 10mA. (–4000P has grounded output, ±10V at 100mA)	±10V at ±100mA. Sustained short across output will not cause damage to amplifier	Isolated from input and ground. ±5V at ±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 ±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 ±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 ±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 1μV/week, noise less than 4μV 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 ±1%. Ten versions, numerous adapters. Model 580.	Linearsyn differential transformers, strokes from ±0.005" to ±1.0". High sensitivity, shock and vibration immunity; immersible. Many specials available.	Differential and single-ended liquid or gas Pressure Transducers sensitivities 21μV/0.01 psig/volt excitation and 210μV/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 ±0.050" to ±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.

CALL IN A HEWLETT-PACKARD SYSTEMS ENGINEER NOW:

TELEPHONE BEDFORD 68052 OR WRITE TO THE SYSTEMS APPLICATION ENGINEER,

HEWLETT-PACKARD LIMITED, DALLAS ROAD, BEDFORD

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

WESTINGHOUSE

Trinistor

SILICON CONTROLLED *RECTIFIERS*

500 m A to

250 A

25-700 V

Full range of gate drive and controller units readily available

Please write for full details to :—

Dept. IE 3/64, Rectifier Division, Semiconductor Department,

WESTINGHOUSE BRAKE AND SIGNAL CO. LTD., 82 YORK WAY, KING'S CROSS, LONDON, N.1.

Tel : TERminus 6432. Telex No. 2-3225.

SUB-MINIATURE COMPONENTS

These components have gained a high reputation for reliability of performance and are widely used in the Radio, Television and Electronic industry at home and overseas.

SOLID DIELECTRIC TRIMMERS

S.56-11/1 P.T.F.E. Dielectric. Bush Mounting. Cap: ·5 pf. to 7 pf.

S.50-01/2 P.T.F.E. Dielectric. 20 s.w.g. Wire Mounting or

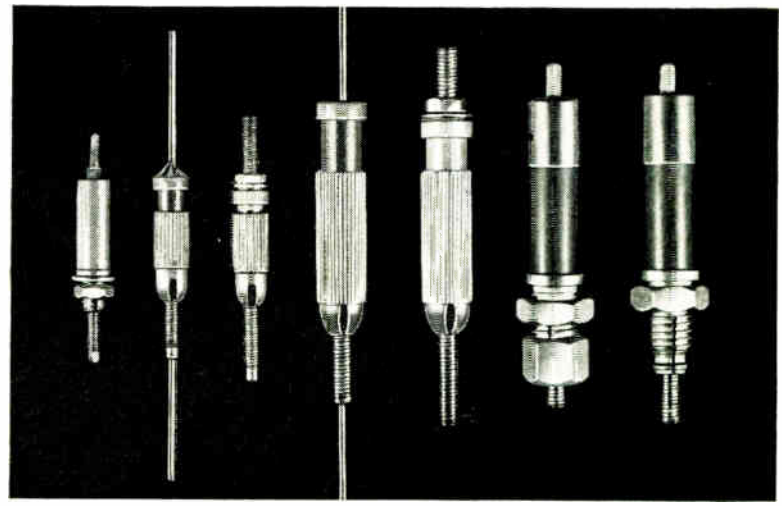
S.50-01/4 Screwed Stem Mounting. Cap: ·7 pf. to 3·3 pf.

S.50-11/3 P.T.F.E. Dielectric. 20 s.w.g. Wire Mounting or

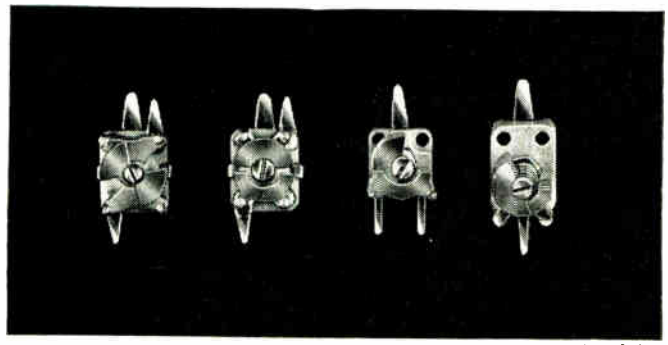
S.50-11/6 Screwed Stem Mounting. Cap: 1 pf. to 12 pf.

S.55-13/1 Mycalon Dielectric. With Locking Nut. Cap: 1 pf. to 10 pf.

S.55-11 Mycalon Dielectric. Without Locking nut.



Actual size



Actual size

AIR DIELECTRIC TRIMMERS

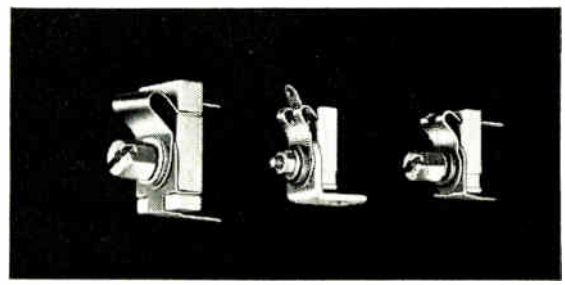
C.39-52 Butterfly type Cap: 7·75 pf. max. each section.

C.39-32 Differential type Cap: 10 pf. max.

C.37-01 Printed Board type Cap: up to 16·5 pf. max.

C.32-01 Cap: 11 pf. max.

COMPRESSION TRIMMERS



Actual size

S.14-01 Printed Board Mounting. Cap: up to 140 pf.

S.15-01 Bracket, or

S.15-11/2 Printed Board Mounting. Cap: 2-25 pf.

Actual size

STAND OFF INSULATORS P.T.F.E. LEADTHROUGHS

P.T.F.E. Leadthroughs: LT. 2-02 LT. 2-02/2.

T.S. 6-01

T.S. 6-01/12 with spill, and internal thread.

T.S. 6-01/6 with spill.

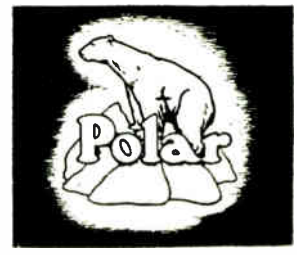
T.S. 6-01/3 Stand Off Alumina Insulator with bollard, and internal thread.

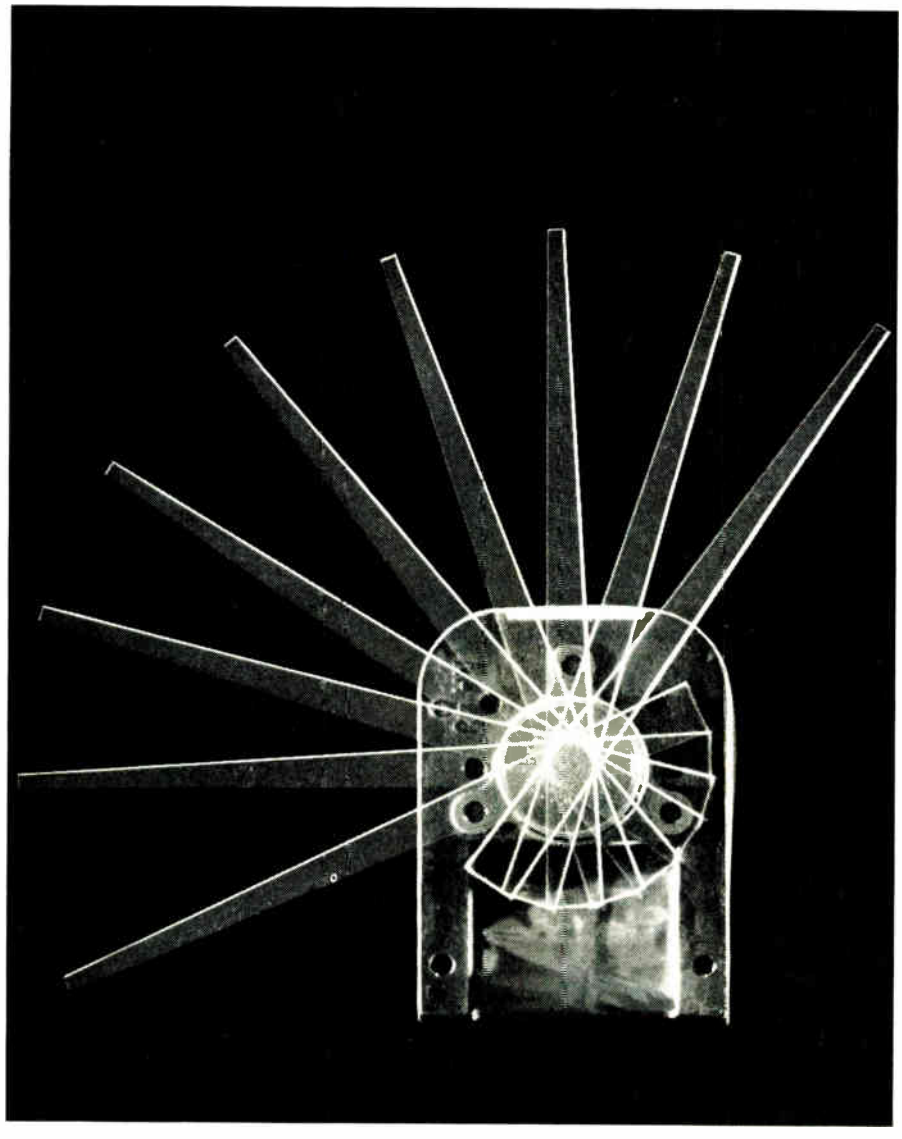
T.S. 6-01/4 Stand Off Alumina Insulator with bollard.

WINGROVE & ROGERS LTD

DOMVILLE ROAD · LIVERPOOL 13 · Tel: Stoneycroft 2265

LONDON OFFICE: 75 Uxbridge Road, Ealing, W.5. Tel: Ealing 7046





Sigma's Cyclonome® Stepping Motor—

An uncomplicated approach to accurate positioning, counting, synchronizing, converting

From Sigma comes an electro-magnetic drive that delivers torque in precise 18° steps...
- ... up to 1,000 steps per second
- ... up to 5 inch-ounces of torque
- ... with no standby power to maintain high holding torque
- ... with only one moving part (no catches, ratchets, escapements)
- ... with size as small as 1 cubic inch.
- ... and requiring only the simplest input circuitry.

Engineers are already applying the Cyclonome stepping motor in chart and tape drives, in analog-digital converting, in impulse counting, in step servos, in remote positioning, in timing.

If you position, count or convert, the Cyclonome stepping motor can benefit you.

Our application engineers will be glad to work with you. If you would like to learn more about the Sigma Cyclonome stepping motor, contact Ad. Auriema, Ltd., Impectron House, 125 Gunnersbury Lane, London W3.

SIGMA DIVISION SIGMA INSTRUMENTS INC

Assured Reliability With Advanced Design/Braintree 85, Mass.

What is a Stepping Motor?

A stepping motor is like a synchronous motor in principle, except that its rotor does not revolve smoothly and continuously when the motor is energized. Instead, on command from the input, the rotor travels an incremental step, stops instantly and locks magnetically in position. When a signal of opposite polarity is applied, the rotor advances another precise step, delivering torque in exact proportion to and at the same rate as the input.

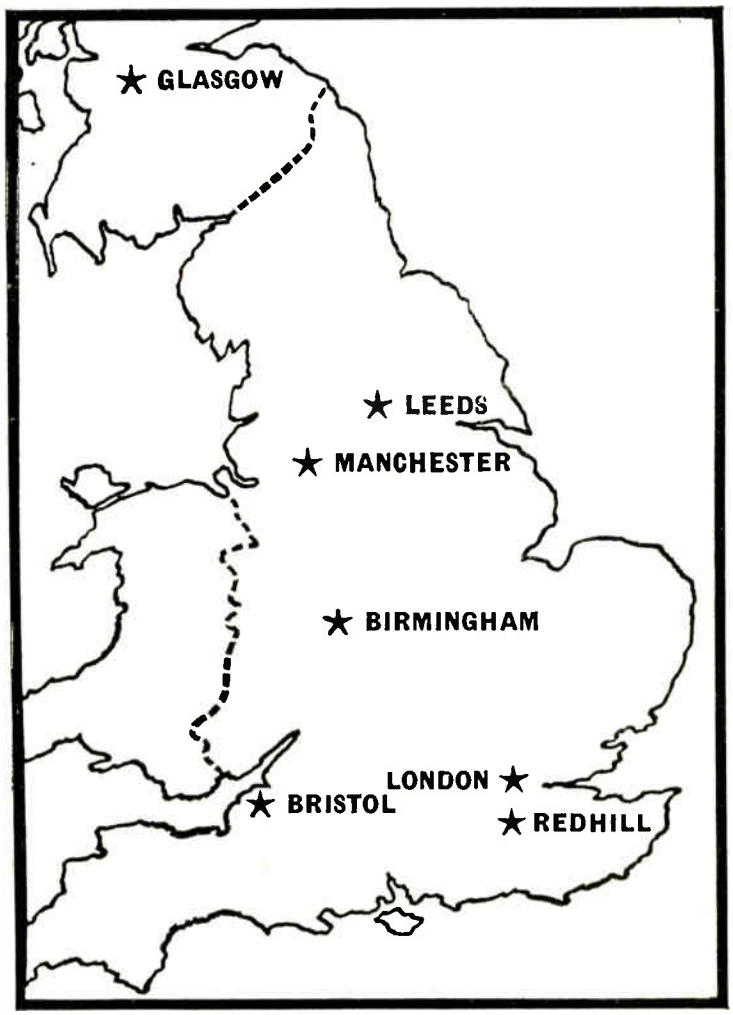
announce a new distribution scheme

STOCK SERVICE

In order to provide an efficient and speedy service of capacitors for manufacturers of ELECTRONIC EQUIPMENT, Hunts have appointed seven NATIONAL DISTRIBUTORS strategically situated throughout the country.

They will all carry comprehensive stocks of those types of capacitors commonly required by electronic manufacturers and they will be pleased to supply you at the same net prices as A. H. Hunt (Capacitors) Ltd. would charge. It should be noted that each distributor has Bonded Stores for items requiring E.I.D. Release Certificates.

Further details supplied freely on request.



full names and addresses

A. C. Farnell Ltd.,
Hereford House, North Court, Vicar Lane, Leeds 2. LEEDS 35111

Gothic Electrical Supplies Ltd.,
Gothic House, Henrietta Street, Birmingham 19. BIRMINGHAM CENTRAL 5060

Harper Robertson Electronics Ltd.,
372 Argyle Street, Glasgow C.2. CENtral 5297

Holiday & Hemmerdinger Ltd.,
71 Ardwick Green North, Manchester 12. ARDWICK 6366

Lugton & Co. Ltd.,
209-212 Tottenham Court Road, London, W.1. MUSEUM 3261/9

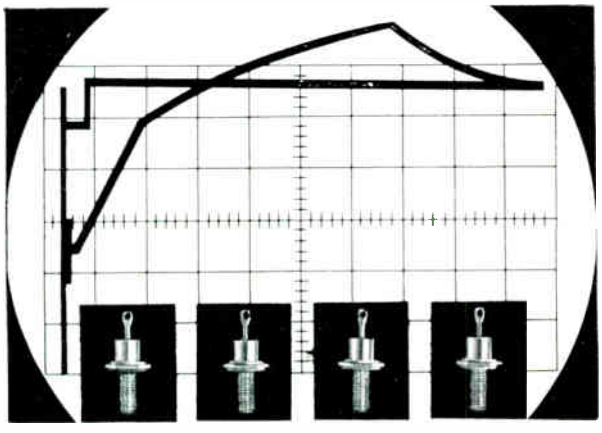
Stewart Aeronautical Supply Co. Ltd.,
Adastral House, Nutfield, Redhill, Surrey. REDHILL 5050

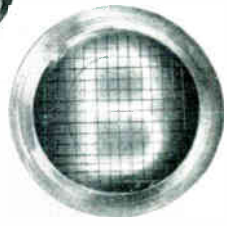
Wireless Electric Ltd.,
Wirelect House, St. Thomas St., Bristol 1. BRISTOL 26434

A. H HUNT (Capacitors) LTD.,
WANDSWORTH, LONDON,
S.W.18 VANdyke 6454
TELEX 25640
Factories also in Surrey
Sussex and North Wales.

STC components review

MARCH 1964





ANOTHER SILICON AVALANCHE RECTIFIER

has been added to the STC range. This is the RAS508AF, a diffused junction stud mounted device with a 4kW reverse power surge rating. Avalanche rectifiers are self-protecting against voltage transients and the avalanche property of the RAS508AF has a voltage limiting characteristic that permits surges fifty times greater than the conventional silicon rectifier can withstand. High voltage stack construction is simplified, the rectifier can be series-connected without voltage equalizing resistors and, in many applications, equalizing capacitors are unnecessary.

RAS508AF	
Rated Forward Current	5A
Rated Crest Working Voltage	800V
Min. Reverse Avalanche Voltage	1000V
Rated Max. Surge Power	4kW
Rated Max. Temperature	125 C
Standard Outline	VASCA SO-10 JEDEC DO-4 IEC 1-103

Write, 'phone or Telex for Advance Information Sheet MF/132 to STC Semiconductor Division (Rectifiers), Edinburgh Way, Harlow, Essex. Telephone Harlow 26811. Telex 81146.

ALL IN ONE!

STC's new Floor Position Indicator Tube, designated Type GN-4BG, displays Basement, Ground and eight additional floor numbers—all in one small, 1·1 in., circle.

Twin passenger lift systems operating over eight floors ground and basement require 220 indicator lamps. Only 22 GN-4BG Indicator Tubes are required to cover the same system, cutting the lamp inspection and replacement task to one-tenth.

This long-life, cold cathode end-viewing device is enveloped in a compact glass bulb coated with a red/orange filter to enhance the display.

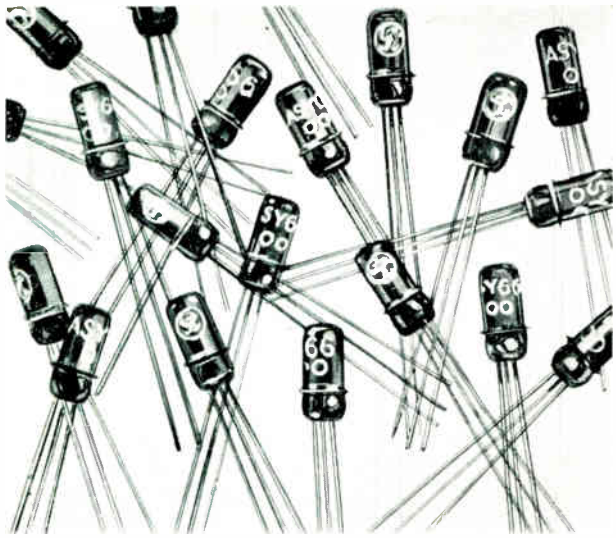
The GN-4BG is specifically designed as a floor position indicator for use inside passenger or goods lifts and beside lift well doors.

ABRIDGED DATA

Base	Nominal Character Height (mm)	Minimum Supply Voltage (V)	Nominal Cathode Current (mA)	Display
B13B	15.5	170	2·1	Numerals 1-8 inclusive, B & G

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

CONTINUED OVER



GERMANIUM TRANSISTORS

Another three devices have been added to the range of STC germanium low frequency transistors. These new p-n-p types are designed for use in driver and output stages, oscillators and low speed switching applications. All three have a collector dissipation of 200 mW and they conform to VASCA SO-2 outline These new transistors are competitively priced and are available with immediate delivery.

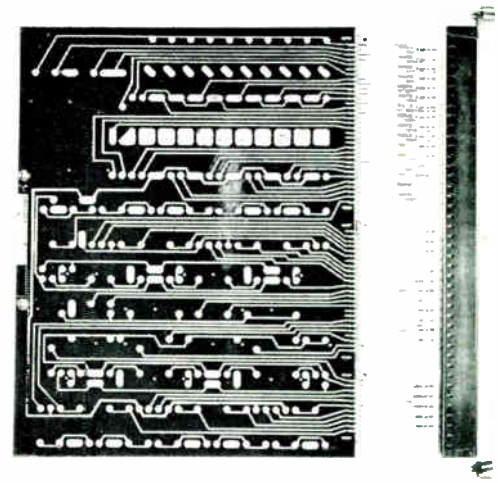
BRIEF CHARACTERISTICS

	ACY34 (Driver)	ACY35 (Driver)	ACY36 (Class B o/p, Switching)
h_{fe} at −2V, −0·5 mA	20-40	—	—
h_{fe} at −2V, −3·0 mA	—	30-75	—
h_{FE} at −7V, −80 mA	—	—	30-90
V_{CBM} (emitter open circuited)	−30V	−30V	−32V
V_{CEM} (base open circuited)	−10V	−10V	−16V
I_{CBO} at V_{CB} −30V	−12μA	−12μA	−12μA

IMPROVED SOLDERABILITY

This is a new feature of STC germanium alloy junction transistors. An improved tinning process on the leads now enables them to be soldered into circuit with greater ease and flexibility. This is especially advantageous to equipment manufacturers employing automatic soldering methods since the risk is considerably minimized of dry joints occurring, either during manufacture or in the field. Maintenance of solderability standards is part of the inspection routine on STC transistors.

Write, 'phone or Telex for details of the whole range of STC germanium transistors to STC Semiconductor Division (Transistors), Footscray, Sidcup, Kent. FOOtscray 3333. Telex 21836.



EDGE CONNECTORS WITH HIGH DENSITY CONTACT GROUPING

ISEP (International Standard Equipment Practice) Edge Connectors from STC have contacts with a pitch of only 0·1 in. (2,54 mm) between contact centres.

ISEP Connectors are the answer to the equipment engineer's requirements for high density, multi-pole edge connectors for use on printed circuit boards carrying large numbers of miniature components.

Features of the new ISEP Connectors are:

Three sizes: 11, 25 and 33-way.

Only connector to meet B P O tests in full.

0·1 in. contact pitch conforms to latest international standards.

Precious metal contacts rolled flat from wire to eliminate sharp edges.

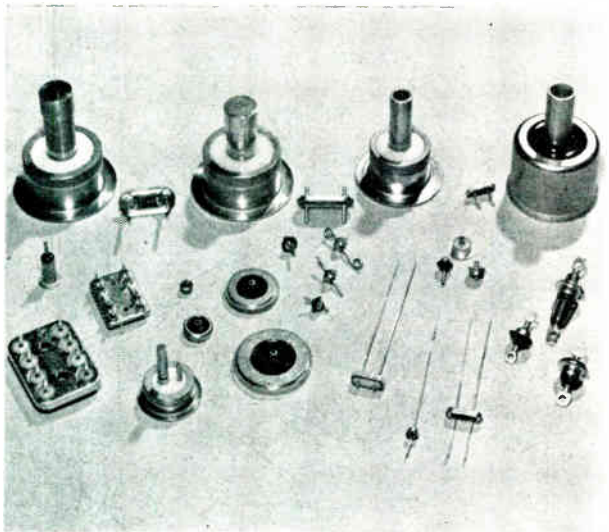
Available with wrap or solder tags.

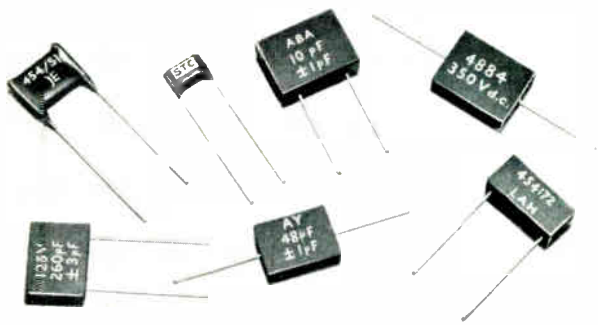
Fully integrates with ISEP racking system.

Competitively priced.

Write, 'phone or Telex for full details and prices to STC Electro-mechanical Division, West Road, Harlow, Essex. Telephone Harlow 21341. Telex 81184.

STC components review





HERMETIC SEALS

of high quality are produced by STC Valve Division for many applications which include transformer and relay terminations, capacitor end-caps, semiconductor encapsulation and crystal bases.

STC seals are notable for high insulation resistance, freedom from leakage and resistance to weather, fungus growth and mechanical shock. In addition to the supply of seals from the wide range immediately available, STC, with their long-established manufacturing resources in this field, are fully prepared to supply suitable quantities of hermetic seals to meet customers' special requirements. Enquiries will be given prompt attention.

Categories of seals available are:—

Single Terminal Types

General purpose—wire termination
General purpose—eyelet termination
Tubular end
Capacitor end-cap
Fly lead

Multi Terminal Types

Crystal base
Multi-terminal lids

For detailed information concerning STC seals write, 'phone or Telex STC Valve Division, Brixham Road, Paignton, Devon, or London Sales Office, Footscray, Sidcup, Kent. Telephone FOOtscray 3333, Telex 21836.

SILVERED MICA CAPACITORS MoA QUALIFICATION APPROVAL

MODULAR DESIGN

Two series of STC moulded mica capacitors are now available. Designed for modular circuitry, they have at least one major dimension standard throughout the range.

Range 454-LWA-71 to 77 covers from 4 pF to 40 000 pF (at 125V d.c.) in seven mould sizes of constant length 0·49 in. (12,5 mm). This range has now received Ministry of Aviation Qualification Approval. In common with the other STC moulded mica series these are high stability capacitors designed to conform to DEF5132. They meet the requirements of humidity classification H6 in the temperature range − 55 C to + 100 C and have a temperature coefficient between −20 C to + 50 ppm/ C.

The other modular series, 454-LWA-66 to 68, covers from 1 000 pF to 15 000 pF (at 350V d.c.) in three mould sizes which vary in thickness only. They have a standard height of 0·49 in. (12,5 mm) and a constant length of 0·69 in. (17,5 mm). Other working voltages are available.

STANDARD DESIGN

The standard range covers from 4 pF to 100 000 pF at 350V and is produced with both a resin dipped and a resin moulded finish. In addition, these capacitors are available for 125V and 750V wkg. The range has been extended to include a new subminiature size.

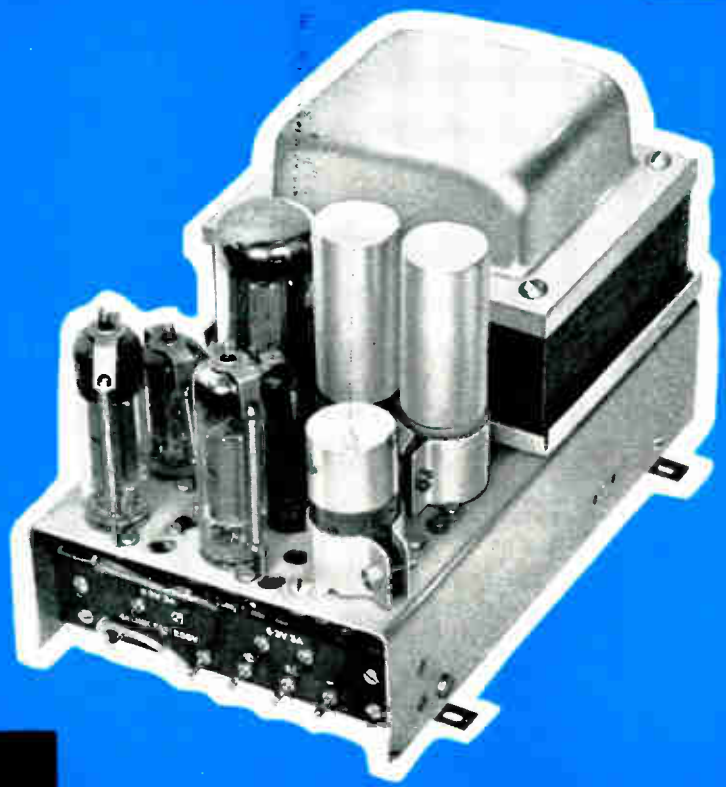
Write, 'phone or Telex for Data Sheets to STC Capacitor Division, Brixham Road, Paignton, Devon, or London Sales Office, Footscray, Sidcup, Kent. Telephone FOOtscray 3333. Telex 21836.

high-grade electronic components by **STC** COMPONENTS GROUP

Todays finest value for only £20

STABILISED POWER SUB-UNIT

MODEL 4931



This very small unit, supplying **250** or **300 V.D.C.** at **150 mA.** max. is ideal for building into your equipment. At this price, with a stability of ±0·1% it is no longer worthwhile designing your own power pack.

Please send details on the following stabilised power sub-units:

4931. 250 or 300V.D.C. at 150mA.
4964. 150 or 200V at 150mA.

4931 ☐

4964 ☐

Name .....

Company .....

Address .....

Detach and send to :

A·P·T ELECTRONIC INDUSTRIES LIMITED

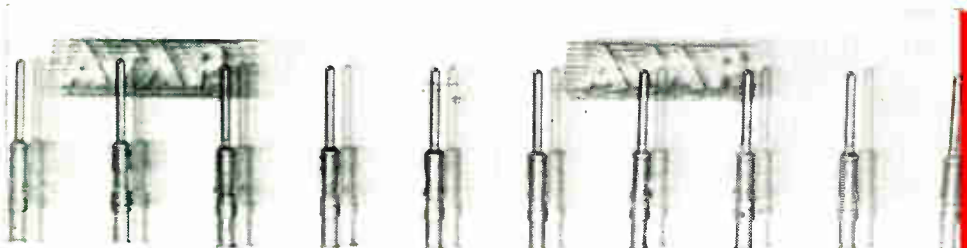
CHERTSEY ROAD, BYFLEET, SURREY
PHONE: BYFLEET 41131 2 3 4 PABX GRAMS: APTRAN, BYFLEET

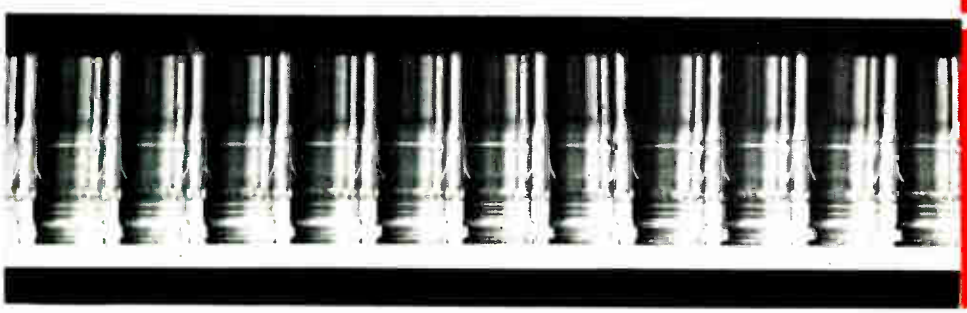
IE 364

SEE US AT
THE A.S.E.E.
EXHIBITION
STAND GG2

AMP SERIES

DESIGNED FOR ALL RATES OF PRODUCTION



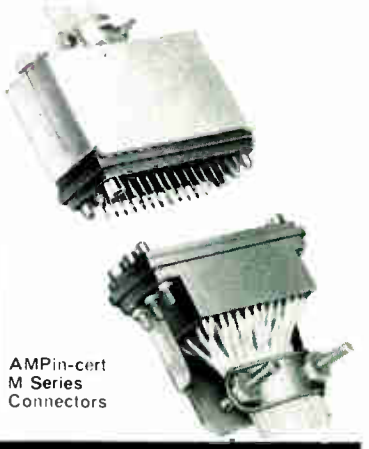


M Series Connectors are the only products of their type which can be applied equally well by hand, pneumatic or automatic crimping machines. For hand use, the Certi-crimp Hand Tools apply individual machine turned or stamped pins and sockets. A pneumatic tool with automatic tape feed can also apply the turned type. For high speed quantity production the A-MP Automatic Machine uses terminals in strip form, giving a rate of output unapproached by any other system. M Series Connectors alone are suitable for quantity production by automation, and enable unskilled labour to provide perfect electrical connections.

AMPin-cert Connectors ensure

Controlled contact pressure Fully floating contacts for exact alignment No post insulation required Contacts easily extractable and interchangeable Low millivolt drop Connectors of 20, 26, 34, 50 and 104 ways Accessories include shields, cable clamps, guide pins and sockets or jack screws Complete crimping equipment for all production levels

AMP precision controlled compression crimp technique



AMPin-cert
M Series
Connectors

Write for new catalogue

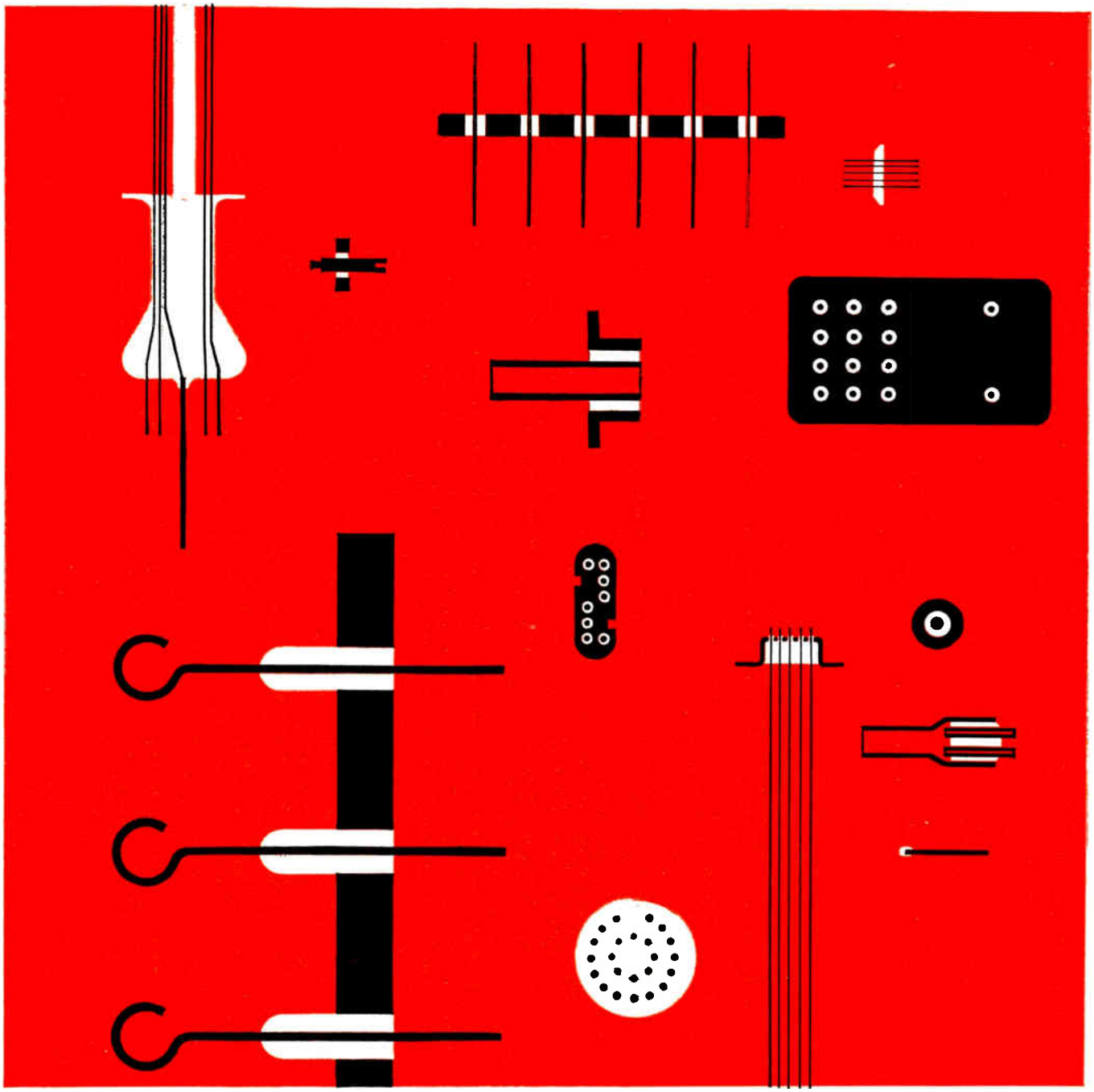
AMP
TRADE MARK
★ Trade Mark of
AMP Incorporated U.S.A.

AIRCRAFT-MARINE PRODUCTS (GT. BRITAIN) LIMITED

Head Office: AMPLO HOUSE, 87/89 SAFFRON HILL, LONDON, EC1
Tel: CHAncery 2902 (7 lines) Telex: 23513 Cables: AMPLO LONDON TELEX

SOUTH AFRICA DISTRIBUTOR: E. S. MOWAT & SONS (PTY) LTD. 51-57 MILNE STREET, P.O. BOX 437, DURBAN, NATAL
ASSOCIATED COMPANIES IN USA., AUSTRALIA, CANADA, HOLLAND, FRANCE, GERMANY, ITALY, JAPAN AND MEXICO

IP 204



GLASS TO METAL SEALS

We are now able to offer a wide range of glass to metal seals (simple, compound and multiple). This range is further extended by facilities to produce the seals in compression, matched or fully bonded vacuum forms with a wide variety of finishes including precious metals.
Deliveries are good and prices highly competitive. High quality and uniformity are ensured by advanced manufacturing techniques.
Our technical liaison engineers will be pleased to meet you at any time to discuss glass to metal seal design and applications.
If you would like further data on this new service to industry, please phone or write to the address below.

A TYPICAL MULTIPLE COMPRESSION SEAL

a NEW service to industry

ERICSSON TELEPHONES LIMITED
ETELCO LIMITED

A Principal Operating Company of the Plessey Group

ERICSSON TELEPHONES LIMITED · ETELCO LIMITED · TUBE DIVISION · BEESTON · NOTTINGHAM · TEL: 254831

ER69

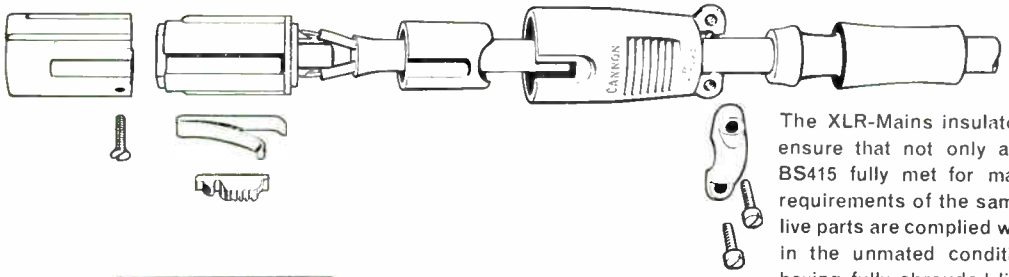
NUMBER ONE IN ELECTRICAL CONNECTORS... 1

NEW XLR MAINS CONNECTOR

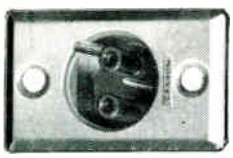
(APPROX. FULL SIZE)

New versatility

Cannon has developed a mains version of the already well established range of high quality audio XLR connectors with latch/lock coupling. This will permit the standardisation by equipment manufacturers and users, of a common type of connector which covers both audio and mains input applications. The XLR-Mains is suitable for cable rated at 2 amps and fully meets the Safety Requirements of BS415. The XLR mains was designed at the specific request of the BBC.

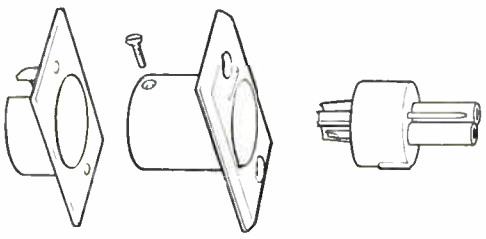


The XLR-Mains insulator has been carefully designed to ensure that not only are the creepage requirements of BS415 fully met for mains voltages but that the safety requirements of the same Specification limiting access to live parts are complied with by *both* halves of the connector in the unmated condition. This has been achieved by having fully shrouded line and neutral socket contacts in the receptacle insert and deeply recessed and shrouded corresponding pins in the plug. The earthing connection is made by a pin contact in the receptacle and by a socket contact in the plug; both the earth contacts are connected directly to the outer shell. By having both pin and socket contacts in each half of the connector and by the shrouding given to the line and neutral contacts, mismating of the mains version with any of the audio versions is prevented. In addition, to provide immediate visual discrimination between the XLR Mains and the XLR Audio series, in both the unmated and mated condition, the insert mouldings and cable bushing of the mains connector are coloured red.



(APPROX. FULL SIZE)

An insulating shroud is available for the XLR-LNE-32 fixed receptacle. This permits electrical isolation of the metal receptacle body from the panel when the prevention of earth loops is desirable. The XLR-LNE connector is fitted with the latch/lock type coupling which is standard on the XLR range.



For any connector requirement consult the world's most foremost name in this highly specialised field.

CANNON ELECTRIC (GREAT BRITAIN) LTD.

168 Old Street, London E.C.1, England

PLANTS IN: LONDON • BORNEM, BELGIUM • PARIS • TOKYO • MELBOURNE • TORONTO
LOS ANGELES, SANTA ANA & ANAHEIM, CALIF. • PHOENIX, ARIZ. • SALEM, MASS.

Sales offices and representatives in principal cities of the world

CANNON PLUGS

CANNON ELECTRIC ®

European Enquiries: Cannon Electric International Inc., Bornem, Belgium. Telephone: (03) 77.03.14.
Scandinavian Enquiries: Sweden: Ab Gosta Backstrom, Box 12033 Stockholm 12. Denmark: Tage Schouboe, 7 Skyttegade, Copenhagen. Norway: Morgenstierne & Co., Wessels Gate 6 Oslo. Finland: OY Chester AB, Uudenmaankatu, 23.A, Helsinki.

Comment

Where values of components are included on a circuit diagram it is quite a common practice to omit the main unit symbol, Ω for example, and to write 100, 39 k, and 2·2 M in place of 100 Ω, 39 kΩ and 2·2 MΩ.

An elaboration of this which we recently came across enables the decimal point to be eliminated by placing the multiplier k or M in its place. Thus, 2·2 MΩ is written as 2M2. Instead of writing 0·1 M or 100 k, which each require four digits, one can write M1 which needs only two. One can, in fact, express in this way any two-figure resistance value over 10 ohms with not more than three digits; that is, two figures and one letter.

A saving of space and of drawing-office time results and this is indeed the object of such abbreviation schemes. Drawing office time is not all that counts, however, the time of the user of the diagram may well be much more important for there are so many more users. A given drawing is usually reproduced in quantity and each user may refer to it many times.

If only 1,000 people have to use a diagram and each refers to it only 10 times, then anything in it which causes as little as one second delay in comprehension amounts to 133 man-hours wasted! It is because of this that we have always placed great importance on clarity in diagrams and have not adopted any of the abbreviated schemes for indicating circuit values.

It will be objected, of course, that the omission of the Ω is a convention just as much as its use and that when one is familiar with it there is no loss of time. This is true as far as resistance is concerned, but when capacitance is considered the difficulty is that there are several possibilities and no universally agreed system. We elaborate this below but the upshot is that the possibilities of confusion are so great that we prefer to retain the unit symbol F. We regard the extra time that it takes our drawing-office staff to include it as time well spent.

Capacitance

This matter of the omission of the capacitance symbol F is touched on in B.S. 530 : 1948. Only capacitance units of μF and pF are taken into account. Values of 0·001 μF and over are written without any suffix to the number; values of 999 pF and under are written with the suffix p. Thus '10' means 10 μF, 10 p means 10 pF.

The system is not a logical one, for the multiplier used should surely apply to the basic unit which is written without any suffix. Logically, therefore, 10 pF ought to be written as 10 μ; that is, 10 μ is an abbreviation of 10 μμF, which at one time was the accepted way of writing this value.

A logical system based on the μF as the unit requiring no suffix, would use m for mμF = nF and μ for μμF = pF.

Alternatively, and we think better, one can make the farad the basic unit and use μ, n and p. Since farad values are never used, this means that all practical values are required to have a suffix and the advantage of having one range of values without a suffix is lost.

We have said that a logical system based on μF should be no suffix, m and μ. We do not recommend this because we are sure that it would cause confusion. The B.S.I. system, up-dated, would probably be no suffix, n and p. In spite of its illogicality, it would probably cause little confusion.

For ease of comparison we tabulate the possibilities which we have discussed.

TABLE

System	μF	nF	pF
B.S. 530 : 1948	0	—	p
Modified B.S.	0	n	p
Logical B.S.	0	m	μ
Logical Farad	μ	n	p

0 no suffix to the numerical value.

Reliability

Nowadays the reliability of electronic equipment is no serious technological problem when it can be operated in conditions of moderate temperature, vibration and shock. Good design incorporating a judicious element of redundancy can reduce the probability of failure to a very small figure. Even when the occasional failure does occur repair can be quickly effected.

Matters are very different in space craft. The apparatus must withstand extremes of temperature, vibration and shock and it must be light and compact. Moreover, if anything does go wrong there is not much that can be done about it.

The recent moon shot is an example. The electronics concerned with launching and guidance clearly worked well otherwise the craft would never have reached the moon. The object was to obtain television pictures of the moon's surface and was not achieved because something went wrong with the equipment. This just emphasizes what we all know, that it is never possible to ensure 100% reliability in any apparatus of any kind.

Self-Healing Circuits

It is possible that in the future a certain amount of repair will be practicable even in a space-craft where there is no possibility of access to the equipment. In Telstar 1, for instance, it proved possible to remedy a defect from the ground as we reported in March last year. There is now news of research into ways of making circuit connections which are able to heal themselves if broken!

There are two approaches. One is by using conductors which grow whiskers! It is well-known that tin does this and it appears that an alloy of tin, aluminium and magnesium works best. If a fine break in the conductor occurs, whiskers grow out of the material to bridge the gap and establish continuity again. The process repeats if a break occurs again. However, it takes several days for the whiskers to grow sufficiently to bridge even a hair-line gap, so that the repair takes quite a long time.

The other approach is to coat the main conductor with a meltable alloy such as indium-gallium. The idea is that the heat generated by a failing current-carrying conductor melts the alloy coating so that it flows into the failing portion to re-establish conductivity. This, of course, has the advantage that the circuit never fails completely.

The research into this is being carried out for the U.S. Air Force by Honeywell Controls.

Lasers

Again in the news are lasers. Bell Telephones have built one 33 ft long, which is surely an outsize. It is, of course, an experimental one. Of more general interest is a triode laser developed by the same organization. The tube has a cathode, grid and anode in the form of parallel ribbons extending about 8 in. along the laser. The presence of the grid allows the energy spread of the electrons to be closely controlled and, in consequence, the efficiency of excitation per electron is increased 100 times.

The grid also enables the light beam to be modulated in amplitude. In the future this may be important for already experimental work on using lasers for communications is being carried out by I.B.M. A laser system is being built, initially for point-to-point ground communications, but later for air-to-ground. An injection laser is to be used with pulse modulation. The receiver is to have a light-collecting reflector with a photomultiplier tube.

In the air-ground experiment it will be necessary to adopt automatic following for the receiving 'aerial' and in the first instance this will be done using a tracking radar locked to the aircraft and controlling the receiver.

In the aircraft the apparatus will have to be 'sighted' by the operator on to the receiver. A gallium arsenide laser is to be used and it will not be cooled to liquid nitrogen temperature since the efficiency is expected to be adequate without this.

THYRISTOR CONTROL OF WARD LEONARD DRIVES

A variable speed drive is commonly obtained by using the Ward Leonard system. This article explains how this basic system is improved by the use of thyristors (silicon controlled rectifiers), for they enable smooth control of speed, and also speed regulation, to be obtained at high efficiency.

*By B. J. HODGSKISS**

THE Ward Leonard system was one of the earliest types of electrical adjustable speed drive to be employed. Originally its most attractive property was the controlled power amplification obtained in a d.c. generator when driven at a constant speed. The basic Ward Leonard arrangement comprises a d.c. motor, with constant field excitation, the armature being supplied from a d.c. generator which is driven by a constant-speed a.c. motor. Adjustment of the generator excitation enables the armature voltage and therefore the speed of the d.c. motor to be controlled. Early Ward Leonard drives were manually-controlled by means of a rheostat in series with the generator field but the subsequent use of electronic amplifiers together with thyratrons or magnetic amplifiers enabled improved performance to be obtained by employing closed-loop control. More recently the use of thyristors together with transistor amplifiers has resulted in further improvement in performance for a given cost, together with better efficiency, reliability and reduction in size of the control equipment.

In addition to the power amplification provided by the d.c. generator, enabling drives of large rating to be built using relatively low power electronic techniques, the Ward Leonard system is also attractive because of its ability to provide stepless speed control of the d.c. motor together with positive or negative torque, for any given speed, at the motor output shaft. In some applications the large overload capacity of a Ward Leonard drive and also the stored kinetic energy in the motor generator set are very useful. In other cases where high performance is required the motor generator set provides good isolation of the d.c. motor from a.c. supply fluctuations. If the motor generator set is driven by a synchronous motor its excitation can be adjusted to control the load power factor.

In addition to the basic system used for controlling the speed of the d.c. motor the closed-loop principle enables other useful parameters to be regulated. Such features as armature current or torque control and the maintenance

*Lancashire Dynamo Electronic Products Ltd.

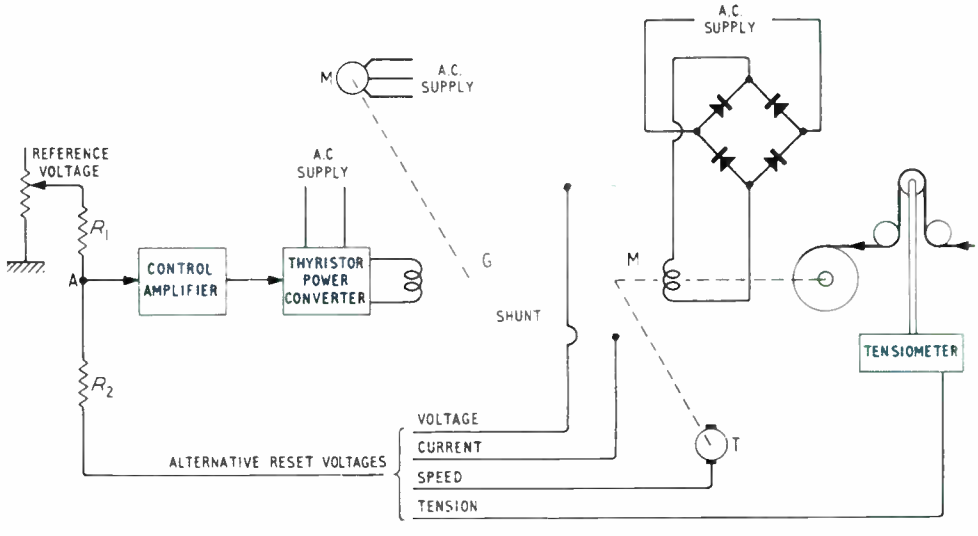


Fig. 1. General arrangement of Ward Leonard drive with thyristor control

of constant tension in strip or web materials are readily achieved by the closed-loop principle. The general closed-loop Ward Leonard arrangement is shown in Fig. 1.

Description of Operation

An adjustable reference voltage obtained from a stabilized d.c. supply is compared by means of resistors R_1 and R_2 with a reset voltage (a measure of the controlled parameter) of opposite polarity. The resulting voltage at point A is a measure of the deviation from the desired value. This voltage is applied to a high-gain d.c. amplifier whose output is used to control the conduction of a thyristor power converter, which supplies the generator excitation. In this way the armature supply to the d.c. motor adjusts the feature of the system which is being controlled (speed, tension, etc.). Polarities in the system are so arranged that the generator excitation is continuously adjusted to make the reset voltage always bear a fixed relationship to the reference voltage. In addition to enabling the magnitude of the controlled feature to be adjusted, the closed-loop system will ensure that any desired value will be maintained despite variations of load or a.c. supply voltage.

The normal direction of power flow is from the a.c. supply through the a.c. motor, d.c. generator and d.c. motor to the load, but under regenerative conditions (e.g., in slowing down a load of high inertia) the direction of power flow may be reversed, the a.c. motor acting as an induction generator returning power to the a.c. supply. In applications involving the frequent starting and stopping of high-inertia loads this feature of the drive can produce a considerable improvement in operating efficiency. Where it is required to maintain the controlled feature constant, despite changes from driving to overhauling load conditions, it is ideal.

In more complex systems, a thyristor power converter may be used to control the excitation of the motor in addition to that of the generator. By controlling only the generator field a constant maximum torque characteristic is obtained, the power output available from the motor being proportional to speed. If the motor field is also controlled, a constant power/speed characteristic can be obtained, a feature which is very useful for a number of industrial applications such as reeling and decoiling drives.

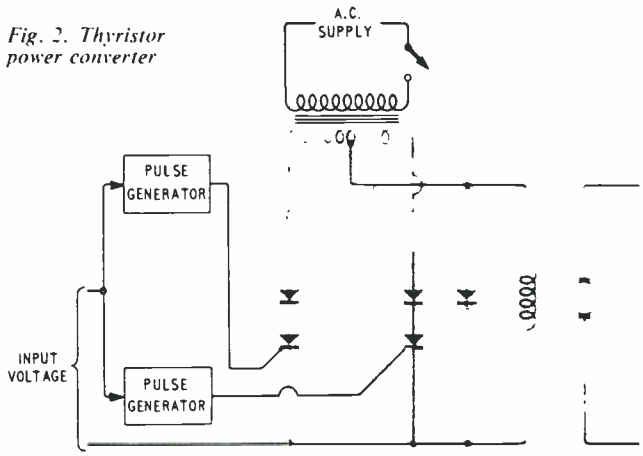
Thyristor Power Converter

The thyristor can be regarded as a three-terminal switch in series with a diode. A low-power electrical signal applied to one terminal (gate) causes the path between the two high-power terminals (anode and cathode) to change from its blocking (off) state to its conducting (on) state, provided that a voltage exists between anode and cathode, the anode being positive. Switching off the thyristor can only be achieved by removing the supply from the anode circuit or by making the anode negative with respect to the cathode.

In its blocking state the leakage current between anode and cathode of the thyristor is very small (typically 3 mA at 500 V) and in its conducting state the voltage drop across the thyristor is very low (typically 1·5 V at 20 A). These characteristics mean that the dissipation in the device is very low, a fact which leads to high efficiency, compactness, and a very light power converter assembly.

The principal characteristics required in the power converter are suitability for supplying loads having inductance and its output voltage must be capable of stepless adjustment over the full range, in sympathy with an input control voltage. In addition to these characteristics it is desirable that the power converter has high efficiency and fast response.

Fig. 2. Thyristor power converter



In order to obtain the most rapid response when operating the power converter from a normal a.c. supply, a full-wave rectifier arrangement was chosen in preference to the potentially more simple half-wave arrangement. Its configuration is shown in Fig. 2.

In addition to the thyristors which handle the excitation power of the generator, the complete power converter contains a pulse generator for each thyristor. Each pulse generator is controlled by the d.c. input voltage and delivers a pulse for each cycle of the mains supply, to its respective thyristor gate electrode. As the input voltage swings over its control range (±6 V), the timing of each thyristor firing pulse is altered linearly from 0° to 180° with respect to the half cycle of supply voltage during which the anode of the corresponding thyristor is positive with respect to its cathode. The outputs of the two pulse generators are phase displaced by 180° so that through the two thyristors full-wave controlled rectification of the supply to the machine field is obtained. Switching off each thyristor is automatically achieved each cycle by the reversal of the a.c. supply voltage.

In order to make the most effective use of the two thyristors, three diodes are also used in this circuit. One diode (overswing diode) is connected directly across the machine field and carries the field current up to the time in each half cycle when a thyristor is turned on. The machine field is inductive, and if the overswing diode were not present the field current would continue to flow through each thyristor until the other one is turned on. In addition to reducing the average current through the thyristor, the overswing diode halves the maximum forward blocking voltage to which each thyristor is subjected. This voltage is equal to the peak of one leg of the supply transformer voltage. The maximum reverse voltage to which each thyristor is subjected is twice the maximum forward voltage, but as thyristors have approximately the same maximum forward rating as reverse rating the reverse voltage can be shared by connecting a diode in series with each thyristor. Diodes of a given voltage rating are far less expensive than thyristors, so that in this way units with ample voltage ratings can be constructed economically.

In any circuit employing thyristors care must be taken to ensure that they are not damaged by excessive voltage transients on the a.c. supply. Experience and measure-

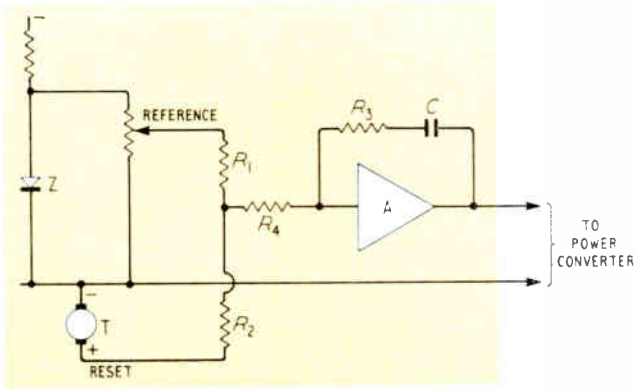


Fig. 3 Speed control network

ments in this field have indicated that short-duration voltage transients occur on a.c. supplies. These transients are frequently in excess of 200% of the normal peak of the sinusoidal supply and are usually associated with load switching taking place on the same supply lines. If a voltage in excess of the peak transient rating of the thyristor is applied across it, then localized break-down of the device may occur at the weakest point of its internal junction, resulting in destruction. If reliable operation is to be achieved then the transient rating of each thyristor must be at least three times the peak of the a.c. supply to which it is normally subjected each cycle.

During normal operation the current conducted by each thyristor is limited by the impedance of the machine field winding being controlled but under conditions of accidental short-circuit of the power converter output, care must be taken to protect the thyristors from damage. This is achieved by connecting in series with each thyristor a high-speed fuse which, at the value of prospective short-circuit current determined by the regulation of the supply transformer, has a lower value of energy let through than the maximum rating of the thyristor.

As a thyristor is very small its surface area from which to dissipate heat is also small. As a consequence, although the amount of power dissipated in a thyristor is low by comparison with the amount of power being handled, if the best use is to be made of the thyristor it must be mounted on a heat sink to increase its effective area. A typical thyristor may dissipate 6 watts while controlling a power of 1,000 watts. The heat sink must be chosen so that, in the highest ambient temperature anticipated, the temperature of the internal junction of the thyristor does not exceed its maximum rating.

By comparison with the use of thyratrons the construction of a range of thyristor power converters is a simple matter. If thyratrons are used allowance must be made for a filament transformer, time-delay unit to cater for thyratron warm-up and space to allow the thyratrons to dissipate the heat generated in them. A typical thyratron may dissipate 80 watts while controlling a power of 1,000 watts. The only ancillary apparatus required by the thyristors is the pulse generator unit which is a compact, plug-in transistorized unit, common to a large range of power converters of different power ratings.

Thyristors enjoy similar advantages over the use of magnetic amplifiers for the control of d.c. machine excitation. In the thyristor the processes of control and rectification are carried out in the same unit, whereas in the magnetic amplifier the two processes are carried out separately. The power loss is consequently much greater and the excessive weight of the magnetic amplifier makes it very difficult to produce a simple compact range of units.

It is often claimed that magnetic amplifiers are more reliable than other power converters, as they employ transformer-type construction, overlooking the fact that all magnetic amplifiers use rectifiers, usually silicon, to which exactly the same arguments must be applied as are applied to thyristors.

Control Amplifier and Networks

The amplifier and network arrangement in a speed control system is as shown in Fig. 3.

The reference voltage, adjustable by means of the speed-control potentiometer, is generated across zener diode Z, the voltage of which is chosen to have a very low temperature coefficient. As a result of the comparison between reference and reset voltages the error voltage generated at the junction of resistors R_1 and R_2 is amplified by a high gain d.c. amplifier. In order to eliminate hunting the amplifier has its proportional or instantaneous gain limited by the network C, R_3, R_4, without reducing its follow-up or steady-state gain. The output voltage of the d.c. amplifier is used to control the power converter in such a way that the output from the d.c. generator, and hence the d.c. motor and its tachogenerator, is always adjusted to maintain the error voltage at zero. The accuracy to which the speed of the d.c. motor will be controlled will depend on the stability of the reference voltage and the measuring accuracy of the tachogenerator. It will also be influenced by the steady-state gain and input stability of the control amplifier and also the stability of resistors R_1 and R_2.

The stability of resistors R_1 and R_2 is not usually a problem, provided that two resistors of similar type are used, and that they are mounted in close proximity. Over moderate periods of time they will both be subjected to the same percentage variation due to temperature and so their ratio will not change.

With tachogenerators of an industrial pattern, the limit of speed-control accuracy is about 0·15%. This is the maximum linearity error with which the tachogenerator output voltage represents its speed, although once a given speed has been selected, fluctuations of speed which are a result of tachogenerator errors can be expected to be somewhat less than this figure.

Variations of speed due to changes of reference voltage are usually a result of temperature or a.c. supply fluctuations. Using a simple zener diode reference, speed variation due to the maximum statutory a.c. supply changes together with a temperature change of 20 °C is less than 1%. If further precautions are taken to ensure that the zener diode carries a constant current and temperature compensation is achieved by using a series combination of zener diodes with mixed individual temperature coefficients, then the reference voltage stability can be made better than 0·1%.

Two important factors combine to determine the effect of the d.c. amplifier on speed-control stability. The first is the input stability, which is defined in terms of the variation of input working voltage for a given output voltage and this is measured in the presence of supply and temperature changes. The second factor is the steady-state gain available from the amplifier. The introduction of

transistors has enabled amplifiers to be constructed having input stabilities equivalent to a speed-control stability of much better than 0·1 %. The use of printed circuits means that the amplifier, together with its associated power supplies, can be built in a very compact form to match the thyristor power converter.

Current Limit

In any Ward Leonard machine system it is desirable to include a means of limiting the magnitude of armature current which can flow around the armature loop in either direction, in order to protect the machine armature windings and commutators. Excessive currents could arise during acceleration and deceleration or due to overload. A voltage developed across the generator interpole winding is used as a measure of armature current, and this voltage is applied to a circuit in the control amplifier which overrides the amplifier output in either direction when the armature current reaches a preset level. To avoid damage to the machine in the event of a prolonged overload, a magnetic overload relay is connected in the armature circuit, with a time delay, to allow the current to rise for short periods up to its current limit value for acceleration.

Construction

Each Ward Leonard regulator consists of a combination of an electronic regulator and machine switchgear components, mounted in an enclosure, usually a floor-standing cubicle. The regulator includes the control amplifier and thyristor power converter.

Provided that the electronic components can be made sufficiently small and light they can be assembled together as a complete sub-unit. Utilizing thyristors, transistors and printed-circuit techniques this is quite practicable. The complete electronic sub-assembly can be mounted along with the electrical components, in a cubicle, and treated in exactly the same way as, say, a contactor, with wires carrying signals and a.c. supply going to it, and wires with the machine field supply emerging.

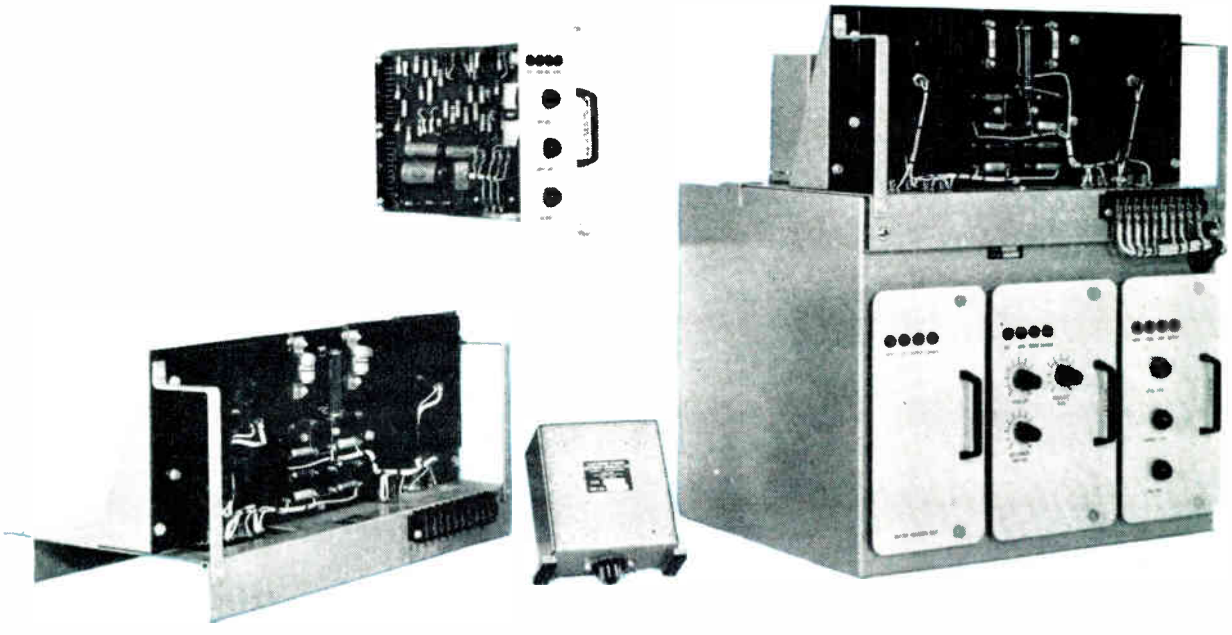
A range of electronic components is illustrated in Fig. 4 showing a number of thyristor power converters each of different power rating and mechanically interchangeable, a pulse generator which normally plugs into a socket on the power converter, and a printed-circuit control amplifier. Also shown is a complete electronic sub-assembly using these components, of the form that would be mounted in a control cubicle.

Fig. 5 illustrates a complete multi-section control cubicle. It will be seen that this incorporates five separate sections, each having an electronic sub-unit and each controlling a separate motor in a multi-motor line drive application. In this particular case four of the drives are accurately speed controlled relative to each other, as they are fed from a common reference voltage. The remaining drive is a reeler drive and this is controlled from a tensiometer as indicated in Fig. 1, in order to maintain a constant tension in the material being reeled.

Conclusions

Thyristors were introduced to this country about five years ago from the United States. Initial experiments with them were somewhat hazardous on account of their price and the general lack of familiarity which attends the introduction of any new device. Since that time the application of thyristors to variable-speed drives of all types has been pursued with vigour, and the time has now been reached when they represent the most attractive method of controlling Ward Leonard drives.

Fig. 4 Range of electronic components



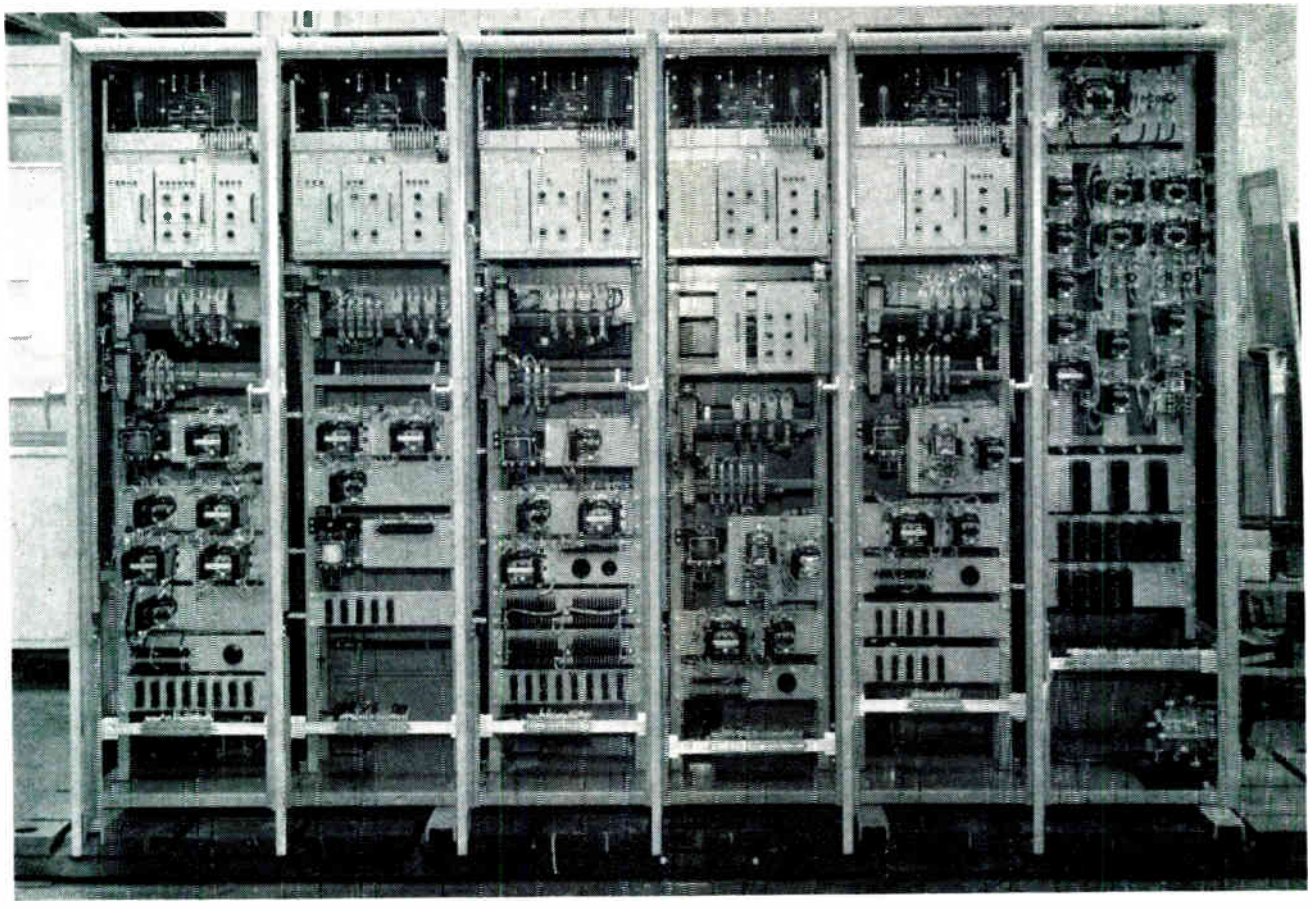


Fig. 5 Control equipment for film casting line

Any initial doubts which may have existed concerning the reliability of thyristors have been conclusively shown to have been connected with their mis-application. The author has had to date experience of several hundred thyristor-controlled Ward Leonard drives installed over the last two years, and so far not a single case of thyristor failure has been experienced in the field. This is a record which compares very favourably with any other known form of adjustable speed drive.

The thyristor is very compact and light and these factors, together with the high power gain and large range of ratings with substantially identical gate control characteristics, enable compact packaging of electronic sub-units to be achieved. This leads readily to the design of a rationalized range of control units, in a wide range of ratings, giving economic manufacture of high performance versatile control systems.

It has been fortunate, though perhaps not surprising, that the introduction of the thyristor followed closely the advent of the transistor. The two devices are perfectly complementary in characteristics, the thyristor being ideally suited to controlling power, from low-level signals generated by transistors. The transistor, in addition to assisting with sub-unit packaging has enabled completely solid-state control circuits to be designed with performance/cost relationship much superior to the previous systems.

The power loss in a thyristor is so low that the efficiency of a Ward Leonard drive employing thyristor control of its generator field is almost solely determined by the efficiency of the rotating machines involved.

The Ward Leonard system of adjustable speed drive is one which is ideally suited to many industrial applications, particularly where regeneration and large overload capacity are required. The introduction of the thyristor to the control of such drives had led to improvements in performance reliability and efficiency, and a reduction in size has ensued. Rapid reduction of thyristor prices in the last two years has resulted in the present situation in which the thyristor power converter is the generally accepted method of controlling Ward Leonard drives.

Different grades of petroleum are passed along a pipeline separated by a 'pig' such as a neoprene sphere. When this 'pig' reaches a certain point in the pipeline it is necessary to detect that it has done so in order that the appropriate valves may be operated to divert the petroleum which follows the 'pig' to a different storage tank. This article describes how the detection works.

ELECTRONIC 'PIG'

By P. R. FORRER *

IN order to reduce the number of pipelines required, it is common practice to utilize a single pipeline for various grades of a petroleum product. To ensure that there is as little intermixing and consequent degradation of the grades as possible, separators are inserted between them which are forced along the pipeline by the following liquid. One type of separator is a neoprene sphere which is slightly larger in diameter than the internal diameter of the pipe. Another type, known as a 'pig', consists of several saucer-shaped discs fitted to a central spindle.

When the separator reaches the end of the pipeline, it must be diverted into a section of pipe where it may be removed, and the following product must be diverted into the appropriate storage tank. In order to facilitate these operations, it is essential that signals are given as the 'pigs' pass one or more points in the pipeline.

There are available a number of 'pig' sensing devices which actuate a switch by means of a plunger or lever which is struck by the 'pig' as it passes. This type of unit is not always reliable, particularly in adverse environmental conditions, because of its reliance on mechanical movement and the difficulty of sealing the unit to withstand the pressures which might be encountered.

Another method utilizes a radioactive source attached to the 'pig'. A detector mounted on to the pipe causes a relay to operate as the 'pig' passes. This method has the advantage that the 'pig' can be traced should it become lost anywhere in the pipeline, but the statutory requirements to monitor personnel and to provide special storage for activated 'pigs' reduce its appeal. An alternative is to use the transmission method, with a radioactive source on one side of the pipe and a detector on the opposite side. This obviates the fitting of sources to the 'pigs', but the monitoring of maintenance personnel is still necessary.

In view of these features, the Engineering Department of the Esso Petroleum Co. Ltd. requested Burndept Electronics Ltd. to conduct trials in conjunction with themselves to ascertain the possibility of using the Burndept proximity switch type BE.238 for this application. Various tests were made to ascertain the changes in capacitance which could be expected from various petroleum products compared with a neoprene sphere or 'pig'. It was found that the

* Burndept Electronics Ltd.

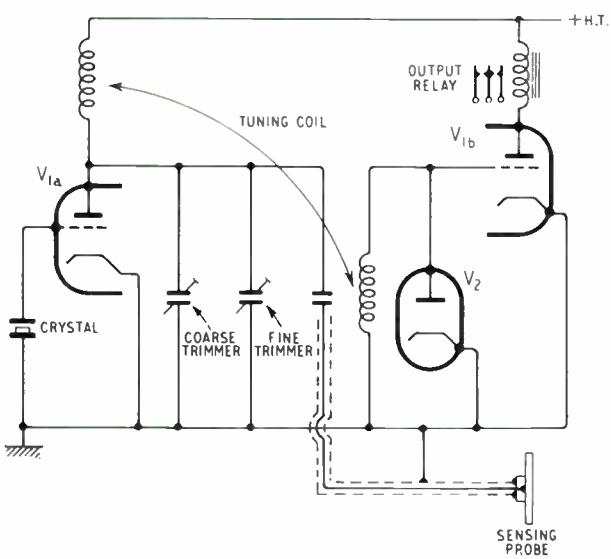
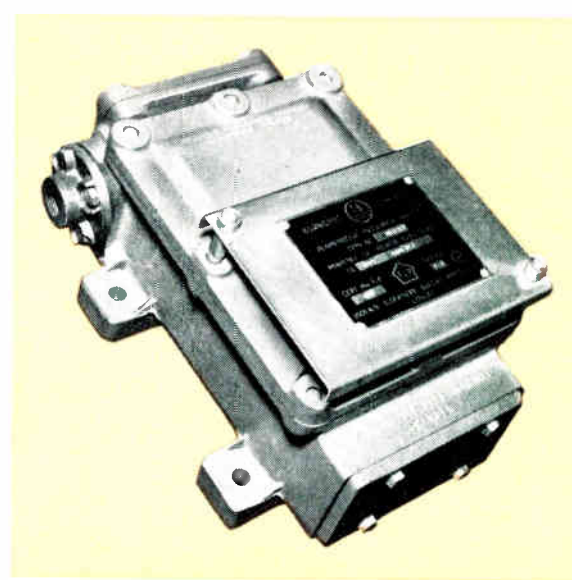
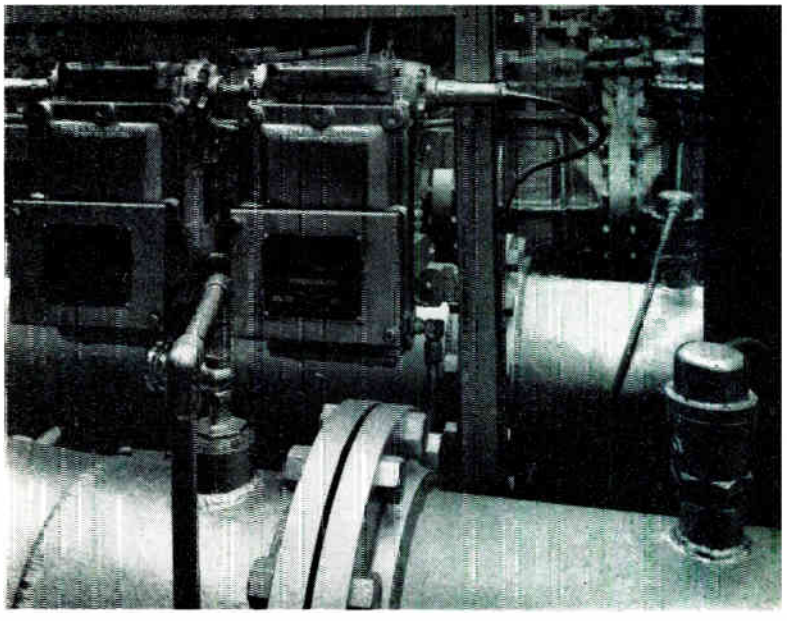


Fig. 1. Simplified circuit diagram of Burndept proximity switch type B.E.238



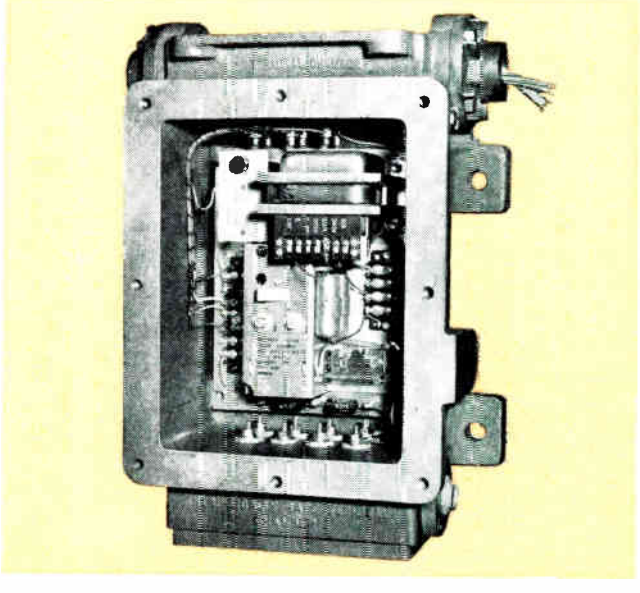
Proximity switch in flameproof casing

DETECTION



Two proximity switches installed at Tynemouth

Interior of proximity switch unit



neoprene could easily be detected when in air, but that the petroleum products also caused an increase in capacitance to almost the same extent. It was necessary, therefore, to design a probe which presented to the proximity switch as large a change in capacitance as possible when the 'pig' was present. The possibility that the 'pig' might be forced along the pipeline, surrounded by air, made it necessary to be able to set the proximity switch to ignore both air and product, but to detect the 'pig' whether it be surrounded by air or product. Many proximity switches are capable of detecting minute increases in capacitance over a short period of time, but long-term stability is essential if reliable operation is to be achieved. The Burndept proximity switch utilizes a 13-Mc/s crystal-controlled oscillator of the Miller-Pierce type, which ceases to oscillate when the critical value of anode capacitance is exceeded (see Fig. 1). This type of oscillator is affected very little by changes in voltage, the change in operating point for 1 volt change in the mains supply being only 0·004 picofarad. Temperature compensation is employed to ensure minimum thermal drift.

Having ascertained that the proximity switch was adequately sensitive and stable for this application, it was

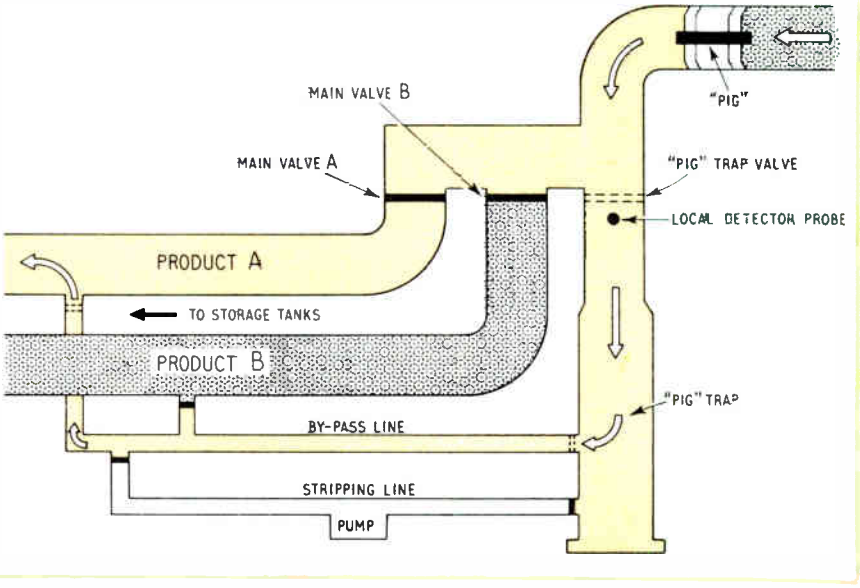


Fig. 2. Sketch of pipe layout at Tynemouth terminal

necessary to obtain Flameproof Certification before any could be installed (Ministry of Power FLP Certificates Nos. 4860 and 4861).

The Esso Petroleum Company have installed proximity switches on the pipelines from the jetty to the storage tank area at their Tynemouth terminal. Each line is equipped with one distant and one local detector. When the 'pig' passes the distant probe, an audible and visual indication is given, the valves being set to cause the flow of product through the 'pig' trap as shown in Fig. 2. When the 'pig' enters the 'pig' trap, a second signal is given, and the 'pig' trap and by-pass line valves are closed automatically. On receiving this signal, the operator opens the appropriate main valve so that the following product is diverted to the correct storage tank. The product remaining in the 'pig' trap is pumped away through the stripping line, and the 'pig' is removed from the trap. The circuit is then reset to await the arrival of the next 'pig'.

Though the Tynemouth terminal is using 'pigs', successful trials have also been made at the Esso Petroleum Company's Bowling terminal where spheres are employed.

Acknowledgments

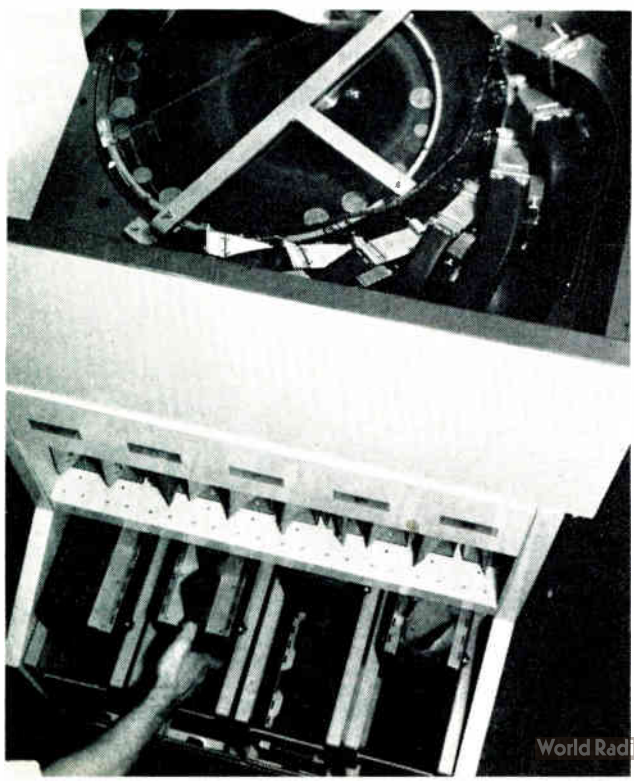
Thanks are due to the Directors of Burndept Electronics Ltd. and the Esso Petroleum Co. Ltd. for their permission to publish this article.

The author also wishes to thank the staff of both companies whose co-operation and assistance is greatly appreciated.

MANUAL coin counting is a tedious and dirty job. Yet the number of coins in circulation increases year by year (nearly 5,000,000,000 coins were in circulation at the end of 1962) and all of them have to be counted many times over by Post Offices, banks, transport depots, department stores, vending machine operators and many others.

A recent development by one of the Elliott-Automation divisions (Automation Accessories of Associated Automation Ltd.) outdates manual coin counting and provides a high-speed efficient handling system. Known as the 'Numismator' automatic coin segregating, counting and bagging machine, it sorts and counts coins of all denominations in current use. The average working rate is 10 coins a second. This represents about £75 worth of coins a minute, if all the coins are half-crowns, or 25 shillings worth of coins a minute, if all the coins are halfpennies. A mixture of coins such as conductors bring into a typical bus depot can be counted at the rate of approximately £320 an hour or £2,500 in a 8-hour day.

An overhead view of the coin-counting machine showing the bag cassettes being loaded



'Numismator' Operation

The machine is designed to sort and bag-up seven different-sized coins. Coins are sorted by mechanically sensing their diameter.

Coins are fed either from a sorting tray, where 'foreigners' are manually extracted, or directly into a chute, and along a conveyor on to a circular rotating table. A vibrating mechanism separates coins from each other so that they drop on to the table one at a time.

By centrifugal force the coins are thrown to the perimeter of the table where they are forced against a raised flange. A fixed helical guide very close to the surface of the spinning table ensures that the coins reach the perimeter flange in succession.

Around the perimeter of the spinning table are positioned the seven double chutes (down which the separated coins are thrown) and their associated sensing blades. The tapered sensing blade for each chute is set at a distance, slightly less than the appropriate coin diameter, from the perimeter flange. The tapered blade lifts the coin and tangential force takes it along the chute. A photoelectric cell is used at the entrance of each chute to count the coins and an electromechanical flap operates to close one section of each chute when the associated bag is filled. The second section comes into operation while the bag is being changed.

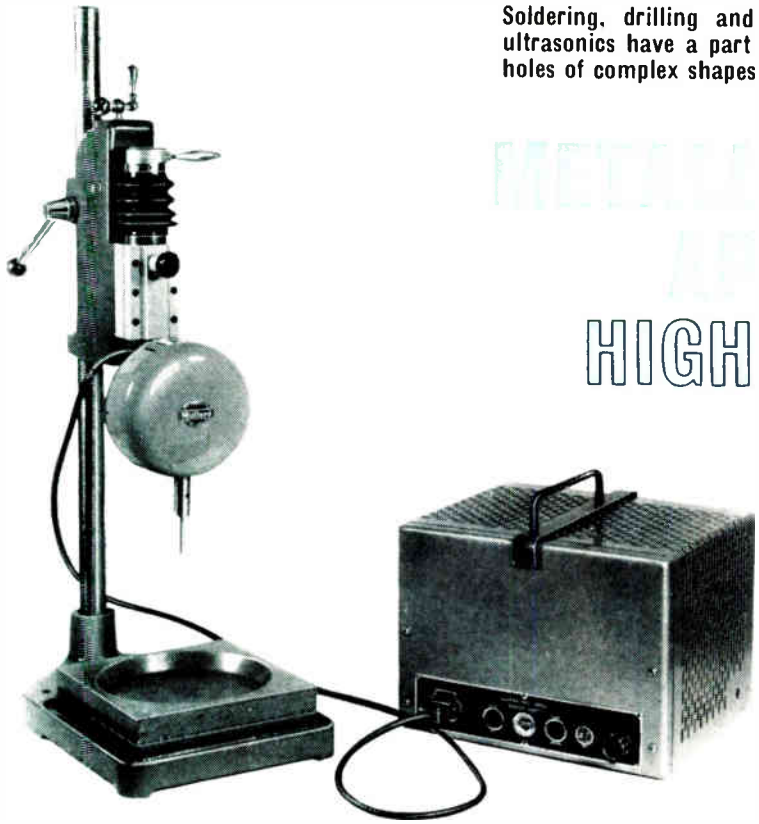
Individual bags are filled with pre-determined numbers of the same denomination of coins. In general, silver is delivered in £5, copper 5s., and cupro-nickel (3d. pieces) in 10s. bags.

Operation is continuous and when a bag is full a buzzer sounds, a red lamp lights and the coins are automatically diverted into a second bag waiting for that denomination. The bags for coppers or cupro-nickel coins are loaded into cassettes of 4 or 6 bags. These are automatically indexed to the next station when a bag is full.

Counters indicate the numbers of bags of the various denominations already filled and the value of the contents of partially-filled bags.

For each of the seven channels and for Treasury notes, tokens and vouchers, sub-totals in £ s. d. can be printed out on a tally roll when a 'print' button is pressed.

For further information circle 52 on Service Card



Soldering, drilling and welding are manufacturing operations in which ultrasonics have a part to play. Ultrasonic drilling, in particular, enables holes of complex shapes to be made in brittle materials.

HIGH INTENSITY

By B. BROWN, B.Sc., Ph.D., A.Inst.P.*

HIGH-INTENSITY ultrasonics have been successfully used in a number of metallurgical applications. The most widely known and utilized of these applications are undoubtedly ultrasonic soldering or tinning and ultrasonic drilling. However, in recent times, ultrasonic welding has also aroused considerable interest and it seems likely that this application will become increasingly utilized. Destructive fatigue testing provides a further use for high-intensity ultrasonics. This technique is quite useful but it is not as widely known or used as the application of low-intensity ultrasonics to non-destructive testing. Other metallurgical applications of high-intensity ultrasonics lie in the treatment of molten metals. Grain refinement, degassing, and the production of unusual alloys can all be readily accomplished but as yet the techniques have been confined to the laboratory and much work remains to be done in this field.

Ultrasonic soldering techniques were developed primarily in order to enable aluminium and its alloys to be soldered. These materials cannot be soldered by conventional methods due to an oxide layer present on the metal surface. This oxide layer cannot easily be removed by the use of fluxes and hence, unless this layer is deliberately chipped or scraped off the surface, the molten solder never reaches the actual metal to make a good contact. Ultrasonic soldering depends on the removal of this oxide layer by cavitation set up in the molten solder. Commercial ultrasonic soldering equipment available at present in this country consists of various forms of tinning baths. Until recently there was also available an ultrasonic soldering iron, but due to lack of demand this instrument is no longer manufactured.

The ultrasonic tinning bath basically consists of a metal bath containing molten solder in which cavitation is produced by the passage of ultrasonic waves. It has been mentioned in a previous article that cavitation intensity increases as the ultrasonic frequency decreases and hence the operating frequency needs to be fairly low. A typical ultrasonic tinning bath is shown in Fig. 1. In this equipment one or two magnetostrictive transducers, resonant at about 20 kc/s, are coupled to the molten solder by half-wave rods through the bath walls. Each transducer is driven by an electronic generator providing an output of 60 W at the required frequency. The solder is maintained at the correct operating temperature by heaters attached to the base and rear of the bath. Components to be tinned are merely dipped into the molten solder near to the end of the coupling rod where the cavitation intensity is greatest. When two stubs are used they are positioned opposite each other with a spacing such that intense cavitation is produced in the entire volume of molten solder between them. The use of tinning baths has the disadvantage that the entire metal area immersed in the solder is tinned and this is not always desirable. Nevertheless, for the tinning of small components they are extremely useful.

Ultrasonic soldering finds very diverse applications in industry. It is extensively used in the electrical industry, where aluminium, due to its low density and good electrical properties, is often used. Applications range from enabling contacts to be made to aluminium foil in capacitors to enabling heavy aluminium cables to be joined by pretinning the cable ends. A particularly important application is in the manufacture of high-quality loudspeakers, in whose construction aluminium wire is often used to ensure a low mass on the cone. Micro-joining equipment has been developed and ultrasonically soldered joints have been made with 0·002-in. diameter gold wire on gold-plated silicon and on aluminium foil only 0·003 in. thick. Recently some interest has been shown in the application of ultrasonics to

* Royal College of Advanced Technology, Salford.

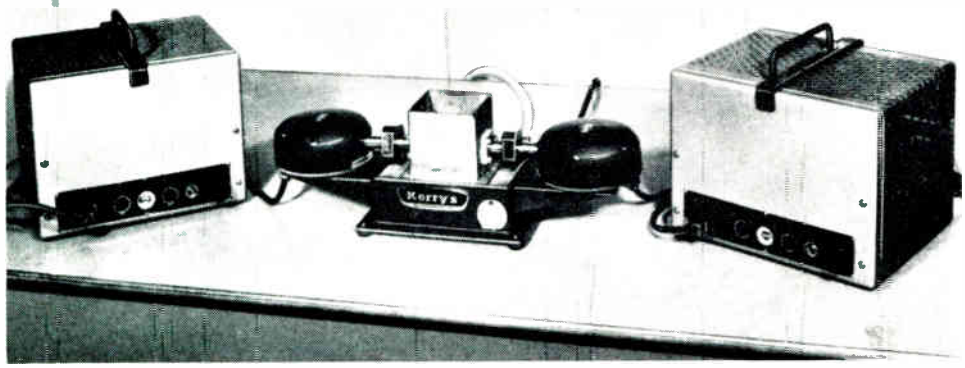


Fig. 1. Ultrasonic tinning bath (Courtesy of Kerry's (Ultrasonics) Ltd.)

conventional solder baths which use tin-lead solders for the processing of components and boards used in printed-circuit techniques. The advantage here is the very smooth tinning which is achieved without the danger of bridging adjacent strips or contacts on printed boards.

The drilling of square holes in glass and similar brittle materials sounds impossible but by the use of the ultrasonic drill such tasks can easily be accomplished. Ultrasonic drilling has nothing in common with the conventional rotary drill but works on a principle similar to that of a pneumatic drill. The basic construction of the ultrasonic drill is shown in Fig. 2. Mechanical vibrations are produced by a magnetostrictive or piezoelectric transducer and the amplitude of the resulting oscillations is increased by the use of a velocity transformer. The actual cutting edge or bit of the drill is normally attached to the velocity transformer by a screw thread to facilitate the rapid interchange of various bits.

The bit is not applied directly to the material being cut, but through the medium of an abrasive slurry, and the actual cutting is carried out by this abrasive being violently driven into the material by the reciprocating action of the bit. Due to the reciprocating action the ultrasonic drill is not limited to drilling round holes and extremely complicated shapes can be drilled by making the bit to the shape required. Abrasives used vary according to the material being worked and for most materials silicon carbide, boron carbide, and aluminium oxide of various grain size are quite suitable. For commercial use the ultrasonic drill is mounted in a suitable drilling stand with facilities for vertical movement. The drilling pressure is variable and it must be adjusted according to the material being worked, shape of the hole, and its size.

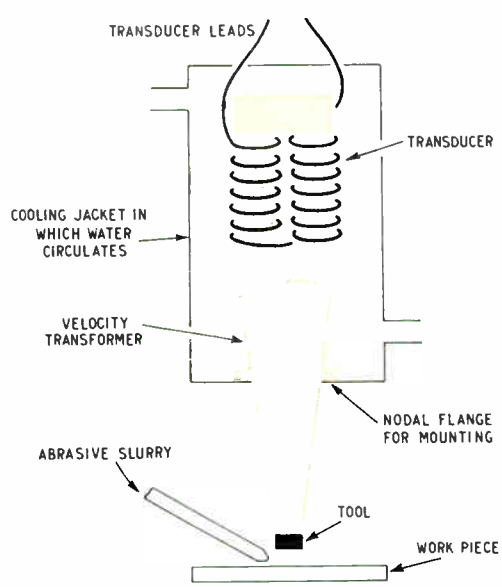


Fig. 2. Basic form of ultrasonic drill

The title block shows the small ultrasonic drill manufactured by Mullard Equipment Ltd. This equipment comprises a 60 W generator driving a magnetostrictive transducer at a frequency of 20 kc/s. A scale is provided so that the static load on the workpiece can be adjusted between 0 and 11 lb and this can be supplemented if necessary by manual pressure. A depth scale graduated in steps of 0·02 in. is also incorporated and can be viewed through a magnifying cursor. If required, a pump to circulate the slurry continuously is also available. This drill is capable of drilling holes from 0·006 to 0·75 in. across to a depth of 0·5 in. and dimensional accuracies of the order of 0·005 in. are claimed on finishing cuts. A larger ultrasonic drill for heavy duty machining is shown in Fig. 3. This equipment also operates at a frequency of 20 kc/s but is provided with a more powerfull electronic generator whose output is adjustable up to 2 kW. This drill will machine holes from about 0·06 in. to about 2·25 in. across. Due to the complex shapes which can be drilled, particularly in brittle materials, the industrial applications of ultrasonic drilling are extremely widespread. The range of materials successfully handled includes glass, ceramics, tungsten carbide, germanium, ruby and other precious stones, etc. The semiconductor industry finds ultrasonic drilling particularly useful for fashioning materials such as germanium. In the watch and jewellery industry, the shaping of synthetic ruby and other stones for watch bearings can readily be carried out and materials such as mother-of-pearl can be engraved or embossed. These few examples serve to show the undoubted usefulness of the ultrasonic drilling technique in industry today.

Ultrasonic welding has been used in the U.S.A. for some years but in this country its development as a commercial proposition has only recently been started. Ultrasonic welding has several advantages over normal welding techniques, although on economic grounds its use cannot always be justified. The main advantages are: (a) no applied heating is required: (b) little surface preparation is necessary: (c)

only slight metal deformation takes place; and (d) no arc, smoke, or spark contamination results. Basically ultrasonic welding consists of causing the two metal surfaces to be joined to slide against each other at an ultrasonic frequency so that bonding takes place. The mechanism of the bonding appears to be similar to the seizure which takes place when no lubricant is used between two metal surfaces moving in contact. The essential parts of an ultrasonic welding system are shown in Fig. 4. The equipment includes an electronic generator to produce electrical oscillations at the required frequency, a transducer, a velocity transformer, a welding tip, a support for the materials to be welded, and some means for applying a clamping force to the material.

Ultrasonic spot welding equipment developed by Mullard Equipment Ltd. is shown in Fig. 5. A magnetostrictive transducer is used and the system vibrates at a frequency of 20 kc/s. The transducer is driven by an electronic amplifier which is self-excited by means of an accelerometer pick-up crystal attached to the free face of the transducer, thus ensuring that the system vibrates at the correct resonant frequency. The actual welding tip consists of a detachable conical insert with a rounded end and is made of titanium. The transducer mounting is hinged and a foot-pedal control brings the welding tip into contact with the workpiece on the anvil. The static pressure between the welding tip and the anvil can be varied between 1 lb and 20 lb and this enables satisfactory welds to be obtained with little deformation between varying thicknesses of different materials. This equipment has been used to weld materials of thicknesses up to 0·01 in. For greater thicknesses of material, satisfactory welds have been limited to copper and aluminium and thicknesses of up to 0·04 in. of these materials have been welded. Industrial applications of ultrasonic spot welding are widespread and a typical example is the joining of aluminium conductors to copper terminals. Ultrasonic seam-welding equipment has also been developed and with this equipment it is possible to seal hermetically such items as sterilized medical equipment in metal foil.

The fatiguing of various metal parts when they are subjected to alternating stresses is of great importance and considerable work is being carried out in industry into the causes of this fatigue. In such work it is often necessary to subject specimens to up to 10^9 reversals of stress and in order to speed up the testing time equipment can be operated at ultrasonic frequencies. Basic equipment is shown in Fig. 6. It consists of a magnetostrictive transducer, resonant at 20 kc/s, and a velocity transformer to which is attached the specimen under test. The method is based on the fact that by the use of a large amplitude velocity transformer, stresses capable of fatiguing the material can be induced in a resonant solid specimen, even though the transducer itself is working under low stresses. The transducer is driven by the usual electronic generator supplying a maximum power of 60 W. To carry out fatigue measurements the strain is set to be a suitable value. The system is then set into vibration and the number of cycles before fracture occurs is noted. The measurements are repeated with several specimens over a suitable strain range and in this manner the strain endurance characteristic of the material may be determined.

The treatment of molten metals by ultrasonics is not a technique in common use in industry. Experiments are confined to the laboratory and in view of the cost of the equipment it seems unlikely that large-scale irradiation of molten metals will ever be carried out. Nevertheless, it is quite feasible that some of the effects produced may well justify the ultrasonic treatment of particular metals or metal mixtures on a small scale in industry. The effects produced when high intensity ultrasonic waves are propagated in molten metals can be grouped under three headings: grain refinement, dispersive effects, and degassing. Grain refinement

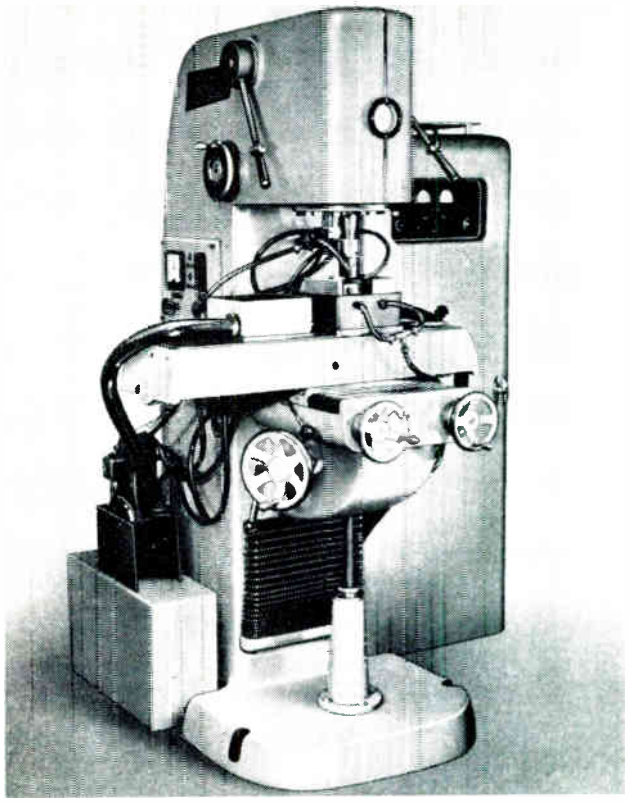


Fig. 3. Heavy duty ultrasonic drill (Courtesy of Kerry's (Ultrasonics) Ltd.)

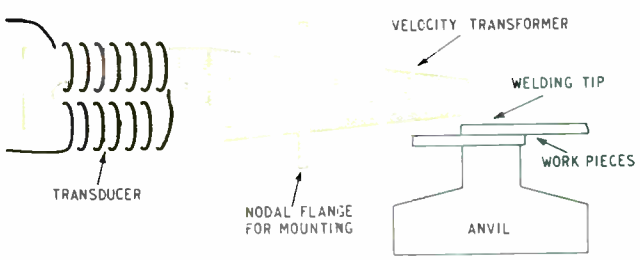
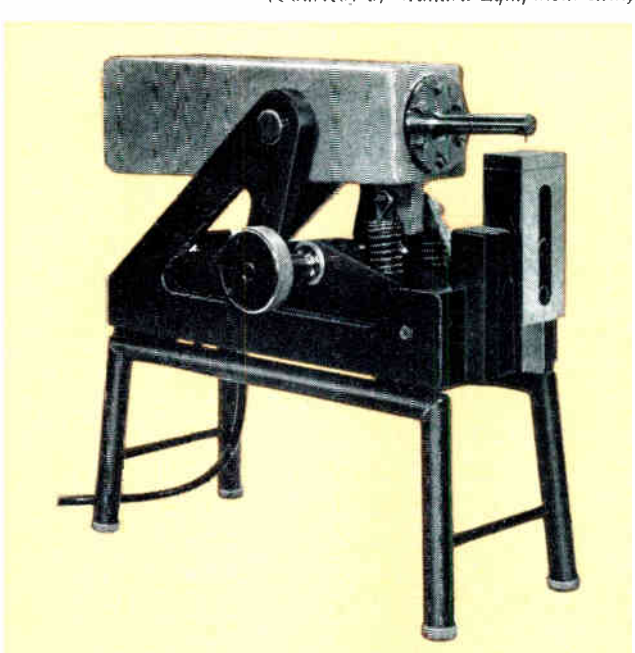


Fig. 4. General form of ultrasonic welding equipment

Fig. 5. Ultrasonic spot welding equipment (Courtesy of Mullard Equipment Ltd.)



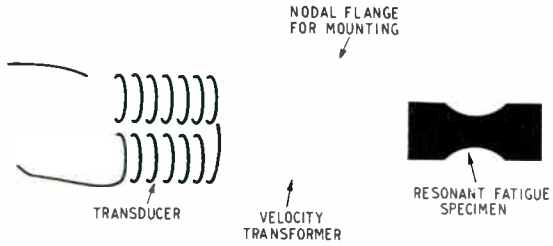


Fig. 6. Ultrasonic fatigue-testing equipment (Courtesy of Mullard Equipment Ltd.)

refers to a reduction in the grain size of the metal, which in many cases results in desirable changes taking place in the metal properties, such as increased hardness, etc. Dispersive effects produced include the production of unusual alloys by uniform dispersion of one metal, such as lead, throughout another, such as aluminium. By this means several alloys with useful properties can be produced. Degassing of molten metals can be readily carried out and this process is sometimes necessary when, if left in the metal volume, the gas could subsequently be a source of defects. All these effects are brought about by cavitation and hence the ultrasonic frequency used needs to be low in order to produce as intense cavitation as possible. Irradiation of molten metals is generally carried out by the use of magnetostrictive transducers which can be attached to the base of a vessel containing the melt or coupled directly to the melt via a half-wave rod. The effects produced by ultrasonic irradiation of molten metals have never been developed to their fullest extent and there is no doubt that considerably more work is necessary in this field.

E.R.A. Installed at Leeds

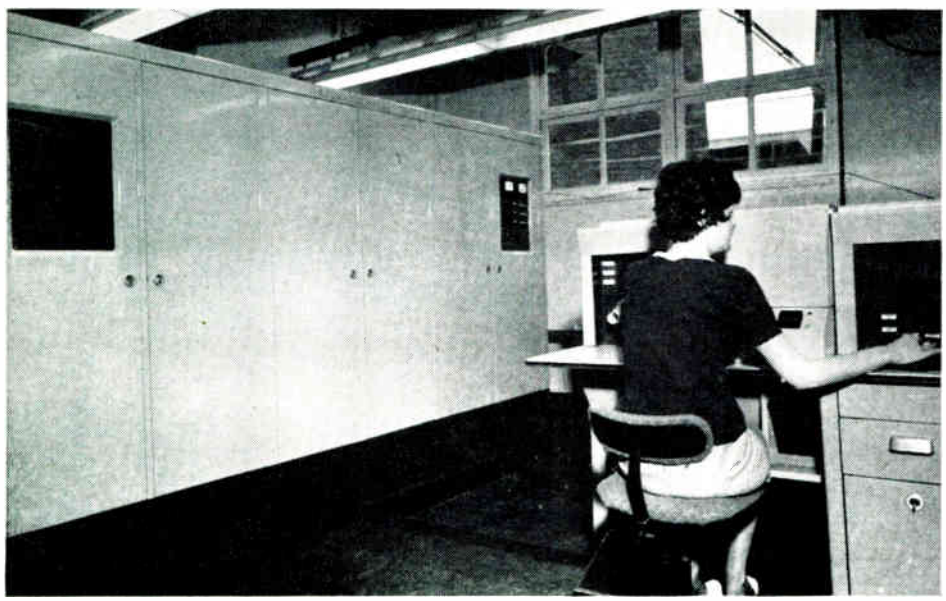
The Electron Reading Automaton (E.R.A.) which reads cash-register tally rolls at high speed, was formally handed over by its designers and manufacturers, Solartron, to the tailors, Montague Burton Ltd., of Leeds, recently. This is the first machine reading conventional printed digits optically to come into full commercial operation in Europe, and is believed to be the first tally roll reader in the world.

The machine bridges the gap in automatic data processing between the printed original document and the computer. It does this by recognizing normal printed characters on account tally rolls, using a video scanner technique, and transfers the information into punched cards. The tally rolls are printed with details of customer transactions by Bell Punch D.P. cash registers at each of Burton's many branches. These details are then used daily for up-dating many of the hundreds of thousands of individual accounts in the permanent records at head office.

E.R.A., reading at up to 400 digits per second, enables the I.C.T. computer, which up-dates accounts, to be used more efficiently. Not only will it save enough punched-card operator labour to justify its cost, but after exhaustive acceptance tests, it has shown itself much more accurate than a human operator, and the possibility of wrong postings is considerably less than in a conventional system.

The basic accuracy of the machine is such that only once in 100,000 characters does it identify a character wrongly, and a built-in check system reveals even these few errors. A most important feature of the design is the ease with which the machine's operator can confirm its interpretation of any characters which are doubtful due to print imperfections. Characters as read are displayed on a television-type screen on the operator console, and a simple re-entry keyboard enables the operator to confirm any character indicated as doubtful.

For further information circle 53 on Service Card



The E.R.A. equipment in operation in the Leeds headquarters of Montague Burton Ltd

DOPPLER IN AIRCRAFT

By G. THOMAS, B.Sc., Graduate I.E.E.*

Part 2. Doppler Navigation in Practice

The general form of modern apparatus for doppler navigation is described in this article. The principles involved were discussed in Part 1.

IN the first part of this article some indication was given of the variety of systems that could be employed to utilize the doppler effect for the purpose of aircraft navigation. In deciding on the 'best' system for a practical equipment, consideration has to be given to the performance of the user aircraft and the performance, reliability, weight and size required of the equipment itself. In this section a description is given of a lightweight doppler navigator designed to meet the needs of jet airliners today and for some years ahead. This equipment, the Marconi AD.560, uses a frequency-modulated continuous-wave (f.m.c.w.) system of transmission coupled with a four-beam moving aerial.

The sensor consists of an aerial, transmitter-receiver and tracker unit, together with an indicator for ground speed and drift and one for distance flown. A block diagram is shown in Fig. 1.

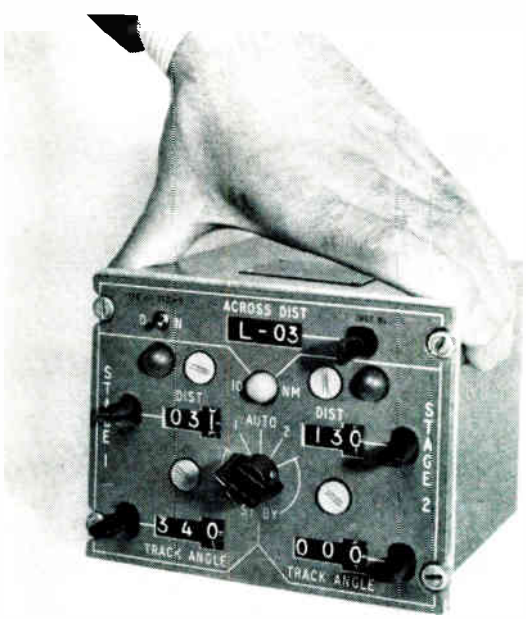
Aerial

The aerial generates four pairs of coincident 'transmit' and 'receive' beams. Varactor waveguide switches controlled from the tracker select one pair at a time. The aerial is positioned by motors driven from the tracker so that equal doppler shift frequencies are obtained from each beam. When the aerial achieves this position it is aligned with the aircraft velocity vector and is then maintained so aligned by servo loops. It is this constant aerial pattern relative to the aircraft velocity vector that enables the moving-aerial system to use beams which lie along lines of constant doppler shift (see Fig. 2). Thus a narrow doppler spectrum can be maintained while using a small aerial aperture. There is also a constant relationship between the doppler signal frequency and aircraft velocity. Pitch and drift information is obtained directly from synchros mounted in the aerial pitch and drift gearboxes. A control differential transmitter also mounted on the aerial drift gearbox adds the drift angle to the aircraft heading, derived from the aircraft compass, to give the true aircraft track angle.

Transmitter-Receiver

The transmitter uses a twin-cavity klystron producing about one watt of power at 8,800 Mc/s frequency modulated at a nominal modulating frequency of 400 kc/s. This power is transmitted down each beam in turn for about half a second. The signals returned from the ground are mixed with a sample of the transmitter output. The delay of the 400-kc/s modulation on the returned signal gives a mixer output containing 400 kc/s and its harmonics. As the whole spectrum of the returned signal experiences the same doppler frequency shift, all components of the mixer output are shifted by the same amount. The receiver accepts the third sideband and after amplification the signal is mixed with the third harmonic of the modulation applied to the klystron to produce the audio doppler shift spectrum. After amplification and filtering this signal is passed to the tracking unit.

When the delay, during the transmission path to ground and back, is equivalent to multiples of 360° of phase shift at the modulation frequency a loss of signal is experienced similar to that which gives protection against breakthrough. This gives rise to a series of critical heights at which loss of signal strength occurs, producing errors. This effect is reduced by having the aerial beams broad laterally so that different parts of the beam experience substantially dif-



Display unit for use with Marconi AD560 doppler navigator

* The Marconi Co., Ltd.

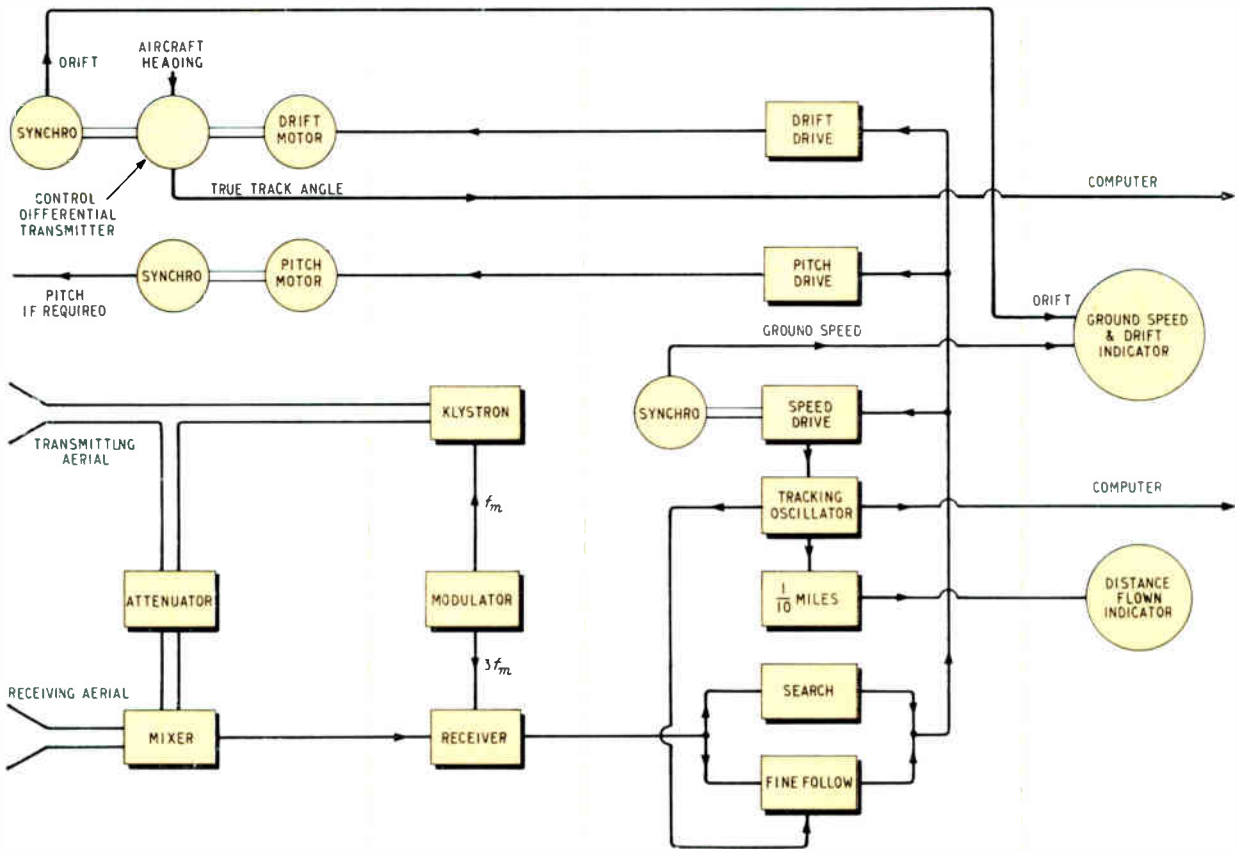


Fig. 1. AD560 sensor block diagram

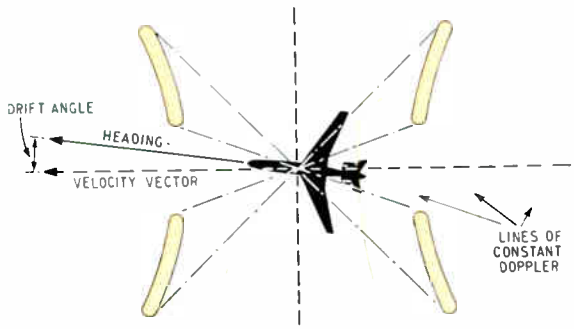
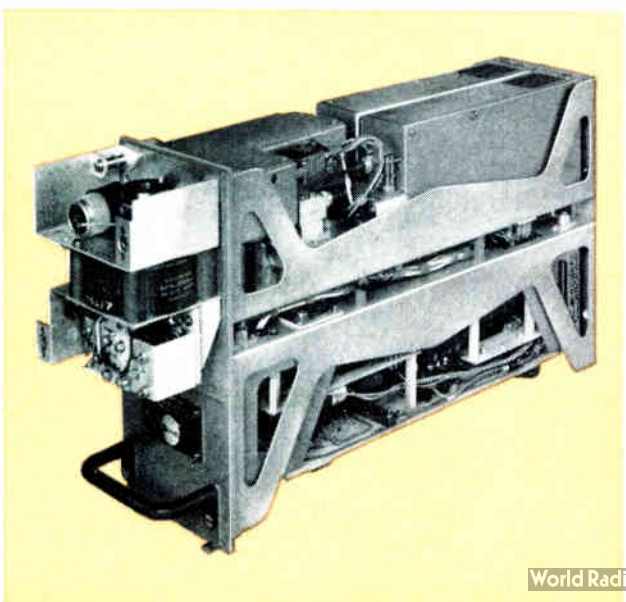


Fig. 2. Aerial beam pattern

Transmitter-receiver with cover removed



ferent delays. To minimize the errors further the modulation frequency is varied slowly ±15% about 400 kc/s; this has the effect of continuously moving the critical heights.

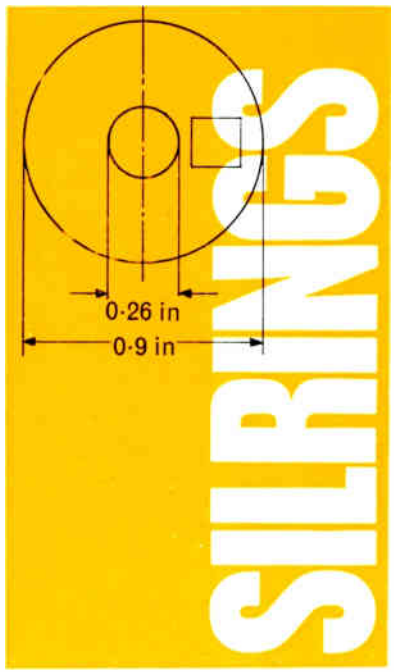
Tracker

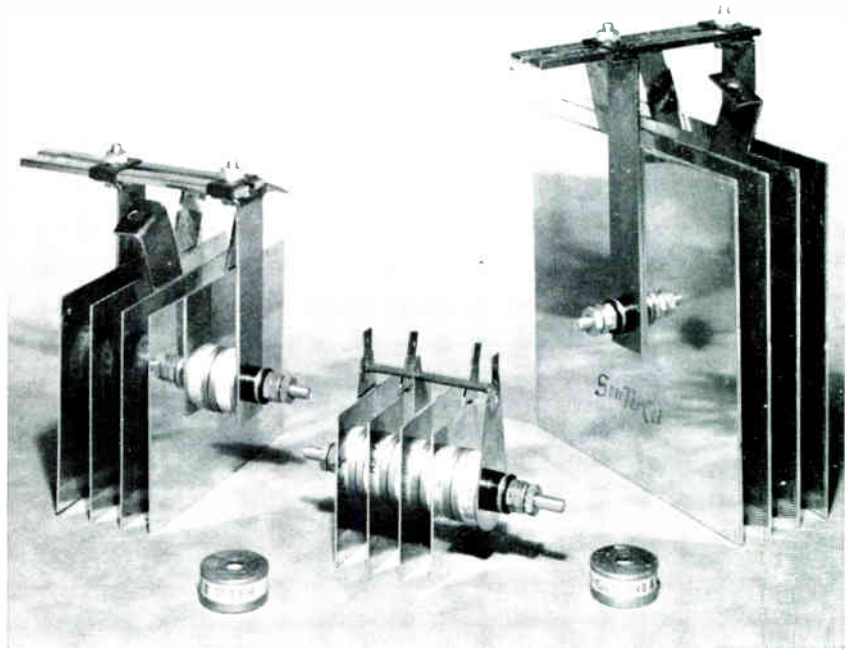
In the tracker there is a tracking oscillator which can be automatically tuned over the whole doppler signal frequency range. A search system utilizing a large number of tuned circuits determines the approximate frequency of the doppler signal from any beam and drives the tracking oscillator towards this frequency. At the same time the aerial servo system drives the aerial so that the doppler signal frequency from that beam approaches the tracking oscillator frequency. This is repeated for each beam in turn until all four beams and the tracking oscillator give very similar frequencies. A fine-follow system with limited capture range then takes over and aligns the aerial more accurately and sets the tracking oscillator frequency at the centre of the doppler spectrum. A flag is operated on the ground-speed indicator when the equipment is locked on. The search system also generates a.g.c. for the receiver and continuously monitors the signal/noise level from the receiver. Should the signal/noise level be insufficient for the correct operation of the tracker, it goes into the 'memory' mode of operation. The aerial and tracking oscillator are locked and ground speed and drift outputs remain at that of the last measured signal.

Computer and Display Unit

The computer and its associated display unit (Fig. 3) accept track angle from the control differential transmitter

(Continued on page 119)





A NEW CONCEPT IN SILICON RECTIFIER STACK PRODUCTION

New in Britain, SILRING rectifier stacks from STC offer the circuit designer and equipment engineer a unique combination of compactness, simplicity and low cost ☐ 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 a range of voltage and current outputs in a variety of electrical configurations. For Data Sheets and prices write, 'phone or Telex STC Semiconductor Division (Rectifiers), Edinburgh Way, Harlow, Essex. Telephone Harlow 26811. Telex 81146.

high-grade electronic components by **STC** COMPONENTS GROUP

6418M.F

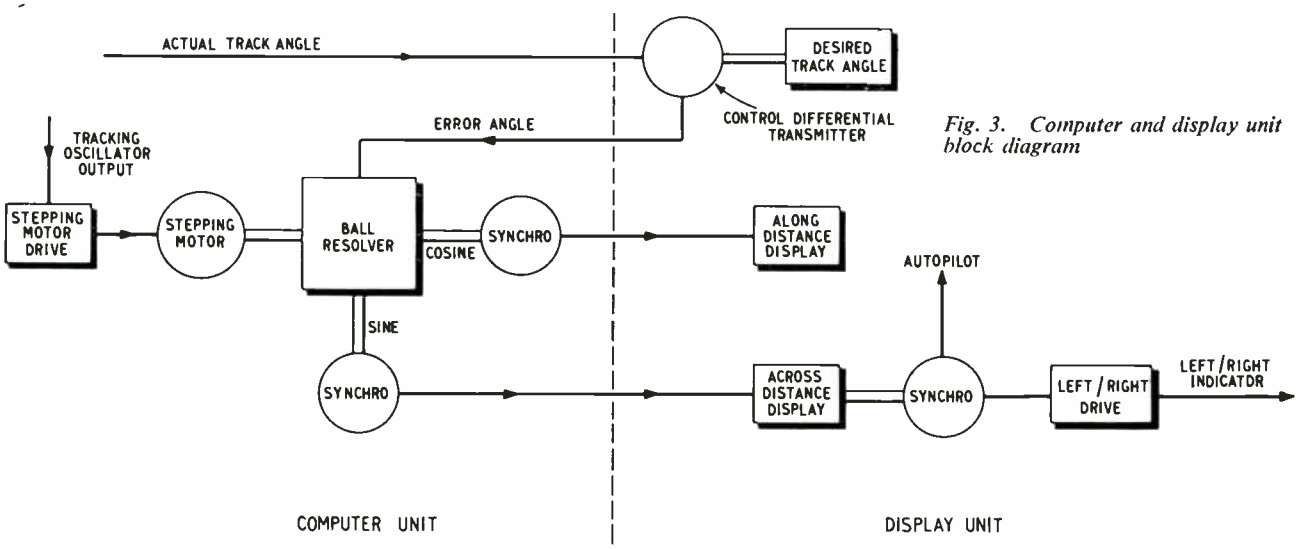


Fig. 3. Computer and display unit block diagram

on the aerial and ground-speed information from the tracking oscillator. This information is then continuously integrated for dead-reckoning navigation relative to any starting point. Provision is made for selecting two legs of a flight plan in terms of track angle and range. The computed aircraft position is then given on the display unit in terms of distance to go along track and left or right distance across track for the particular leg being flown. Provision is made for automatic change over on completion of a leg, the previous leg is then available for resetting. Outputs are available for driving a left-right indicator and an autopilot.

In the display unit the track angle is compared with the required track angle in a control differential transmitter, the difference being the error angle. In the computer this error angle is set up in a ball resolver which is driven by a stepping motor fed from the tracking oscillator. Sine and cosine outputs from the ball resolver corresponding to across and along track distances are fed back to the display unit and drive mechanical counters.

Design Features

While in the air the pilot or navigator can test the serviceability of the equipment. First, if the equipment is 'locked on' and working normally, the servos can be displaced and then observed while pulling back to the previous display of speed and drift. Secondly, if the equipment goes to 'memory', a synthetic signal can be fed through the sensor. The outputs of speed and drift are locked but the equipment will respond by operating the flag if serviceable. This test is useful in distinguishing between a failure in the equipment and loss of signal due, for example, to a patch of calm water.

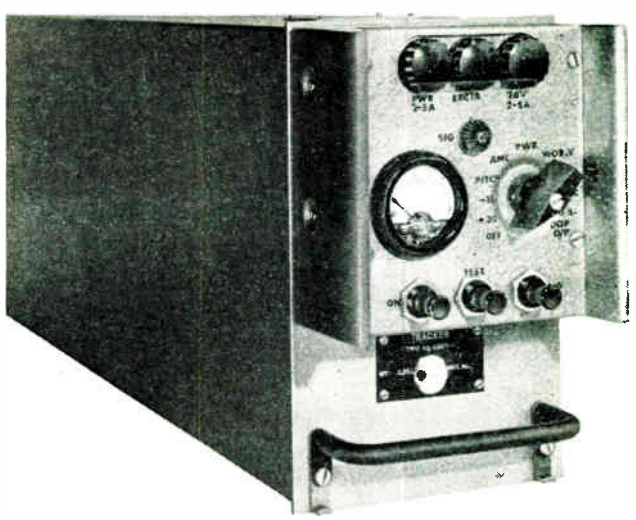
For ground testing, the tracker and computer carry test units on their front panels which enable more elaborate tests to be carried out to determine the serviceability of each unit.

Apart from the klystron the equipment is completely transistorized and mechanical devices such as relays have been eliminated wherever possible.

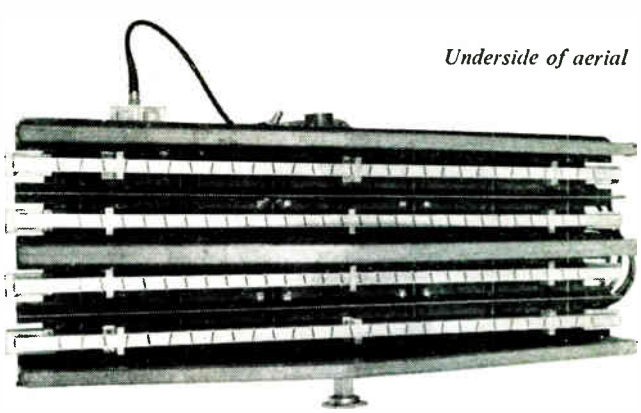
The majority of the circuits are housed in sealed modules, thus avoiding the effects of high humidity.

Equipment Performance

The sensor measures ground speeds from 90 to 1,000 knots (alternative versions cover ranges up to 2,000 knots) and drift angles over the range 30° port to 30° starboard. It operates at heights from 20 ft to 60,000 ft over land or sea states of Beaufort 2 or greater, in angles of bank up to 20° and angles of climb up to 25°. The accuracy of speed and distance flown is better than ±0·3% and of drift angle better than ±0·25%. Sea bias is −0·25%. In the computer the along track computation error does not exceed ±0·2 % of distance flown $\pm\frac{1}{4}$ n.m. The across track computation error does not exceed ±0·5% of distance flown $\pm\frac{1}{4}$ n.m.



Tracker with test unit mounted on front panel



Underside of aerial

EQUIPMENT REVIEW

1. Pulsed Ferrite Phase Shifter

Nore Microwave have recently introduced a switchable phase shifter using ferrite rings mounted on a dielectric rod which has a copper conductor passing through the centre. A pulse of energy fed along the copper conductor causes the rings to become magnetized and a reversed current will change the direction of magnetization. Consequently, with the rings magnetized and the power flow in one direction, the direction of r.f. polarization has the same sense on both sides with respect to the steady remnant field. Reversing the direction of the current through the copper conductor or the direction of r.f. power will alter the sense of polarization.

The result is a switchable non-reciprocal phase shifter with a switching time of 50 nsec and a centre frequency of 9,400 Mc/s. Power handling capability is 40 kW maximum, 24 kW mean. Bandwidth is 500 Mc/s and v.s.w.r. better than 0·8 : 1.—*Roberts Electronics Ltd., 17 Hermitage Road, Hitchin, Herts.*

For further information circle 1 on Service Card

2. Transistorized Relay

A plug-in relay designed to satisfy the demand for a switch suitable for operation from either a sensitive thermostat or a low power signal has been developed by B & R Relays. A transistor amplifier is incorporated between the relay and the plug fitting.

Measuring $2\frac{5}{8} \times 1\frac{1}{4} \times 5$ in. high complete with socket and weighing 13 oz. the BO7 can be supplied with a variety of contact arrangements, in addition to a range of light/heavy and light duty contacts for switching and indicating functions. Heavy duty contacts rated at 15 A 250 V a.c. resistive may also be fitted, thus making a separate switching device unnecessary.

Activation of the relay is effected in two ways, either by closing the external (thermostat) contacts or by applying the signal across pins 8 and 17. With the former, sensitivity is such as to allow for the resistance of this contact to be as high as 50 kΩ; with the latter, the minimum signal for satisfactory operation is 700 mV.—*B & R Relays Ltd., Temple Fields, Harlow, Essex.*

For further information circle 2 on Service Card

3. Photoelectric Relay

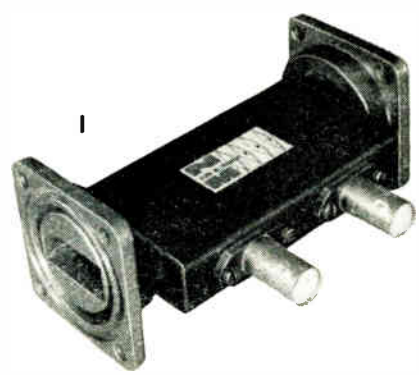
Simmonds Relays have introduced a further item of Visolux photoelectric equipment manufactured by Richard Siering GmbH, of Berlin, called the type LS photoelectric relay. Basically the equipment consists of a fully-transistorized amplifier switch using a printed circuit with self-contained power pack and an output relay with one change-over contact.

The amplifier switch is activated by a scanner, and scanners with ranges from 1 to 10 metres between light source and receiver are available. Single beam reflex scanning heads can also be provided and certain light projectors can be fitted with an infra-red filter to make the radiation invisible. For dusty atmospheres, projectors and receivers can be fitted with compressed air operated fans and, if required, the equipment can be supplied in waterproof or explosive-proof cases.—*Simmonds Relays Ltd., Temple Fields, Edinburgh Place, Harlow, Essex.*

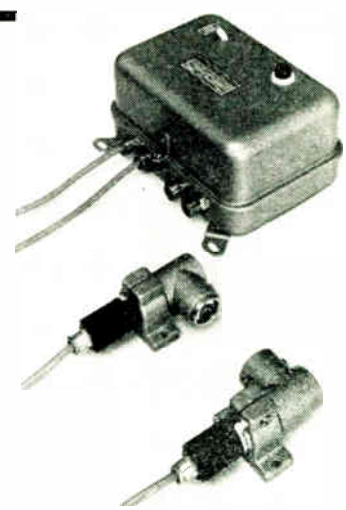
For further information circle 3 on Service Card

4. Autobalance Adaptor

An instrument developed by Wayne Kerr enables accurate measurements of the resistive and reactive terms of an unknown impedance to be made without manual balancing. Operated in conjunction with the B221 universal bridge, the Autobalance adaptor

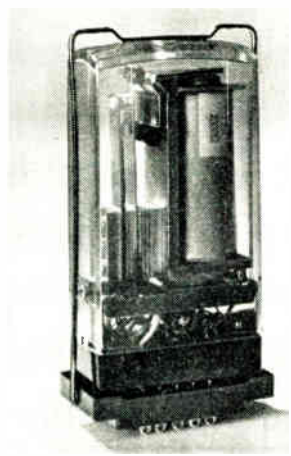


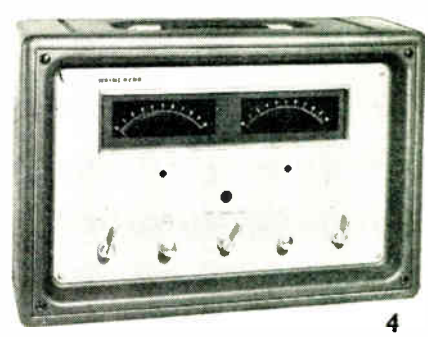
1



2

3





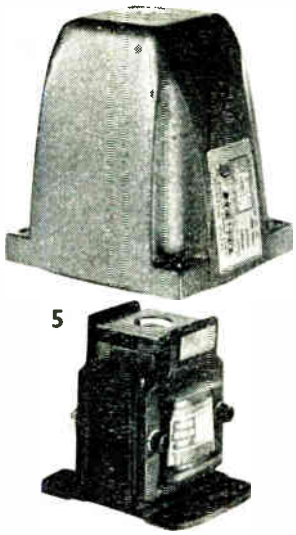
4

AA221 electronically maintains a constant state of balance, presenting variations in the value of either term on a twin-meter display. The basic 0·1% accuracy, range and discrimination of the bridge are unaltered.

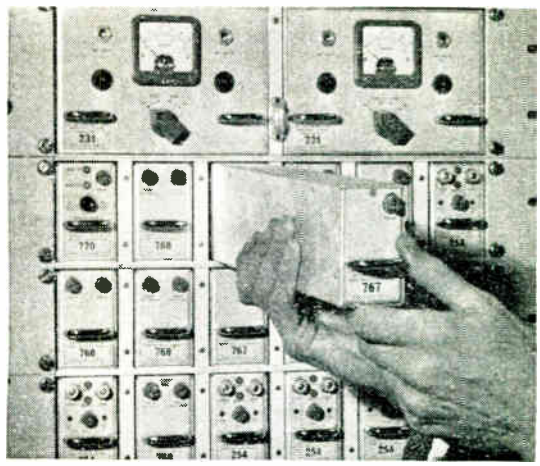
For batch testing, the bridge vernier controls can be so adjusted that the meters read mid-scale at the desired nominal value. By using a mask on the meter scales, components can be checked using unskilled labour. Outputs from the metering circuits are also brought out to jack sockets at the rear of the adaptor for the operation of automatic batching equipment, digital voltmeters, printers, recorders, etc.

The Autobalance adaptor, transistorized and powered by an internal battery, provides both signal source and detector. For continuous use, a mains-operated power supply is available.—*The Wayne Kerr Laboratories Ltd., New Malden, Surrey.*

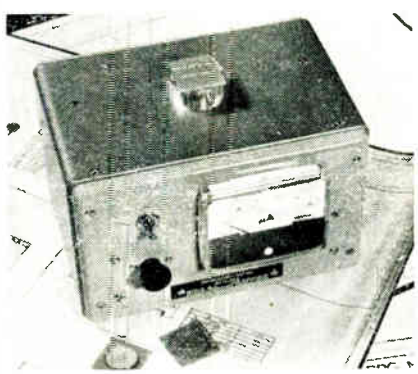
For further information circle 4 on Service Card



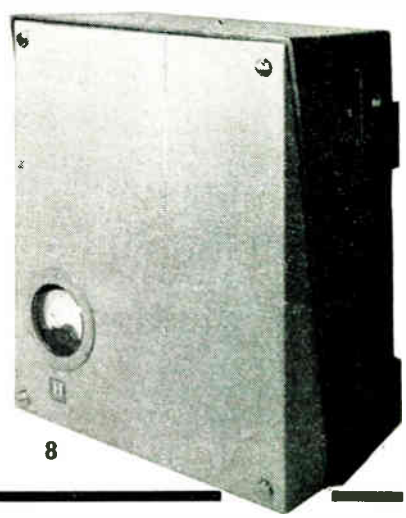
5



6



7



8

5. Enclosed Solenoids

Enclosed Teen series Decco solenoids are now available from Expert Industrial Controls, for use with J.I.C. hydraulic valves. The covers of these solenoids are die-cast aluminium and are fitted with a manual actuator pin.

Any Teen series Decco solenoid with a stroke of up to ½ in. can be fitted without losing any of the shock mounting features. These units are also available without shock mounting and are then interchangeable with existing units of different make.—*Expert Industrial Controls Ltd., Lount Works, Ashby-de-la-Zouch, Leicestershire.*

For further information circle 5 on Service Card

6. Video Switching System

A semiconductor video switching system announced by E.M.I. Electronics is of modular construction, so that facilities can be provided to meet individual requirements and further modules can be added as needs grow; six units can be fitted in a mounting frame and accommodated in a 19-in. rack or E.M.I. standard case. New design techniques have not only reduced the rack space requirement, but also improved the performance, and the system is suitable for use with all television standards, for both monochrome and colour.

An important facility, when cutting from one shot to another, is the ability to switch during the vertical-blanking interval without flashing or streaking across receiver screens. Other advantages are a high degree of interchannel cross-talk isolation and increased reliability resulting from the exclusive use of semiconductors.—*E.M.I. Electronics Ltd., Hayes, Middlesex.*

For further information circle 6 on Service Card

7. Resistivity Tester

A resistivity test set, known as type 74711, has been developed by Standard Telephones & Cables. An interesting feature of the new instrument is that samples of the material to be tested are not placed in electrical contact with the set, which is designed to measure the damping effect of the sample on a lightly-loaded tuned circuit. The resistivity range is from 10^{-2} to $10^{-5}\,\Omega$ cm.

The 74711 is particularly useful for the rapid production-line testing of thin slices of semiconductor material in the manufacture of transistors. The tuned-circuit damping method employed is much quicker in use than the conventional four-point probe method of resistivity checking. In addition, the thickness of thin sheets of semiconductor material of known resistivity can also be measured, and changes in resistivity around discontinuities in large-area samples can be detected.

The 74711 is fully transistorized and uses printed circuits. Measuring 8¼ in. long by 5½ in. high by 6⅜ in. deep the set weighs approximately 5 lb. The test coil projects ¾ in. above the top of the case.—*Standard Telephones & Cables Ltd., Connaught House, 63 Aldwych, London, W.C.2.*

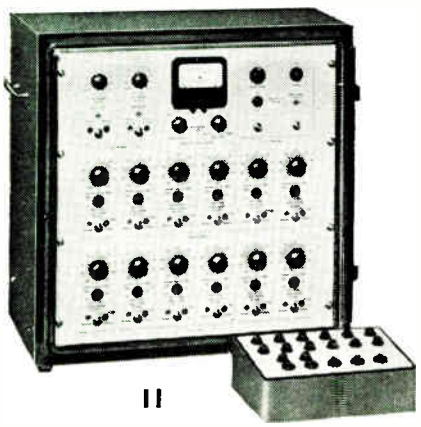
For further information circle 7 on Service Card

8. Low Differential Pressure Transmitter

Honeywell Controls have designed for use in the process industries a low-range differential pressure transmitter which uses a combination of manometer and force balance principles, having a fast response and covering ranges between 0–0·5 in. and 0–8 in. w.g., process pressure or pressure differential. Transmitted signals are 3 to 15 p.s.i., and 4 to 20 mA d.c. for the

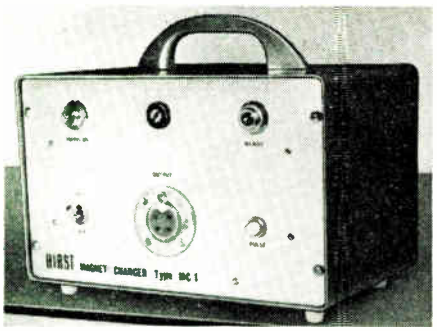
9

10



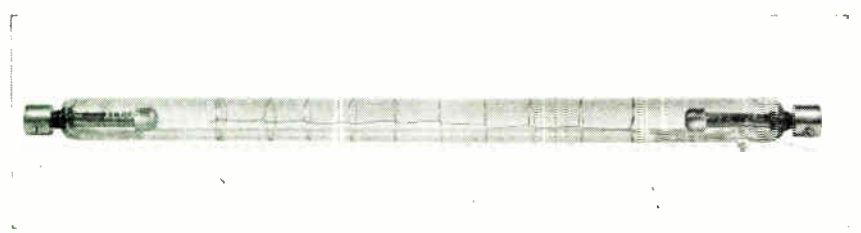
11

12



13

14



15

pneumatic and electric versions, respectively. Damping against pulsation in applied pressures is provided by a hydraulic damper using silicone fluid.

The compact weatherproof housing can be wall mounted or mounted on horizontal or vertical pipes of 3, 4, 5 or 6 in. diameter. Overall dimensions are 14½ in. high, 7½ in. deep and 12 in. wide.

Simple span and zero adjusters are included and rapid calibration checks can be made with the check weight provided. The range is continuously adjustable within the limits shown, enabling recalibration to new ranges to be achieved simply and rapidly on site. A built-in indicator for continuous indication of output signal value is an optional feature.—*Honeywell Controls Ltd., Ruislip Road East, Greenford, Middlesex.*

For further information circle 8 on Service Card

9. Magnetic Tape Handler

A digital tape transport which offers low maintenance and down time as a result of a new tape drive has been introduced by Ampex. Designated the TM 7, this tape handler uses a servo-driven single capstan system which reduces the number of mechanical parts associated with the tape-drive mechanism by 80% compared with conventional transports. In addition, all sliding friction between the oxide surface of the tape and the transport is eliminated, except across the read/write head and tape cleaner.

The TM 7 has a tape speed of 36 i.p.s., packing density of 200 and 556 b.p.i., and start/stop time of 10 msec. Start/stop distance is 0·180 in. ±15% ; rewind speed is 180 i.p.s. It is compatible with IBM 729, IBM 7330, Ampex TM 4 and Ampex TM 5 transports. The unit requires no periodic mechanical adjustments and makes full use of start time to accelerate tape uniformly, resulting in low tape tensions and gentle tape handling. It can be supplied with solid-state circuitry to provide low-cost memory systems.—*Ampex Great Britain Ltd., 72 Berkeley Avenue, Reading, Berks.*

For further information circle 9 on Service Card

10. Voltage/Current Calibrator

Magnetic memory core characteristics, and similar complex signal sequences, can be calibrated by the model 1085 dual level voltage/current calibrator now available from Computer Test Corporation, of New Jersey. The calibrator superimposes two independent reference voltages upon input waveforms so that they may be compared on a display oscilloscope. Analysis of a.c. pulse or d.c. signals

ranging from 1 mV to 10 V may be made, and with the use of an external attenuator, signals up to 200 V can be measured.

The 1085 generates two highly stable d.c. voltages which are independently variable from 0 to 10 V. These voltages are referenced to cascaded zener diode circuits which can be subdivided into increments as small as 1 mV by temperature-compensated resistors. Reference amplitudes are controlled by two linear potentiometers.

Reference voltage levels may be either positive or negative and adjusted to correspond visually with a specific point of the unknown waveform. Digital readout dials are provided for each reference output to prevent interpolation errors. The calibrator also features a long-life, mercury-wetted reed relay as a mechanical chopper, a reference line intensity control and a signal selector that permits the display of any one of four unknown input signals.

The model 1085 weighs 10 lb and measures 10 × 5¾ × 6¾ in.—*Computer Test Corporation, Route* 38 *& Longwood Avenue, Cherry Hill, New Jersey, U.S.A.*

For further information circle 10 on Service Card

11. Noise Limit Indicator

An apparatus has been designed by Brüel & Kjaer to provide high-speed assessment of the quality of production-line outputs as regards noise and vibration, by automatic comparison with a pre-set standard for the type of unit concerned. The instrument measures noise and vibration levels in up to 12 frequency bands simultaneously.

It has been designed to offer the utmost simplicity in operation after setting up, and an untrained worker can easily interpret the indicating panel. Rejections are indicated by means of red lamps, one to each frequency band, thus eliminating the possibility of confusion or errors from meter readings.

The testing can normally be carried out in less than 10 seconds. By means of a 'sensitivity increase' circuit it is possible to divide the accepted units in two classes, with a quick extra check classifying the unit as 'standard' or 'extra-fine'.—*Brüel & Kjaer, Naerum, Denmark.*

For further information circle 11 on Service Card

12. Ultrasonic Thickness Gauge

An ultrasonic thickness gauge for production testing is now being introduced by Dawe allowing measurement of the thickness of pipes, tanks, pressure vessels, etc., when contact is only possible on one side.

The instrument is known as the type 1109 Visigauge 14 and for the first time immersion testing facilities have been incorporated in the unit. This enables continuous measurements to be made at high speed on the production line on both flat plate and thin wall tubing. This method is of particular value in the manufacture of precision fuel element tubes for nuclear power reactors.

The instrument employs a 14-in. c.r.t. on which the thickness is directly displayed and will measure a wide range of thicknesses from 0·006 to 2·0 in. on a direct reading scale. Such scales are interchangeable and are dependent on the material being subjected to test.

Considerable freedom of movement is facilitated by the use of long cables of up to 1,000 ft. Automatic monitoring and recording facilities can be provided as an optional extra to give greater control over manufacturing processes.—*Dawe Instruments Ltd., Western Avenue, Acton, London, W.*3.

For further information circle 12 on Service Card

13. Portable Magnetizer

The third model in the Hirst Electronic range of magnetizing equipments, the MC/1 magnet charger, is now available. This portable, self-contained, mains-operated unit (10 × 6 × 6¼ in., weight 12 lb) has been specially developed for light magnetizing work on devices such as thermostats, small motors and loudspeakers, door catches, relays, toy magnets, etc.

Operation is simple and requires no skill, initiation being by push button. Output is fixed at 40 joules, and the price is £40, with fixtures extra if required.—*Hirst Electronic Ltd., Gatwick Road, Crawley, Sussex.*

For further information circle 13 on Service Card

14. Moisture Content Meter

A new model of the 'Protimeter Timbermaster', a meter which can measure the moisture content of timber, is being manufactured by Sir John Gallwey (Instruments).

The moisture content of 93 different species of timbers can be read directly off the meter's scale plate. Readings for another 60 species of timber can be determined by using a simple conversion chart. The moisture content is expressed as a percentage of the dry weight of timber and the meter will record readings as low as 7%.

All the operator has to do is to push a twin electrode into the timber, press a button on the meter and read off the moisture content. The 'Protimeter Timbermaster', battery operated, is easily portable as it measures 5 × 6 × 2½ in. and weighs 3½ lb. The price is £30.—*Sir John Gallwey (Instruments) Ltd., Fieldhouse Lane, Marlow, Bucks.*

For further information circle 14 on Service Card

15. Ruby Laser Flash Tubes

English Electric has introduced two linear quartz flash tubes, types XL604 and XL605, which are primarily intended for the excitation of ruby lasers. These tubes are filled with a gas mixture which, when triggered, gives a light output spectrum similar to the absorption characteristics of ruby laser crystals.

The maximum input energy per flash of the XL604 is 1,250 joules with a nominal duration of 1·0 msec. Maximum operating voltage is 3 kV. It has an arc length of 5·5 in. and a typical flash rate of 2 per min.

Maximum input energy of the XL605 (illustrated) is 5,000 joules per flash with a nominal duration of 3 msec. Maximum operating voltage is again 3 kV. Flash rate is typically 1 every 2 min and length of arc 6·5 in. —*The English Electric Valve Co. Ltd., Chelmsford, Essex.*

For further information circle 15 on Service Card

16. Alpha Radiation Monitor

A portable instrument which can detect alpha radiation even in the presence of high gamma fields, so making it ideally suited for detecting leakage from radium needles by direct examination, has been developed by E.M.I. Electronics. This instrument, alpha monitor type PAM1, is also suitable for monitoring americium 241 and radium 226 for alpha radiation.

In the past, instruments could not detect low levels of alpha radiation in strong gamma fields, and when monitoring radium needles it was necessary to make wipe tests to determine whether they were leaking: with this instrument the needles can be directly monitored. The sensitivity of the PAM1 is such that small leaks, difficult to detect by a wipe test, can be detected even in a 50-millicurie needle.

The monitor is of all-transistor construction, is battery operated and incorporates a standard E.M.I. 100 sq cm alpha probe type AP3. The ratemeter is housed in a durable reinforced plastic case which fits neatly over the probe. If required, the probe can be detached from the ratemeter and used separately. The phosphor is zinc

sulphide on Perspex and the photo-multiplier is E.M.I. type 9600H. Weight of the complete instrument is 3½ lb.—*E.M.I. Electronics Ltd., Hayes, Middlesex.*

For further information circle 16 on Service Card

17. Frame Size 11 Potentiometers

Salford Electrical Instruments have extended their range of precision potentiometers to include frame size 11. All dimensions including location spigots are to the requirements of this international size.

Resistance values from 500 Ω to 50 kΩ can be supplied, wound on toroidal formers using nickel-chromium resistance wire or precious metal wire for low noise applications. The temperature range is −40 to +85 °C and rating is 2 W at 20 °C. Independent linearity tolerance is ±0·5%.

The potentiometer is available in up to four-gang units. Extra taps can be fitted, each one being connected to a single turn of wire. Gold plated side terminals are standard for ease of soldering external connections. Corrosion-resistant aluminium alloy is machined to form the 1·06 in. diameter case.—*Salford Electrical Instruments Ltd., Peel Works, Silk Street, Salford* 3, *Lancs.*

For further information circle 17 on Service Card

18. Coaxial Reflectometers

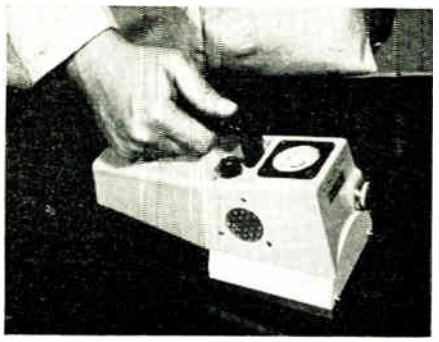
A range of coaxial reflectometers, suitable for permanent installation in coaxial lines for monitoring incident and reflected power for users of u.h.f. equipment, has been introduced by A.T. & E. Features include a high power handling capacity and low insertion loss. Back-to-back resistive loop directional couplers make slotted line measurements unnecessary.

Available types cover frequency ranges from 50 to 500 Mc/s. The one designed for use in the 150- to 300-Mc/s range has a minimum directivity of 40 dB. Coupler sensitivity is 500 μA for 10 W incident power. Maximum primary-line standing-wave ratio is better than 1·05 : 1 and there is negligible primary-line insertion loss. The power-handling capacity is up to 300 W.—*A.T. & E. (Bridgnorth) Ltd., Bridgnorth, Shropshire.*

For further information circle 18 on Service Card

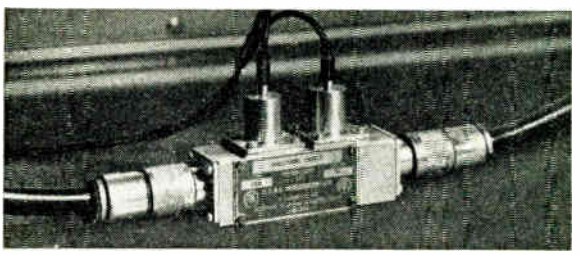
19. Photo-Electric Counter

To meet the need for a high speed photo-electric counter at an economical price suitable for all types of industrial application, Photronic Controls have designed the counting control type CU.



16

17



18

This control comprises a projector and photo-transistor receiver capable of operating over any distance up to 10 ft, together with a control unit containing the power supplies, transistor amplifier and high speed electromagnetic, 6-figure counter. Power consumption is 10 W.

The unit is capable of counting at a speed of 2,400 per min and requires a light-beam interruption of only 5 msec for reliable operation. At the end of the 6-figure count, the counter automatically re-sets to zero and continues counting; it can also be re-set to zero at any time by the operation of a push button. Price: £25 complete. — *Photronic Controls Ltd., Randalls Road, Leatherhead, Surrey.*

For further information circle 19 on Service Card

20. High Accuracy D.C. Meters

The Greibach Instruments Corporation have announced a line of extremely accurate direct-reading analogue voltage and current meters developed to satisfy the requirements for a rugged, compact portable or panel-mounted instrument capable of rapid d.c. measurements with an accuracy of 0·025 f.s.d.; i.e., approaching that obtainable by potentiometric methods.

These 'selective expansion' meters do not require multiple dial turning or null balancing, are capable of withstanding repeated overloads without deterioration and feature a non-parallax hairline light-beam pointer. They are available with single or multiple ranges. — *Greibach Instruments Corporation, 315 North Avenue, New Rochelle, N.Y., U.S.A.*

For further information circle 20 on Service Card

21. Time/Frequency Meter

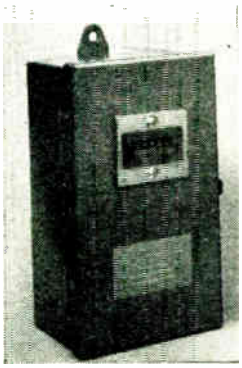
Venner Electronics has introduced the TSA 3436, a compact general-purpose instrument giving 6-digit indication of frequency and period up to 1·2 Mc/s, and providing time measurement from 1 μsec to 100,000 sec. It can also be used as a counter at rates up to 10^6 p.p.s.

Designed for laboratory use, or for quality control applications in industry, the transistorized TSA 3436 measures 14¼ × 3⅞ × 10½ in. Main features include three gating times, optional blanking between results, and self-checking. The instrument can carry out period measurement of either 1 or 10 cycles in a choice of 6 time units; an a.c./d.c. input switch allows high sensitivity on a.c. inputs while response is maintained on d.c. at a lower sensitivity. — *Venner Electronics Ltd., Kingston By-Pass, New Malden, Surrey.*

For further information circle 21 on Service Card

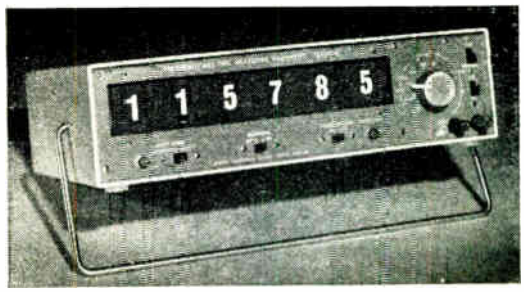
22. Frequency Counters

Two transistorized high-frequency counters are available from Hewlett-Packard. Models 5242L and 5244L are designed to fill a need for high



19

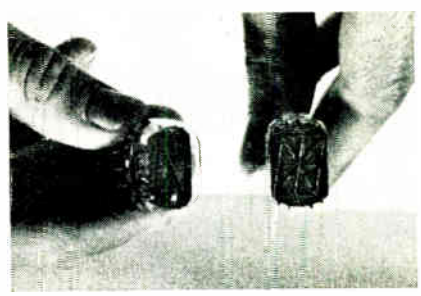
20



21

22

23



24

performance at medium cost in the d.c. –50 Mc/s range. Both counters are suitable for bench or rack mounting.

Model 5242L operates from 0 to 20 Mc/s and the 5244L from 0 to 50 Mc/s; both counters measure frequency, period and frequency ratio. Readout is on a digit in-line display and time-base stability is better than ± 2 parts in 10^7 per month.

A photoconductor storage stage is included between the decade counting units and the Nixie readout tubes. This storage stage serves to eliminate flicker in the readout during counting and also significantly increases the maximum sampling rate in the 1 and 10 sec gate positions.

The counters have 100 mV r.m.s. sensitivity, operate from −20 to +65 °C and provide a binary-coded decimal output for digital recorders. If desired, for high accuracy applications, 8-digit registration and/or time-base stability better than ± 3 parts in 10^9 per day are available.—*Hewlett-Packard Ltd., Dallas Road, Bedford.*

For further information circle 22 on Service Card

23. 1,600-Amp Circuit-Breaker

Chilton announce the introduction of a 1,600-A moulded case circuit-breaker. This represents an extension of the present range which is manufactured under licence from the Westinghouse Electric Corporation.

The type PA AB De-ion moulded case circuit-breaker features interrupting capacities of 130 kA (symmetrical) at 240 V a.c., 85 kA (symmetrical) at 415 V a.c. and 65 kA (symmetrical) at 600 V a.c.

Available in 2- or 3-pole forms and with a choice of 5 interchangeable trip units providing continuous current ratings at 40 °C from 1,000 to 1,600 A. Standard accessories include shunt and undervoltage releases; auxiliary switches and motor operating mechanism are available. Dimensions are 22 in. high × 12 in. wide × 9 in. deep.—*Chilton Electric Products Ltd., Hungerford, Berks.*

For further information circle 23 on Service Card

24. Alpha-Numeric Indicator

A Burroughs alpha-numeric Nixie tube, available from Walmore Electronics, can display any letter of the alphabet, any number from 0 to 9, or special symbols. The type B-5971 has 13 individual selectable cathodes arranged in a rectangular matrix mounted in a single plane inside a rectangular-shaped glass envelope. The appropriate combination of cathode segments is selected by means of external circuitry to form the alpha-numeric character; a continuous red neon glow illuminates the characters.

A brightness of 200 ft lamberts allows the 0·7-in. characters to be read at a distance of 25 ft even under high ambient light conditions. Because the cathode segments are in the same plane, a 150° view angle is obtained. The compact rectangular shape of the indicators allows mounting on 0·8 in. centres, thus reducing the size of the overall display. This Nixie tube has characteristics allowing operation from low-cost germanium or silicon transistor 'memory' circuits. — *Walmore Electronics Ltd., 11-15 Betterton Street, Drury Lane, London, W.C.2.*

For further information circle 24 on Service Card

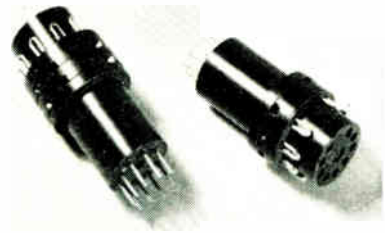
25. Absolute Pressure Transducer

The Solartron vibrating-cylinder absolute-pressure transducer has been improved and the new model, type NT.4-980.3, is claimed to be the most accurate of its type commercially available.

The signal-to-noise ratio has been increased by a factor of ten and the new method of applying the pressure to be measured to the inside of the cylinder provides a ten-times overpressure facility as opposed to one-fifth full pressure applied with the previous type. The transducer will withstand 20 *g* up to 5 kc/s.

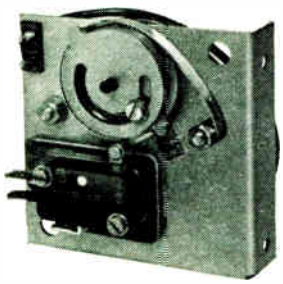
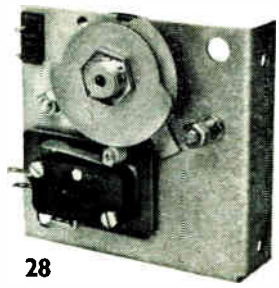
The size has been reduced by a third: this has been accomplished by the redesign of the amplifier, which now fits into the end cap. The 'dead volume' has been reduced to approximately 0·25 cu in., resulting in a considerable improvement of the instrument's response time. The output has been changed from sine to square-wave form with a rise time of less than

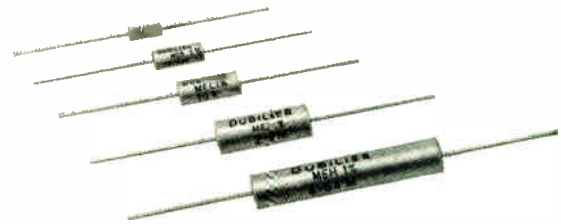
25


26



27



28


29

1 μsec. Accuracy is better than 0·1%. A range of adaptors enables the instrument to be used with most fluids.—*The Solartron Electronic Group Ltd., Farnborough, Hants.*

For further information circle 25 on Service Card

26. Valve Test Adaptors

'Accel' test adaptors, available from Britec, are precision-made turret-plugs (combined valveholder and base pins) with side test points, male and female, for measuring instrument probes. Two types are available: for voltage or for current testing.

Voltage adaptors are supplied for 7-pin (B7G), 9-pin (B9A) or 8-pin subminiature valves. The valveholder is connected to the base pins and to the side test points for voltage tests on each electrode while the valve is in circuit.

Current adaptors are supplied for 7-pin (B7G) or 9-pin (B9A) valves. The valveholder is connecter to a male and female side test points, while the base pins are connected to other female side test points, for current testing of each electrode whilst the valve is in circuit.—*Britec Ltd.*, 17 *Charing Cross Road, London, W.C.2.*

For further information circle 26 on Service Card

27. Double-Action Miniature Switch

The Furnesco co-ordinate switch is three-dimensional and has a double action. The contacts are on the internal surface of a tube and are produced by a combination of flush bonding and electroplated circuit techniques. The contacts can be interconnected on the surface or within the wall of the tube and can be extended lengthwise or radially for external connection.

The moving contacts are carried by an insulated shaft which has two motions, rotary and longitudinal. Quite complex switching patterns can thus be obtained. For example, the rotary action may provide the equivalent of four ganged single-pole four-way switches, while the push-pull action provides the equivalent of a further single-pole four-way switch having its four contacts joined to the four switch arms of the ganged switches. The illustration shows the small size of the switch.

A model having a contact arrangement performing this function is available for demonstration purposes but, in general, the contact pattern is made to suit customers' requirements.—*R. W. Furness & Co. Ltd., Cromwell Road, Whitstable, Kent.*

For further information circle 27 on Service Card

28. Pre-set Timers

The Haydon Division of Ether Ltd. have added to their existing range a series of pre-set timers to meet the requirement for an accurate low-price synchronous unit. The motors and switches (5-A change-over) used on these timers have C.S.A. approval, and are rated at 110/240 V, 50/60 c/s.

The type DA 1003 delay timer employs a clutch motor and has a maximum delay time of up to 8·5 min. When the motor is energized, the clutch engages and the motor drives a cam, which, at the end of a set time delay, actuates a switch. The minimum order that can be accepted for this timer is 25, and the cost for quantities up to 99 is £3 10s. each.

The type CA 1004 cycle timer employs a single adjustable cam driven by a motor. Standard time-cycles available are: $\frac{1}{60}$, $\frac{1}{30}$, $\frac{1}{15}$, $\frac{1}{10}$, $\frac{1}{6}$, $\frac{1}{5}$, $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{2}$, 1, 2, 4, 6, 8, r.p.m. The cost of this timer for quantities from 1 to 24 is £3 10s. each.—*Haydon Division, Ether Ltd., Caxton Way, Stevenage, Herts.*

For further information circle 28 on Service Card

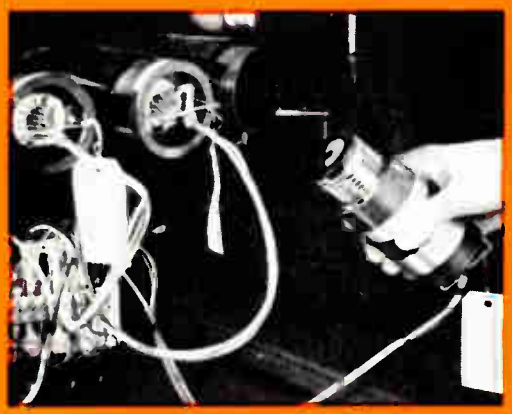
29. Metal-Film Resistors

Recently released by Dubilier are type ME metal-film resistors which are available in five power ratings and resistance values of 30 Ω to 10 MΩ subject to range limitations set by power rating. The standard tolerance is ±1% but closer tolerances of 0·5%, 0·25% and 0·1% are available dependent upon temperature coefficient.

The outer casing for the lower power ratings is a moulding of moisture-resistant, high-temperature plastic insulation, and for the 1- and 2-W ratings a porcelain tube with hermetic end seals. All five sizes have very low noise level independent of the resistance value, normally below 0·1 μV/V.

The voltage coefficient when measured between one-tenth and full rated voltage is less than 5 p.p.m./V

(Continued on page 127)



EMI TOP TUBES

FOR PERFORMANCE & RELIABILITY

No ordinary tubes these! In radar, nucleonics, science, broadcasting and other professional applications, EMI electron tubes have a superb record of performance and reliability. They are precision manufactured to the highest standards of accuracy and EMI's research and development programme covers a wide range of new tubes and techniques. EMI is at the service of design and development engineers in solving application problems.

Reply card

Please send me further details of the following

- ☐ Photomultiplier Tubes and Photoconductive Devices
- ☐ Microwave Tubes
- ☐ Camera Tubes
- ☐ Cathode Ray Tubes and Storage Tubes

Also a copy of the

- ☐ EMI Klystron & Waveguide data selection chart
- ☐ Photomultiplier Tube selection chart
- ☐ I would like to receive regular information regarding new developments.

NAME AND POSITION (BLOCK LETTERS PLEASE)

COMPANY'S NAME

ADDRESS

TELEPHONE EXT No

EMI offers a very wide range of special tubes

These are brief details of some of the EMI special tubes.
For further information please send the reply-paid card to EMI.

PHOTOMULTIPLIER TUBES AND PHOTOCONDUCTIVE DEVICES

EMI is the largest producer of photomultiplier tubes in Europe and these tubes are outstanding for very low values of dark current obtainable, with high gain, photosensitivity and stability of operation. They are supplied with various types of photo cathode for specific applications. 'S' cathode tubes for example are particularly suitable for carbon 14 and tritium counting. Solid state radiation detectors are also available for specialised applications.

MICROWAVE TUBES

EMI Reflex Klystrons include a wide range of plug-in klystrons and tuneable cavities giving continuous coverage from 3,000 to 12,000 M/cs. ('S' to 'X' band); a new advanced design 'J' band tube is now in the late stages of development. Integral cavity types covering 'K', 'Q' and 'J' band, have improved tuner for good frequency stability and freedom from microphony. A four cavity, water cooled Klystron with a gain of 50 dB and capable of handling peak powers in 'S' band of 100 kW is also available. *Magnetrons.* EMI produces a range of packaged magnetrons for high power pulse operation, designed for use in 'J', 'Q' and 'O' bands.

CAMERA TUBES

EMI Camera Tubes include the following:—
4½" image orthicons both standard and high sensitivity tubes. C.P.S. orthicon – the ideal tube for systems conversion. A wide range of EMI 1" vidicon tubes including the latest high resolution low heater wattage vidicons (with prefabricated targets). Special vidicons including high sensitivity ultra-violet sensitive tubes for use in UV microscopy, infra-red sensitive tubes and a long lag tube suitable for radar/TV scan conversion or for recording single strobe flash pictures. A recent addition to the range is a tube with a fibre optic face plate.

CATHODE RAY TUBES AND STORAGE TUBES

The EMI range of high quality, high precision cathode ray tubes includes all types of radar tubes from 2" airborne radar tubes giving extremely high definition to 21" metal coned tubes.
Oscilloscope tubes include those capable of recording single transients with a rise time of 1 millimicrosecond. Film scanners and TV monitor tubes are also available.
A barrier grid storage tube which is finding wide application in medical electronics and other fields is a new addition to the range.

Postage will be paid by Licensee

No postage stamp necessary if posted in Great Britain or Northern Ireland

BUSINESS REPLY CARD
Licence No. SOX 64

E M I ELECTRONICS LTD
VALVE DIVISION · DEPT. EC5
HAYES · MIDDLESEX · ENGLAND

EMI

EMI ELECTRONICS LTD
VALVE DIVISION · HAYES · MIDDX
TELEPHONE: HAYES 3888 · EXT 2165

for all values. They can be supplied in five different temperature coefficients from ±150 p.p.m. per °C down to ±15 p.p.m. per °C. The resistors are non-inductive up to approximately 100 Mc/s except in the case of the low-resistance high-power types.—*Dubilier Condenser Co.* (1925) Ltd., *Ducon Works, Victoria Road, London, W.3.*

For further information circle 29 on Service Card

30. Paste Solder

Perdeck Solder Products have announced the development of their 'Kolosol' mark 2 paste solder. Claimed to be the first stable suspension of metallic solder in a non-corrosive flux, it comprises 85% solder to B.S. Specification in a non-corrosive flux to A.I.D. Specification D.T.D.599.

Being in the shape of a dense paste, it can be used as a replacement for solder washers, shims, wire and other preformed shapes. The intimate mixture of solder and flux avoids the formation of dry joints and is primarily intended for work on clean copper- and brass-plated components and most non-ferrous metals with the exception of aluminium and other difficult-to-solder metals.

Flux residues do not have to be removed, and if left on the joint will act rather like a lacquer. However, if required, normal trichloroethylene vapour degreasing methods can be employed. Industrial trial packs of 'Kolosol' at nominal prices and supplies in 1, 2, 5 and 7 lb tin cans are available ex stock.—*Perdeck Solder Products Ltd., Abbey Mills, Waltham Abbey, Essex.*

For further information circle 30 on Service Card

31. Epitaxial Micrologic Elements

SGS-Fairchild 'Micrologic' integrated digital microcircuits are now available in production quantities in planar epitaxial form. Epitaxial construction has doubled both switching speed and d.c. noise immunity. Additionally, the new elements offer an increase of more than 30% in logic level separation throughout the temperature range −55 to +125 °C.

The nine elements composing the epitaxial micrologic family permit the synthesis of all computer logic functions and make use of a modified form of direct-coupled NOR logic. The elements are: a buffer (μL900), a counter adapter (μL901), a flip-flop (μL902), a gate (μL903), a half-adder (μL904), a half-shift register (μL905), a half-shift register without inverter (μL906), a 4-input gate (μL907) and a dual 2-input gate (μL914).

Smaller in area than in the original non-epitaxial elements, the silicon chips are now thicker and stronger. Packaging is in TO-5 cans. Illustrated is an enlarged view of a μL901 chip: the actual size is $\frac{1}{16}$ in. square.—*SGS-Fairchild Ltd., 23 Stonefield Way, Ruislip, Middlesex.*

For further information circle 31 on Service Card

32. Digital Display Counter

Herga Electric have developed a versatile counter which employs uniselectors and relays to reduce cost and provides an illuminated display of the count in progress, each digit screen measuring $3\frac{3}{4}$ × 3 in. A smaller size (1 × $\frac{3}{4}$ in.) is available and the display can also incorporate short legends and fractions.

The construction permits a wide variation in individual design allowing actuation of contacts at predetermined counts, batch counting, alarm signalling, etc. The maximum count rate is approximately 600 counts per minute.

The unit illustrated measures 16 × 21 × 13 in. deep and is intended for wall mounting. Initiation of this unit is by means of a photoelectric control, although many other forms of initiation are possible. Power requirements are 240 V, 50 c/s, at $\frac{1}{2}$ A. — *Herga Electric Ltd., Wallingford Road, Uxbridge, Middlesex.*

For further information circle 32 on Service Card

33. Sub-Miniature Relay

A sub-miniature relay, with a volume of less than 0·04 cu in., has been developed by G.E.C. (Telecommunications).

With a single changeover contact rated at 24 V, 0·5 A, non-inductive for low-level speech circuits, this relay is suitable for many general-purpose applications including mounting on to printed-circuit cards. It has an operating speed of 50 p.p.s. and a mechanical life expectancy of 50 million operations.

Contact reliability is achieved by using solid precious-metal contacts and a contact pressure of 10 gm. All organic compounds have been excluded from the sealed contact compartment and the insulation resistance is not less than 500 MΩ at 500 V d.c.

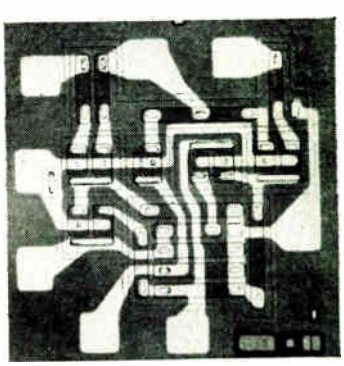
Measuring 0·265 × 0·265 × 0·531 in. and weighing 2·3 gm—without mounting—the relay is available with coil voltages of 1·5, 6, 12 and 24 V.—*G.E.C. (Telecommunications) Ltd., Telephone Works, Coventry.*

For further information circle 33 on Service Card

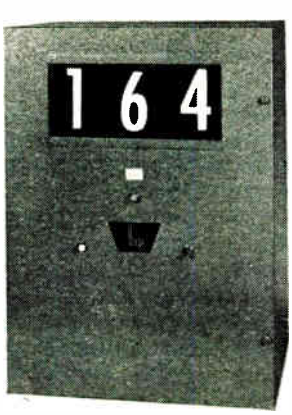
34. Shaft Rotation Monitor

A unit has been designed by Advance Controls to give a warning when a monitored shaft slows down or stops.

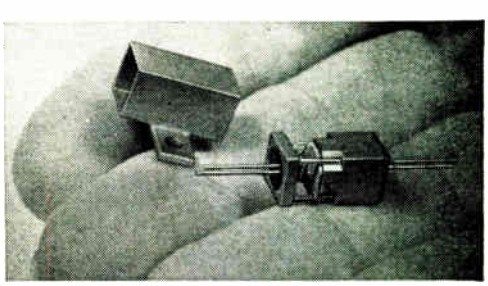
30



31



32

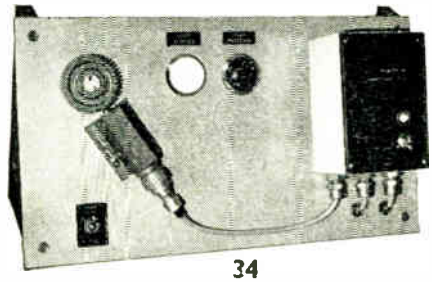


33

Electrical impulses are obtained through a non-contacting magnetic probe mounted near a toothed wheel on the rotating shaft and these impulses hold a relay in the monitor in an energized condition. When the shaft stops, the relay becomes de-energized and its contacts can be used to actuate alarm signals or to control other equipment. An existing gear wheel on the shaft will energize the magnetic probe of which a wide range of sizes and shapes can be supplied.

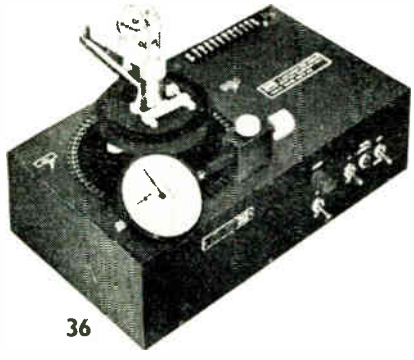
Various models are available for use on any a.c. or d.c. supply, and no warm-up time is necessary as semiconductor devices are used. The standard models are fitted with a 'test' push-button and a relay with change-over contacts capable of switching up to 440 V at 5 A. Prices of the rotation monitors are from £18 and probes from £4 5s.—*Advance Controls Ltd., Imperial Lane, Cheltenham, Glos.*

For further information circle 34 on Service Card

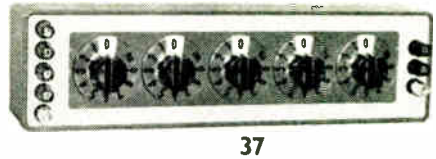


34

35



36



37

35. Compact Thyratrons

English Electric has introduced two new hydrogen thyratrons, the 6587 and the 6777, which are designed for use in compact equipments where space is at a premium, and are intended for pulse operation at high repetition rates; both incorporate hydrogen reservoirs for long and reliable life.

The 6587 (illustrated), which is mechanically smaller than (7·25 in. high) and electrically superior to the 5C22, embodies a tetrode-type electrode structure. The peak forward voltage is 16 kV, peak anode current 325 A and heating factor $3{\cdot}9 \times 10^9$ VA p.p.s.

The 6777 has a maximum peak forward voltage of 8·0 kV, a peak anode current of 35 A and a heating factor of $0{\cdot}75 \times 10^9$ VA p.p.s.—*The English Electric Valve Co. Ltd., Chelmsford, Essex.*

For further information circle 35 on Service Card

36. Dividing Heads

A series of steel and aluminium dividing heads suitable for use with all types of rotating components such as synchros and resolvers is now available from Wayne Kerr-Gertsch. They are capable of rotating through the full 360° on precision bearings. Large dial indicators give direct readings of angular position of the vernier control with 3-second resolution, and scales are engraved for both clockwise and counter-clockwise rotation at 5° intervals.

Model DH-5 has an accuracy of ±15 seconds of arc and the holding arm can accommodate components from size 8 to size 23, the items under test being supported by their shafts to prevent error. Model DH-8 is accurate to ±5 seconds of arc and accepts components from size 5 to size 15.

A special version, the DH-8M, is designed for both automatic and semi-automatic operation. In automatic operation, the head advances 5° every six seconds, pausing four seconds at each step. Cam-operated micro-switches provide switching for programming synchro-resolver standards and bridges, phase-angle voltmeters and recorders. — *The Wayne Kerr Laboratories Ltd., New Malden, Surrey.*

For further information circle 36 on Service Card

37. A.C. Voltage Dividers

The model DT58 Dekatran, one of a series of decade transformer voltage dividers manufactured by Electro Scientific Industries and available through Livingston Laboratories, is a five decade a.c. voltage divider with a terminal linearity from 50 c/s to 1 kc/s of 5 parts per million and a resolution of 10 parts per million of the input. The frequency range is 50 c/s to 10 kc/s. The maximum input voltage is 350 V r.m.s. above 1 kc/s decreasing to 35 V r.m.s. at 100 c/s.

These and other features such as high input impedance, low output impedance and low phase shift make these instruments suitable for voltage and current division, turns ratio measurement, divider calibration and impedance comparison work. The price of the DT58 is £118 excluding duty.—*Livingston Laboratories Ltd., 31 Camden Road, London, N.W.1.*

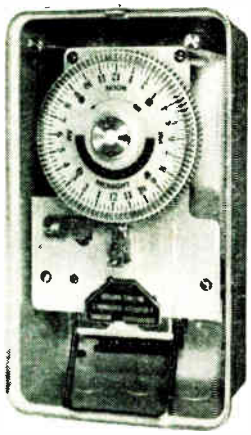
For further information circle 37 on Service Card

38. Process Control Time Switch

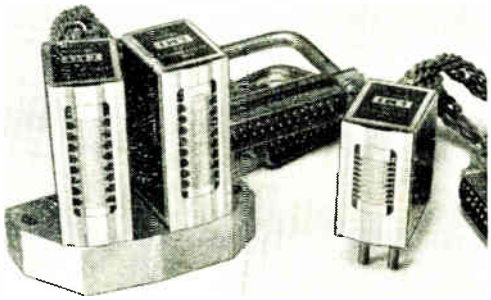
A time switch suitable for the control of laboratory equipment and test gear and for automatic sampling and process control work, has been introduced by Venner. Named the Multiset, it is designed for applications requiring switching periods of varying duration over a 24-hour cycle.

Periods of operation are easily selected by lifting tabs which are fitted into the 24-hr dial at 15 min intervals, each tab representing a period of 15 min. When 'on' periods of longer than 15 min are required, it is only necessary to lift the appropriate number of adjacent tabs.

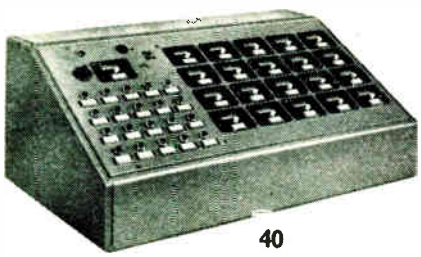
Rated at 10 A, 200/250 V a.c. the Multiset has a 5-way terminal block with separate clock connection and is of plug-in construction. A pressed



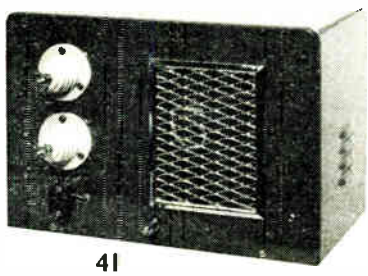
38



39



40



41

metal case is designed for surface mounting with conduit entry, and has a bottom-hinged, quick release front cover with glass window for the 4¼ in. diameter dial. The price is £12 10s.—*Venner Ltd., Kingston By-Pass, New Malden, Surrey.*

For further information circle 38 on Service Card

39. Magnetic Heads

A range of magnetic heads, the Emidata 'E' series, is now available from E.M.I. Electronics. These heads have been designed specifically for multi-track instrumentation and data-processing systems where high consistency of performance is required.

The high performance characteristics and long life of all heads in a stack are achieved by rigid control of gap depth during manufacture. The heads also have a higher order of accuracy of gap alignment and azimuth than the previous 'S' range of heads with which they are completely interchangeable.

Mean azimuth and gap scatter is such that the in-line edges of all gaps in an assembly lie within a zone 200 μin. wide and square to the base. The elevation, or head stack tilt, is held within a similar zone 500 μin. wide. The standard gap lengths are 0·0005 in. for recording and 0·0002 in. for playback.

The heads give a high-frequency response up to 100 kc/s and have a long wavelength response of 0·1 in. Cross-talk rejection is extremely good. The record heads write tracks which are wider than the playback heads, allowing for possible tape weave. All IR1G and SBAC track configurations are available up to 33 tracks interlaced on 1 in. tape. Special track pitch and width can be supplied to special order. The heads are supplied wired to miniature Cannon plugs. —*E.M.I. Electronics Ltd., Hayes, Middlesex.*

For further information circle 39 on Service Card

40. Numerical Quantity Analysers

The series 488 range of statistical analysers has been designed by English Numbering Machines to provide custom-built equipment to meet particular numerical quantity analysis problems at an economical cost. These keyboard instruments record numerical data on a number of registers. In the simplest form, each key is associated with one register and each depression of a key adds one count to its register.

The model illustrated has twenty registers and a grand total register. All registers are individually resettable to zero. This model is also provided with an automatic pulsing device. This causes the selected register to count at a controllable rate for as long as the appropriate key is depressed. The operator releases the key when the required quantity has been entered.—*English Numbering Machines Ltd., Queensway, Enfield, Middlesex.*

For further information circle 40 on Service Card

41. High-Voltage Protection Unit

A self-contained protection unit intended to safeguard electrical or electronic equipment against damage by voltage breakdown is now available from The M-O Valve Company.

The unit uses the cold-cathode surge diverter, type E3020, is small in size, low in cost and requires no additional power supplies. It provides protection over the range 500–6,000 V, supports a fault current of 2,000 A and operates in less than 1 μsec. The sensing transformer, relay, limiting resistors and surge diverter which make up the protecting unit are housed in a metal case 12 × 8 × 7 in.

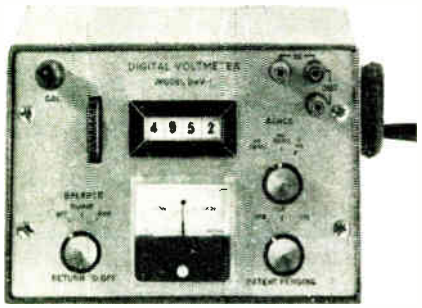
The user merely interrupts the high-tension lead to the equipment to be protected and connects it through the two high-voltage terminals on the front panel. The other two terminals of the unit are connected in series with the 'no-volt' release of the power-supply circuit breaker or contactor.—*The M-O Valve Co. Ltd., Brook Green Works, London, W.6.*

For further information circle 41 on Service Card

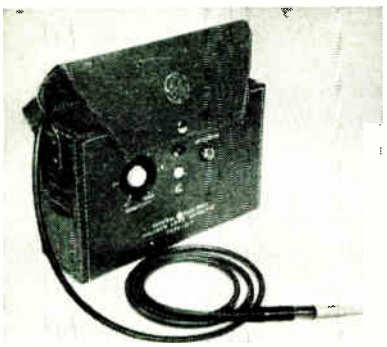
42. Low-Cost Digital Voltmeter

The model DmV-1 digital voltmeter, developed by Scientific Furnishings uses a simple manual balance technique to provide a performance comparable to that of more expensive instruments. The 4-digit, co-planar, in-line readout provides 0·02% resolution, with a sensitivity of better than 10 μV and an absolute accuracy of 0·15%, with a built-in Weston cell to permit rapid standardization checks. The decimal point shifts automatically with range change.

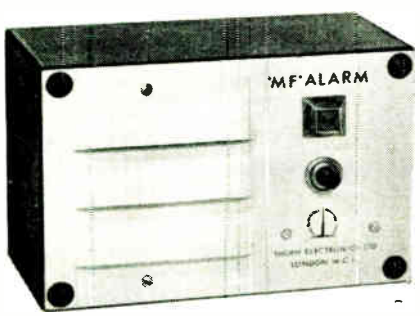
The maximum internal range is 500 mV, and a plug-in unit is available to provide additional switched ranges up to 500 V and current ranges from 0 to 100 μA up to 0 to 5 mA. In operation, a single control knob, geared to a helical slidewire and a digital indicator, is used to adjust a galvanometer to the null point. The potentiometric method ensures zero loading error with infinite input resistance at balance. The instrument measures 5½ × 5 × 7½ in. and has a self-



42

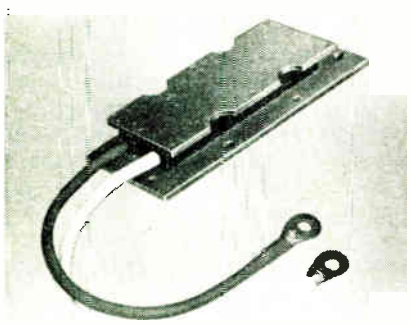


43



44

45



contained mercury battery power supply. Price £59.—*Scientific Furnishings Ltd., Electronics Division, Poynton, Cheshire.*

For further information circle 42 on Service Card

43. Leak Detector

A miniature leak detector recently announced by International General Electric weighs only 6 lb and measures 10 × 6½ × 3½ in. overall. The pencil-shaped probe is designed to reach awkwardly situated installations.

The external control on the left can be set to the range of leak specified, and the inner dial is used to balance out background halogen in contaminated atmospheres. On the right a standard leak source allows for checking the sensitivity of the probe before use.

The H-7 has an audible alarm, which rises in pitch as the leak source is neared. The sensitive element has a life of 100 hours, and costs a fraction of a conventional platinum element to replace. Consumption is 35 W from a standard mains supply. — *International General Electric Co. of New York Ltd., Industrial Electronics Division, Boulton Road, Reading, Berks.*

For further information circle 43 on Service Card

44. Mains Failure Alarm

Using four 1½-V dry cells as a power source, the Thorn M.F. alarm is a detector unit giving both audible and visual warnings should a power supply fail. Designed originally for monitoring mains power, its flexible design allows it to be used for many other purposes, even allowing warning to be given more than a mile from the point monitored.

A sturdy metal case, 6 × 4 × 3 in., houses an integral alarm bell and red signal lamp, both being operated by a Thorn Pygmy relay when the alarm mechanism is triggered off. This unit is inexpensive, easy to install and requires virtually no maintenance.—*Thorn Electronics Ltd.*, 105-109 *Judd Street, London, W.C.*1.

For further information circle 44 on Service Card

45. Peltier Batteries

Mullard has introduced three batteries of Peltier elements suitable for a wide range of cooling applications where a compact 'cold source' is required. Typical uses are small-scale refrigeration in medical and biological research and heat sinks in transistor equipment. The batteries use bismuth telluride as the thermoelectric element.

Type PT11/20 is designed for an operating current of 18 to 22 A at 1·0 to 1·2 V, and has a maximum cooling capacity of 16 W. Its minimum life expectancy is 2,000 hr of continuous operation at 20 A. Type PT20/20 (illustrated) has an operating current of 20 A at 2 V, a cooling capacity of 23 W, and a minimum life expectancy of 2,000 hr at 20 A. Type PT47/5 operates at 5 to 6 A and 5·0 to 5·4 V and has a cooling capacity of 16 W. Its minimum life expectancy is 2,000 hr at 5 A.

Both the PT11/20 and PT47/5 are available with a flat copper plate for use with solid surfaces, or with fins for the cooling of gases or liquids. Type PT20/20 has flat copper plates. All three types are supplied ready for immediate use.—*Mullard Ltd., Mullard House, Torrington Place, London, W.C.*1.

For further information circle 45 on Service Card

46. O-Band Klystron

E.M.I.'s O-band klystron type R9653, a reflex oscillator, is a new addition to the range of E.M.I. millimetre-wave tubes. Applications are expected to be varied, but will include electron spin resonance, materials research, and microwave testing and development work, including scaled aerial experiments. The tube has a mechanical tuning range of about 4 Gc/s in the 4-mm band and variants are being developed to cover the frequency range 65 to 85 Gc/s.

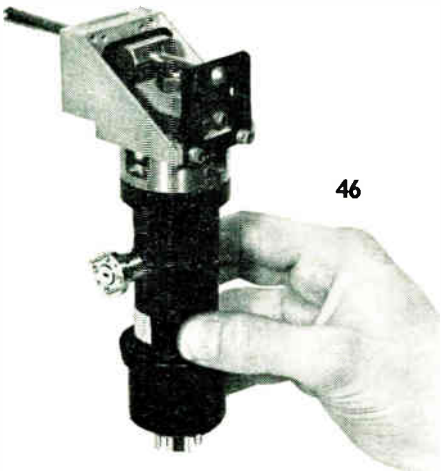
A resonator voltage of between 2·0 and 2·5 kV at 25 mA produces a power output in excess of 10 mW and electronic tuning is of the order of 100 Mc/s between the half-power points. Output is taken from waveguide size WG 26 (RG 99/U) and the standard flange is the American type UG 387/U, although other types can be fitted by special request. — *E.M.I. Electronics Ltd., Hayes, Middlesex.*

For further information circle 46 on Service Card

47. Pressure Transducers

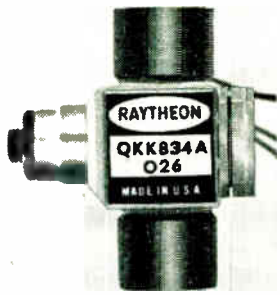
To measure static or dynamic gaseous or liquid pressure, Intersonde have introduced the types PR14 and PR15 bonded strain-gauge pressure transducers covering pressure ranges of 0–1,000 p.s.i.(gauge) to 0–10,000 p.s.i.g.

The pressure responsive element common to both types is an accurately machined tube on which bifilar strain gauge elements are wound and connected in a four-arm bridge configuration. Both transducers have an output resistance of 350 Ω and produce an output of 22 mV at full rated pressure with 15 V excitation. The combined non-linearity and hysteresis error is within 0·25% of full range and the operating temperature limits extend from −40 to +120 °C.



46

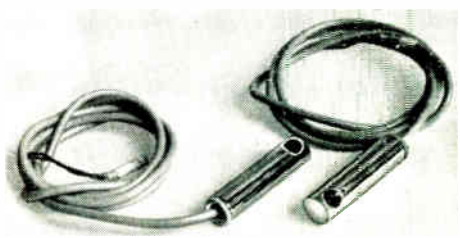
47



48

49

50



51

The type PR14 is provided with pin terminals and the type PR15 with an integral flying lead, both transducers measure 4·9 in. long by 1·06 in. diameter and both have a ¼ in. B.S. pipe thread pressure inlet.—*Intersonde Ltd., The Forum, High Street, Edgware, Middlesex.*

For further information circle 47 on Service Card

48. Miniature Klystrons

Six dielectric klystrons for use as parametric amplifiers and local oscillators in the 23·6 to 35·6 Gc/s range have been introduced by Raytheon. Designed to provide extremely stable operation in missile and space environments the units measure 2·05 × 2·00 × 0·80 in. and weigh 5 oz.

These klystrons have minimum power outputs ranging from 10 to 100 mW. Although the standard units are mechanically tuned, all can be supplied in fixed-tuned and trimmable versions.—*Raytheon-Elsi, S.p.A., Villagrazia, Palermo, Italy.*

For further information circle 48 on Service Card

49. Digital Deviation Ohmmeter

Electro Instruments' model 6200 digital deviation ohmmeter, available from Livingston Laboratories, will measure and indicate resistance deviations from ±5% to ±0·01% of a given value. Resistances may be compared with an external standard resistor or the model 6202 resistance decade unit which provides measurement ranges from 1 Ω to 10 MΩ.

The accuracy is ±0·01% ±1 digit from 10 Ω to 1 MΩ and within 0·1% outside these limits. Deviation values are displayed on a 3-digit Nixie tube readout. Other features are transistorized circuitry and an average readout time of 1 sec. The price of the model 6200 is approximately £1,178, exclusive of import duty.—*Livingston Laboratories Ltd., 31 Camden Road, London, N.W.1.*

For further information circle 49 on Service Card

50. Sub-miniature Switch

Miniature Electronic Components have designed a robust single-pole changeover toggle switch in a sub-miniature size. The model TS has a quick-make, quick-break action, and it has been successfully tested up to 100,000 operations on full load. Two models are available, which are identical except for the internal contacts. Both are 0·25 in. in diameter, and 0·50 in. in body length, and are intended for panel mounting.

The TS70, with 5 silver contacts, is rated at 1 A resistive, at 50 V d.c. or 0·25 A at 125 V a.c. Type TS71, with gold-plated contacts, is rated at 100 mA at 1 V d.c. The initial contact resistance of the former is 10 mΩ, and of the latter 6 mΩ. The operating temperature of both types is up to 85 °C.—*Miniature Electronic Components Ltd., St. Johns, Woking, Surrey.*

For further information circle 50 on Service Card

51. Right-Angle Photo-Electric Units

Hird-Brown have introduced the lamp projector type MP91 and photo-cell receiver type MR91. These have been designed for use in applications where the normal type of projector and receiver cannot be accommodated because of lack of space in line with the light beam.

The MP91 and MR91 which have an effective working beam length of 3 in., can both be fitted in a space 1½ in. greater than the necessary beam length. In certain circumstances the beam length of the standard unit can be increased. Where a longer beam length (up to 12 in.) is essential, this can be obtained by using an SGS-Fairchild phototransistor instead of the OCP71 fitted as standard.

These right-angle viewing heads were designed for use with Hird-Brown standard photo-electric controls but they are also available for use with any suitable photo-electric scheme.—*Hird-Brown Ltd., Flash Street, Bolton, Lancs.*

For further information circle 51 on Service Card

TRANSISTOR OPERATING CONDITIONS—1

In the short series of articles, of which this is the first, the problems of biasing an earthed-emitter transistor are discussed. This article deals with precautions for preventing the ratings of the transistor from being exceeded. Later articles will cover temperature effects and component tolerances.

By W. TUSTING

IN this series of articles the aim is to present the information and procedure necessary for the choice of resistor values in transistor biasing circuits. A good deal has been written about this, especially about the effects of temperature, and most textbooks now deal with biasing circuits quite extensively. The aim in most of them, however, is to give the reader an understanding of the nature of the problems and to indicate the kind of solutions commonly adopted. The practical problem of deciding upon the proper resistance values for any particular case is dealt with much less frequently.

From the designer's point of view this practical problem is the important one and it is to its solution that everything in these articles will lead. Some of the information included will necessarily be more or less a repetition of that in the textbooks, but one important matter will be treated which the writer has been unable to find covered in any adequate way. This is the effect of resistor, transistor and supply-voltage tolerances. In a reasonably well stabilized circuit, their effect upon the operating point may be much greater than that of temperature.

A transistor is extremely robust and long lived provided that it is operated within its maker's ratings, but it is much more easily damaged than a thermionic valve by excessive current, voltage or temperature. Whenever it is practicable to do so, therefore, it is desirable so to design a circuit that there is no possibility of the ratings being exceeded.

The first step in design is always to decide upon the range of ambient temperatures over which the equipment must operate. In this connection ambient temperature means the temperature inside the box containing the apparatus rather than room temperature. For a small transistor without a heat sink it is the temperature of the air surrounding the transistor.

For domestic broadcast receivers a minimum temperature of 40 °F is often adequate, for few people will want to listen to broadcasting in a room at a lower temperature. At the other extreme, in this country temperatures of over 90 °F are rare. So a range of 40–90 °F or, say, 4–35 °C is often adequate.

A car radio, however, must operate over a bigger temperature range. It must operate first thing in the morning when the car has been left standing all night in the winter in, perhaps, 15° of frost. It must also operate when the car has been parked all day in summer sun with the windows shut. The temperature range for this country is likely to be 17–120 °F, or roughly −9 °C to 50 °C. In other countries it may be greater. Industrial equipment may have to operate in more severe conditions.

The first effect of temperature is that it limits the power which may be dissipated at the collector junction. This power is always limited by temperature, for the real limitation is not power as such but the temperature of the junction itself. For a germanium transistor the temperature limit is commonly 75 °C. If this is the ambient temperature no dissipation at all is permissible. If the ambient temperature is 50 °C, then a dissipation which increases the junction temperature by 75 − 50 = 25 °C is permissible.

For small transistors, the maximum power which can be dissipated at the collector is given by

$$P_{tot} = \frac{T_{jmax} - T_{amb}}{\theta} \qquad (1)$$

where T_{jmax} = maximum junction temperature, commonly 75 °C

T_{amb} = ambient temperature

θ = rise of junction temperature per milliwatt.

For the OC71 transistor $\theta = 0{\cdot}4$ °C/mW and for this transistor equation (1) reduces to

$$P_{tot} = \frac{75 - T_{amb}}{0{\cdot}4}$$

Table 1 shows the effect upon P_{tot} of temperature for the OC71, calculated from this relation.

The basic earthed-emitter transistor circuit is shown in Fig. 1. The collector dissipation is $P_c = V_{ce}I_c$.

Now

$$V_{ce} = E_{cc} - I_c(R_e + R_c) - I_bR_c$$

The term I_bR_c can be safely ignored because I_b is very small compared with I_c; also R_e is usually small compared with R_c. Therefore,

$$P_c \approx E_{cc}I_c - I_c^2(R_e + R_c) \qquad (2)$$

Table 1

T_{amb}		P_{tot}
°F	°C	(mW)
131	55	50
113	45	75
95	35	100
77	25	125
59	15	150
41	5	175
23	−5	200

This is a maximum when $I_c = E_{cc}/2\,(R_e + R_c)$

and then
$$P_c = \frac{E_{cc}^2}{4(R_e + R_c)} \qquad (3)$$

Since the power is a maximum under this condition it follows that if we make it equal to P_{tot}, the maximum permissible dissipation at the highest ambient temperature, it will be impossible to exceed the dissipation limit for any condition of base bias. For safety, therefore, the first requirement is to make

$$R_e + R_c \geqslant \frac{E_{cc}^2}{4P_{tot}} \qquad (4)$$

If the resistance in the external collector–emitter circuit is high enough any danger of the condition known as thermal runaway is avoided. This condition can occur when a kind of positive feedback exists. An increase of temperature normally increases the collector current. If the increase of collector current increases the collector dissipation this further increases the junction temperature and so raises the collector current again. The net result can be that current and temperature continue to rise and the transistor is destroyed.

It is clear from equation (2), however, that when the circuit resistance is sufficient the dissipation does not continually increase with collector current. It reaches a maximum and then *decreases* for a further increase of current. Beyond this point an increase of ambient temperature increases the collector current, but decreases the dissipation and so the junction temperature rises by an amount which is smaller than the change of ambient temperature.

Consider an OC71 transistor at an ambient temperature of 25 °C. From Table 1 the permissible collector dissipation is 125 mW. If $E_{cc} = 12$ V, then from equation (4) we must have

$$R_c + R_e = 144/500 = 0{\cdot}288\ \text{k}\Omega = 288\ \Omega$$

This is a much lower value of resistance than would normally be used, but if the temperature is 55 °C the permissible dissipation is only 50 mW and the resistance must not be less than 720 Ω.

If $E_{cc} = 12$ V and $R_e + R_c = 0{\cdot}5$ kΩ, Fig. 2 shows the collector dissipation P_c plotted against collector current I_c. It is a maximum of 72·5 mW at 12 mA. With an OC71 at 45 °C there would be no danger from collector dissipation whatever the collector current, for at this temperature 75 mW is allowable. For other reasons, which we shall come to later, there is a separate limit on current, but for the moment we are ignoring this. However, if the temperature rose to 55 °C, we might be in trouble for the permissible dissipation is then only 50 mW. We should then exceed the rating if the current were in the range 5·3 mA to 19·2 mA and for safet the resistance of the circuit would have to be increased.

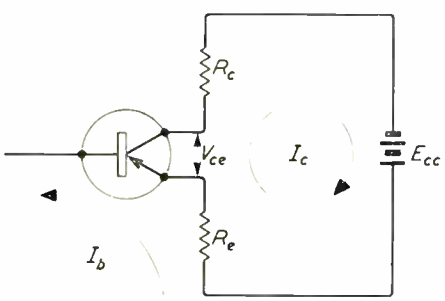


Fig. 1. Basic circuit of earthed-emitter transistor

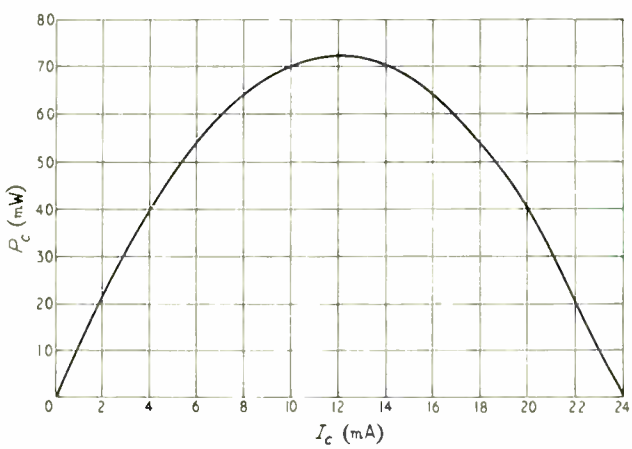


Fig. 2. Variation of collector dissipation P_c with collector current I_c when the external resistance is 500 Ω and the power supply is 12 V

This points a moral. External resistance is a safeguard only if the ambient temperature does not exceed the design figure. There is always a danger of breakdown if apparatus is used in a higher ambient temperature than it was designed for. The designer must always be very careful to assess the maximum temperature in which equipment will be used.

The inclusion of sufficient resistance according to the relation of equation (4) will prevent excessive collector dissipation, but it is not in itself a sufficient requirement for operating within the transistor ratings, however. There are current and voltage limits as well as power.

If I_{cmax} is the maximum permissible direct collector current, it is impossible to exceed it if

$$R_c + R_e \geqslant \frac{E_{cc}}{I_{cmax}} \qquad (5)$$

This relation will generally give a different value for

$R_c + R_e$ than equation (4). When it does, it is necessary to choose the higher of the two. The same resistance values are obtained for the two conditions only when

$$P_{tot} = E_{cc}I_{cmax}/4.$$

The final limit is on V_{ce}. There is a maximum permissible value $V_{ce\,max}$ which must not be exceeded. Assuming that the circuit does not provide the transistor with an inductive load, V_{ce} is its greatest when the base bias is such that the collector current is cut off and it then equals E_{cc}. To keep within the voltage limit under all conditions we should thus have

$$E_{cc} \leqslant V_{ce\,max} \qquad (6)$$

All this can be summarized under a series of safety rules:—

1. Determine the maximum collector dissipation P_{tot} for the maximum ambient temperature from the maker's data; also I_{cmax} and $V_{ce\,max}$.
2. Limit E_{cc} to a value not exceeding $V_{ce\,max}$.*
3. Use equation (4) to determine a lower limit for $R_e + R_c$.
4. Use equation (5) to determine a lower limit for $R_c + R_c$.
5. Settle on the higher of the two limits obtained under rules 3 and 4.

* With some transistors $V_{ce\,max}$ depends on the resistance included in the base circuit and falls as the resistance increases.

Examples

Consider an OC71 transistor with $P_{tot} = 125$ mW at $T_{amb} = 25$ °C, $I_{cmax} = 10$ mA, $V_{ce\,max} = 20$ V.

1. Let $T_{amb} = 45$ °C, $E_{cc} = 20$ V. Using equation (1), $P_{tot} = 75$ mW.
   From (4) $R_c + R_e \geqslant 400/300 = 1{\cdot}33$ kΩ
   From (5) $R_c + R_e \geqslant 20/10 = 2$ kΩ
   The current limitation is the more severe and we must see that the total resistance is not under 2 kΩ.
2. Let $T_{amb} = 45$ °C, $E_{cc} = 4{\cdot}5$ V. As before $P_{tot} = 75$ mW.
   From (4) $R_c + R_e \geqslant 20{\cdot}4/300 = 0{\cdot}068$ kΩ
   From (5) $R_c + R_e \geqslant 4{\cdot}5/10 = 0{\cdot}45$ kΩ
   Again the current limitation is the more severe, and all will be well if $R_c + R_e$ is not under 450 Ω.
3. Let $T_{amb} = 55$ °C, $E_{cc} = 20$ V. Then $P_{tot} = 50$ mW.
   From (4) $R_c + R_e \geqslant 400/200 = 2$ kΩ
   From (5), as before $R_c + R_e \geqslant 2$ kΩ
   In this case, the resistance limits are the same. At a higher temperature P_{tot} will be smaller and then the limit on $R_c + R_e$ will be set by power. Thus at 60 °C, $P_{tot} = 37{\cdot}5$ mW and $R_c + R_e \geqslant 400/150 = 2{\cdot}67$ kΩ. In most practical cases it is current rather than power which sets the limit to the minimum permissible value for $R_c + R_e$.

11-Gc/s LINKS FOR TV OUTSIDE BROADCASTS

To relieve overcrowding in the 7-Gc/s band at present used for television outside broadcast links, the B.B.C. has bought two portable wide-band links operating in the 11-Gc/s band. The new links, which have been supplied by Mullard, are undergoing appraisal and propagation tests by the Corporation.

The equipment can provide a single- or double-way link. For the latter, s.h.f. heads are available for multiplexing to a single parabolic aerial. The double head may comprise two transmitter units, two receiver units, or a transmitter and a receiver, depending on the operational requirements. Both the receiver and transmitter units are interchangeable within the head and may be plugged-in to give the required combination quickly without electrical or mechanical adjustment.

In designing the link, special attention has been given to simplicity and ease of operation. The individual units—control unit, s.h.f. head and parabolic aerial—are of light yet sturdy construction and therefore easily transported and erected on site. A useful feature under field conditions is that the transmitting and receiving control units can be operated at distances up to 500 ft from the head, which is weatherproof.

The equipment gives a signal-to-noise ratio of 58 dB over a range of 20 miles using 4-ft parabolic aerials. It has an 8-Mc/s bandwidth and can therefore accommodate 625-line monochrome or colour t.v. signals (with or without associated sound), radar signals, or up to 120 telephone channels. A typical installation comprising a single s.h.f. head, transmitter control unit and 2-ft diameter parabolic aerials weighs approximately 108 lb. Power supply requirements are 220 V ±7%, 50 c/s.

For further information circle 54 on Service Card

Mobile wide-band microwave link, type TV11

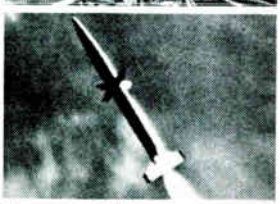
DEPARTMENTAL APPROVAL CERTIFICATE NS.3020/2, covering STC Solid Tantalum capacitors, has been granted by the Ministry of Aviation. The approval is based on a successful test programme carried out by SRDE to Draft DEF 5134-A-1 and is pending the finalization of this specification ☐ The STC solid tantalum capacitor series was extended recently by the addition of a 50 volt rating. Rated working voltages at 85°C are now: 50V, 35V, 20V, 15V, 10V and 6V d.c. This range of capacitors is manufactured entirely in the United Kingdom under full Quality Control and all units are aged for 7 days before shipment ☐ Capacitors to 5% and 10% tolerances are now available, in addition to the standard 20% capacitance tolerance. Write, 'phone or Telex for Data Sheets to STC Capacitor Division, Brixham Road, Paignton, Devon, or London Sales Office, Footscray, Sidcup, Kent. Telephone FOOtscray 3333. Telex 21836.

high-grade electronic components by **STC** COMPONENTS GROUP

64/4MC

Wandleside make CABLES

For reliability and efficiency, railway signalling and control systems depend on Wandleside Cables.



Wandleside are specialists in the manufacture of electric wires and cables for all high temperature applications.

In the Television studios you will find Wandleside Cables playing their part in the programme.

Wandleside Cables were used for flight test instrumentation on the first Vickers Armstrong V.C.10.

for every job!

Whatever the application, whatever the industry Wandleside Cables have the right cable for the job. Wherever reliability, efficiency are required . . . whether it's transport, electronics, entertainment or flying . . . Wandleside carry the load. There is a comprehensive range of Wandleside cables to cover the specific requirements of almost every kind of industry.

Why not discuss your problem with us?

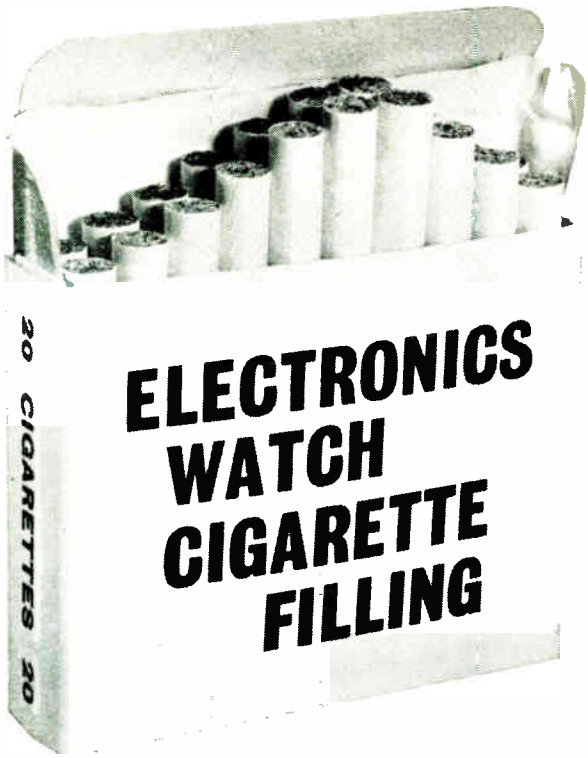
Wandleside Warren Wire Company Limited now hold the M.O.A. Design Approval for P.T.F.E. Aircraft Cables

WANDLESIDE CABLES

WANDLESIDE CABLE WORKS LTD.
Wandsworth, London, S.W.18
WANDLESIDE WARREN WIRE CO. LTD.
Dunmurry, Belfast, Nth. Ireland

WANDLESIDE CABLE WORKS LTD., 106 GARRATT LANE, WANDSWORTH, LONDON, S.W.18

Telephone: VANdyke 7544 Telegrams: Wandleside, London, S.W.18 Telex 261355 (FALKS GROUP)



ELECTRONICS WATCH CIGARETTE FILLING

Cigarettes have to be made to close limits of weight. This article describes how each individual cigarette is measured automatically by determining its beta-ray absorption.

By P. J. ROBINS

IF a 6 per cent manufacturing error could cost, in tax alone, £1,100 a day per machine, how long would a company stay in business? This is no hypothetical sum from a child's primer but a real problem which could face a manufacturer of cigarettes. A modern machine requires five pounds of processed tobacco every minute and the highest tax rate is £3 16s. 4½d. a pound.

To handle a high-priced commodity like tobacco, electronic weighing, analysis and direct control of machines have been developed to hold the quantity used as a filler to within ±1 per cent of a calculated figure. Without equipment of this accuracy, cigarette manufacturers would have to play safe to remain solvent and use less tobacco than now in each cigarette.

Cigarettes are not sold to consumers by weight. Principal governing factors in what the smoker pays are quality of tobacco, and much of it is a blend of U.S. and Rhodesian leaf, and the amount of blended tobacco in each cigarette. Every brand will be priced according to its variation on one or both of these economic dominants.

Processed cigarette tobacco is not the most tractable commodity with which to fill a narrow band of paper at high speed. Most hardy hand-rollers know that shreds tend to tangle or run thin and in fact to be of uneven density along quite a short length of paper. At machine-making speeds where 2,000 cigarettes a minute are cut from a continuous rod several feet long, control of the tobacco filler must be precise and rapid.

British smokers are said to be the world's most difficult to please. Although this selectivity creates problems in the industry, it has forced manufacturers to adopt high standards and the automatic machines reflect these exacting requirements.

Largest builder in the world of production cigarette-making machines is Molins Machine Co. Ltd., Deptford, a company with 50 years of continuous application in this field. More than three-quarters of its production is sustained by export orders.

The latest in the series of its British built automatic machines can be fitted with control equipment which scans continuously the density of tobacco in each cigarette, gives meter indication, expresses digitally the percentage of cigarettes in each of five weight zones, records automatically the percentage of cigarettes in the correct weight sector, and can give pen-recorder traces that enable faulty parts of the machine to be pinpointed with precision.

Cigarette making, like many automatic processes, follows a Gaussian distribution pattern. By recording percentages of cigarettes at five weight levels—extra light, light, correct weight, heavy and extra heavy—machines can be studied to ensure that they are correctly following this pattern.

High-Speed Filling

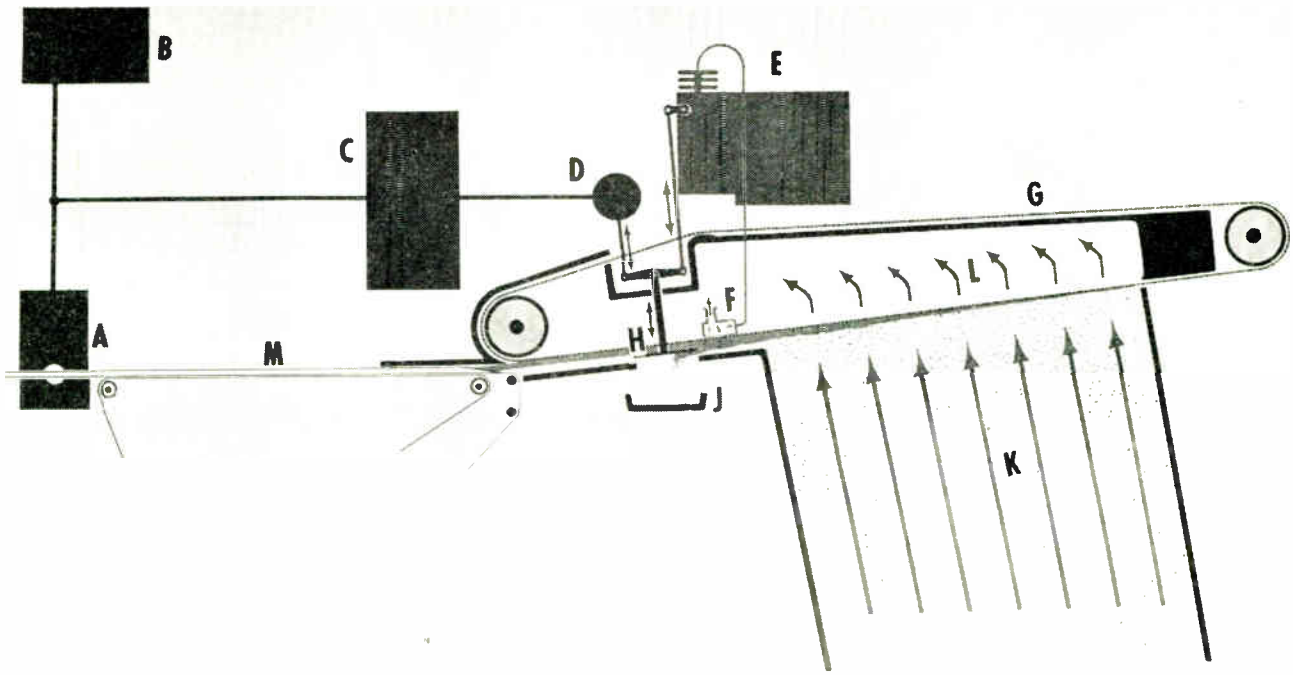
Molins' method of raising processed tobacco from its hopper is by first lifting it mechanically and then blowing it up a flume. Pneumatic lifting restricts the size of tobacco shreds that reach the first stage and tangled or heavy pieces fall into a collecting box. The rest reaching the top of the flume are drawn on to a moving perforated band by air suction. This adhering filler is trimmed to the correct thickness by two rotating discs before being deposited on a continuous band of paper which is then formed and pasted.

The revolving blades are movable and their distance below the belt can be varied automatically to maintain a constant thickness of tobacco for depositing on the paper.

Nucleonic Measuring

Until quite recently machine outputs were checked by weighing sample batches or individual cigarettes by hand. The first test gave an indication of general tendencies towards light or heavy filling and the second could show cyclic variations in the machine. But manual checking has a long response time and requires a comparatively large amount of labour.

The first step towards faster electronic control came with



Tobacco blown up flume (K) adheres to the moving suction band (G). A sensing chamber (F) connected to bellows at (E) detects changes in the thickness of adhering tobacco. At the same time information on the filled rod (M) from beta scanner (A) through electrometer (C) changes to mechanical control at (D) of rotating discs (H). These two sensors give precise and instant control over the position of the discs

the use of nucleonic density measuring equipment. A continuous rod of wrapped tobacco passes through a scanning unit and beta energy pulsed at a rate equal to one cigarette length in the scanning chamber is directed at the rod. The energy is attenuated in direct relation to the amount of tobacco filler under surveillance. Unabsorbed energy passes to an ionization chamber to give an output which is compared with a reference current of opposite polarity.

Any out-of-balance current goes to an electrometer which amplifies the signal and gives a direct indication of light or heavy filling. It also controls the tobacco being hauled up on its first stage from the hopper.

The electrometer also routes a fixed-frequency signal from a 1-kc/s oscillator to drive electro-mechanical counters. These give visual indication of weight percentages in each of the five zones. The normal distribution pattern followed in cigarette making allows for about 66 per cent of them to be very close, within ±2 per cent, of the desired weight; 26 per cent will be just outside this band, about ±3 per cent weight deviation; and the rest will fall into the 'extra', or not greater than 6 per cent weight deviation category. A 6 per cent deviation, incidentally, is not normally detectable by a smoker either by feel or time of smoking.

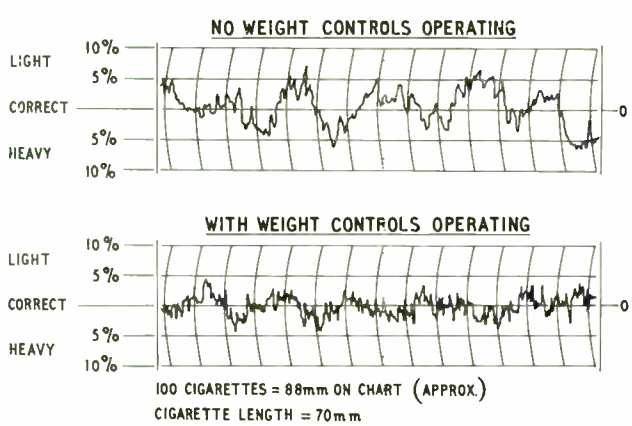


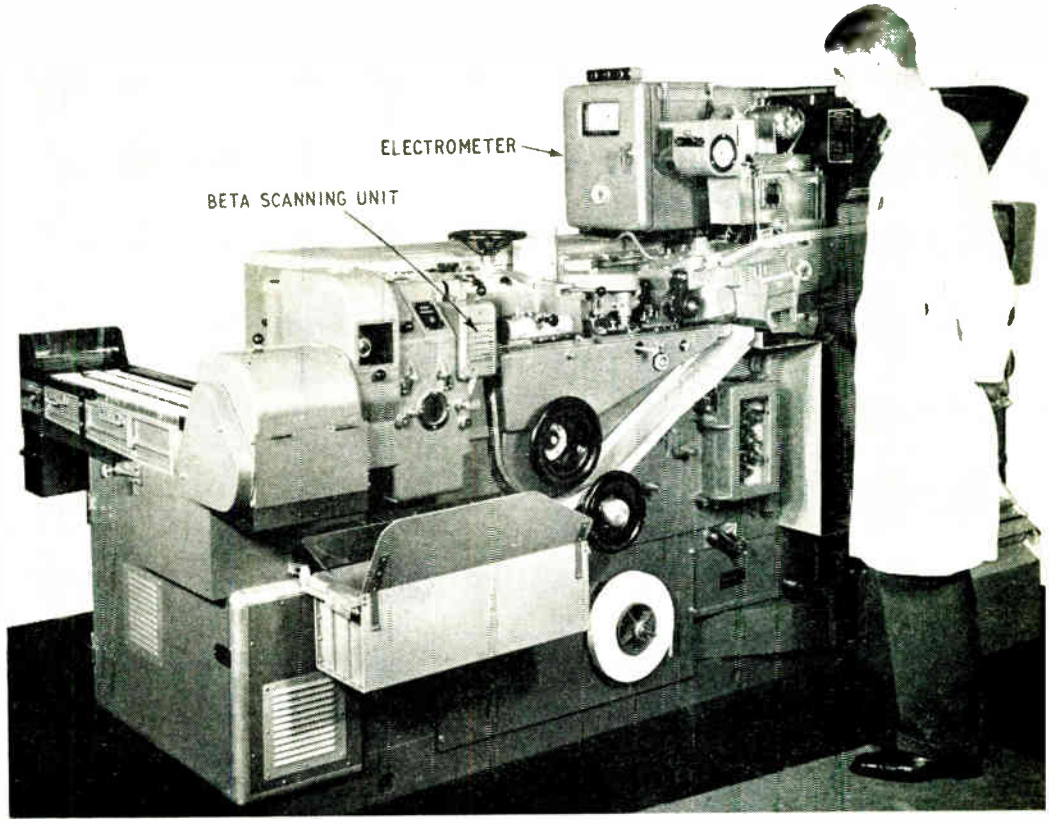
Chart records of cigarette weights with and without the weight controls in operation

Analysing Equipment

When a number of machines are running, it is convenient to take sample checks of each one at regular intervals. A spacing of one or two hours between investigations is acceptable. Large, or sudden changes in the rhythm of production would be noticed by the 'catchers' or machine minders, where a gradual change would not, and it is in this sphere that electronic analysers are required.

A Molins central analyser and logger scans sequentially and automatically 50 machines. After connection to the first, the equipment begins a 100 second study of the continuous rod. This period covers the manufacture of over 3,000 cigarettes. Experience has shown that a sample of at least 1,000 is required to give an accurate indication of random weight variation.

Information from this study appears on counters at the central desk giving percentages in each of the five zones and a print-out is made of cigarettes in the 'correct' category. If, at the end of a run, the percentage in either extreme category exceeds the set limits or the percentage in the correct zone does not reach a set lower limit, the correct category is printed but the machine automatically makes a second analysis. If this confirms the first indication of abnormality, all five categories are printed in red, a warn-



Latest automatic cigarette making machine is a Molins Mk 8. Tobacco filler formed into a paper wrapped rod passes through the beta scanning unit and meter indication is given on the electrometer

ing given, and automatic selection of the next machine continues.

At this point the controller can begin a separate analysis of the faulty machine by switching in one or two chart recorders. One will give a record of the collective weight of batches of 50 cigarettes. A second and high-speed pen recorder supplied by Smiths Industrial Division gives a record of individual weights of each cigarette. Examination of both charts provides a general check on machine performance. The high-speed recorder will indicate cyclic abnormalities which can be related directly to parts of the machine.

In one case on a machine being tested before delivery the analyser print-out showed a steady fall from 80 per cent in the correct zone which was allowed to continue to the unusual level of 39 per cent. When the high-speed pen chart was examined it revealed a period of 5·5 cycles per second. Since at the known operating speed a pulley driving the perforated band was running at 5·5 revolutions a second, this pulley was inspected. A piece of tobacco embedded on its periphery had been forcing the perforated tape against a shoe and caused the tape to slow down once every revolution of the pulley.

Operation

A typical method of operating analysing equipment in production conditions would be:

1. With average correct weight category figures of 66 per cent a low alarm limit is set at 62 per cent. This would give a print-out in red and a particular watch would be kept on the machine but:
2. if a machine shows less than 58 per cent or a left or right deviation from the normal-distribution pattern a run is made with a high-speed pen recorder:
3. if this check shows the machine to be incorrect, the weight category percentages are recorded on a form which is attached to the recorder chart and passed to:
4. the shop foreman who, if he is unable to analyse the cause from the chart, will stop the machine for a detailed examination.

At the moment the record-analyse-correction loop requires human intervention but thinking is now directed towards a fully automatic, self-analysing and correcting circuit. This would be able to adjust for certain standard, known causes of machine deviation.

Analogue Computer Service

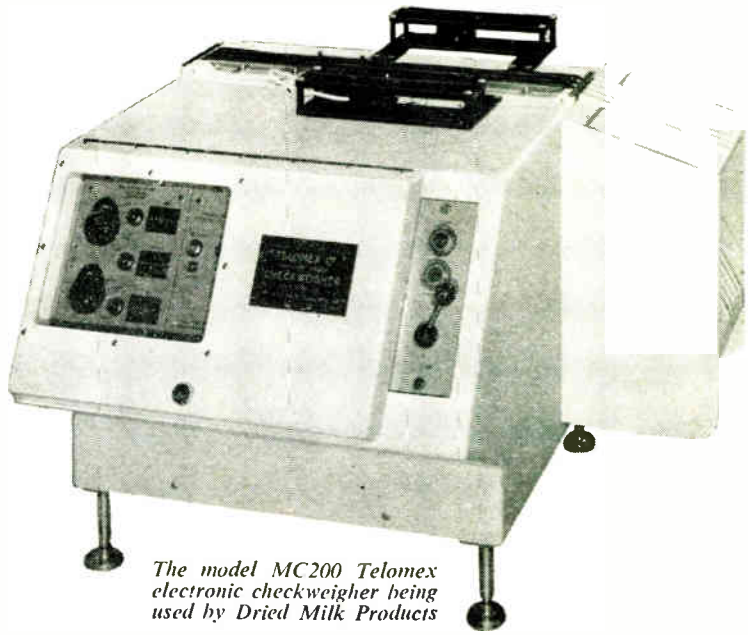
An analogue computer is a first class 'tool' for solving differential equations, particularly those which include non-linearities or discontinuities. One of the main advantages of the analogue method is that it enables the sensitivity to any coefficient to be assessed and so gives the engineer the 'feel' of a problem.

Another firm to offer the advantages of analogue computers to industry is Handley Page. They are offering for hire four Short & Harland general-purpose consoles each capable of containing 18 linear function units and 36 scaling units or other combinations of standard units.

One or more consoles containing standard units may be hired for operation by the hirer at a charge of £15 per day per console. Handley Page staff are available to give advice and, as an additional service, operate the computer and/or provide a consultant service. Reservation may be made by 'phoning Gladstone 8000, ext. 69.

For further information circle 55 on Service Card

PRODUCTION LINE ELECTRONIC CHECKWEIGHERS



The model MC200 Telomex electronic checkweigher being used by Dried Milk Products

THE 1963 Weights and Measures Act and the increasing speed of production lines will undoubtedly encourage manufacturers to study automatic 'continuous flow' checkweighing systems.

One such system, using electronics, has been developed by Telomex Ltd. and installed in many food manufacturing and processing plants, including those producing biscuits, confectionery, soft drinks, cereals and tinned milk puddings. The applications of checkweighers are also rapidly diversifying into engineering, pharmaceutical and other fields.

A typical installation is that at the Carmarthen factory of Dried Milk Products Ltd. Here two electronic checkweighers are in operation. One checks that the correct weight of rice and sugar has been dispensed into cans. The second checks the final weight after milk has been added and cooking has taken place.

Checkweigher Operation

At Dried Milk Products the checkweighers are set to pass all cans reaching the stipulated gross weight and to reject underweight production. Both operate in identical fashion. The cans travel on a nylon belt across the weigh head of the machine. The arrival of a can on the weighing platform is detected by a photoelectric cell, whose output signal brings an electronic servo system into operation. This servo mechanism produces a restoring force sufficient to return the weighing platform to its 'no-load' position. This force is generated by passing a current, controlled by the photocell, through a coil attached to the weighing platform and situated in the field of a permanent magnet. Since the force is directly proportional to the coil current, this current is a direct measure of the weight of the can.

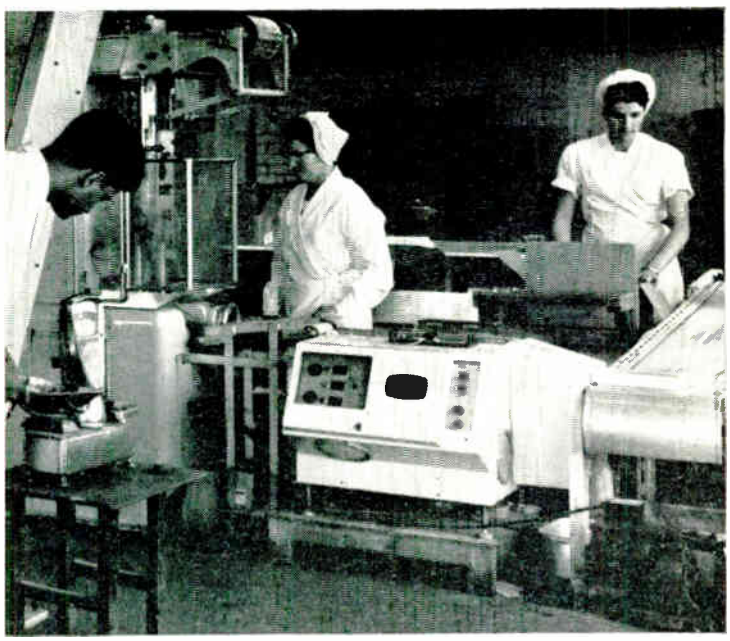
At the same time the magnitude of the coil current is compared in a discriminator circuit with a pre-set reference current, corresponding to the lower weight limit of the cans. If the measuring current is below this pre-set value, a ram is energized and pushes the can off the belt into a 'reject' container. In addition, the number of cans which exceed the minimum required weight of $15\frac{1}{2}$ oz by more than 3 grammes is recorded by the checkweigher.

A further aspect of these checkweighers is the automatic record kept by them of the number of packs handled in all weight categories; i.e. correct-, under- and over-weight.

One model, typical of the range, can check packs of up to 28 oz ± 1 gramme, at speeds of up to 200 per minute.

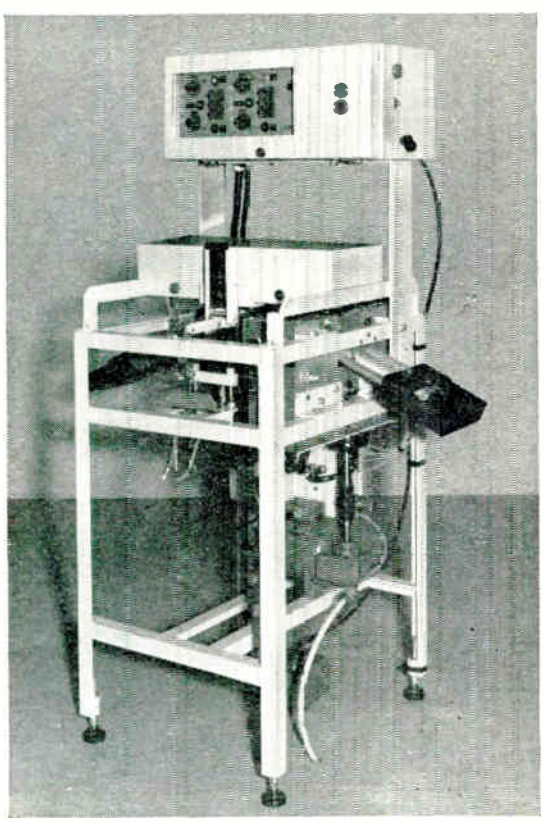
For further information circle 56 on Service Card

Another MC200 in action. At John Mackintosh's confectionery factory at Norwich underweight boxes are pushed to the far side of the belt by a ram. This section is cordoned off and the underweight cartons are made up, reweighed and returned to the production line



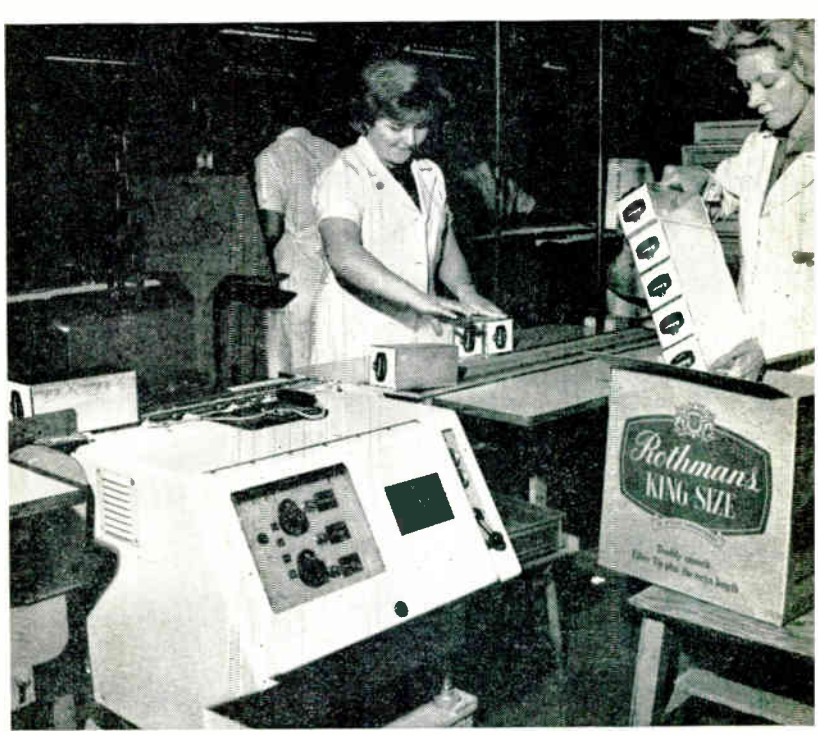
An electronic checkweigher receiving packs of sweets at the Mazawattee Confectionery Co. Ltd., London

High-speed checkweighing of Oxo cubes at Oxo Ltd



This model MX300 can weigh light capsules, tubes and other rounded objects. It can simultaneously grade them into five weight categories at speeds of up to 150/min. Accuracy is ± 0·05 gm in normal cases. Two machines of this type are being used at B.O.C.'s Tottenham-based factory to check and grade 'Sparklets' syphon bulbs

Illustrated here at Carreras Baildon plant is another checkweigher handling cartons of Rothmans King Size cigarettes. It can achieve an accuracy of 0·1 gm at 200 packs per minute



ELECTRONICS AT THE A.S.E.E.

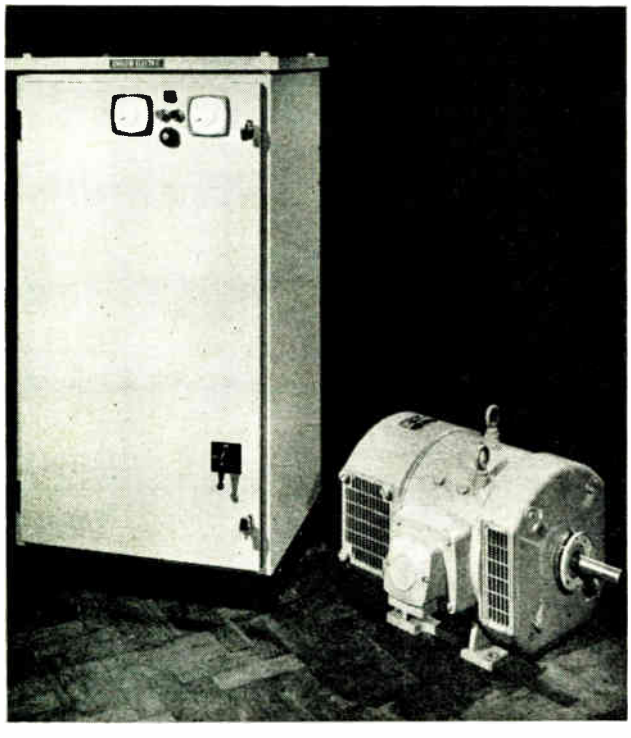
At the twelfth Electrical Engineers (A.S.E.E.) Exhibition, being held at Earls Court from 18th to 25th of this month, a record number of 650 exhibitors are displaying products covering every aspect of the electrical engineering industry in the fields of generation, distribution and utilization of electrical energy.

The last square foot of stand space was sold over three months ago; so great was the demand that areas normally occupied by features or specialized displays arranged by the organizers were released in order to accommodate the maximum number of exhibitors. While the British contribution is in itself a record, in addition, and for the first time, over 73 overseas firms from 17 countries are taking part.

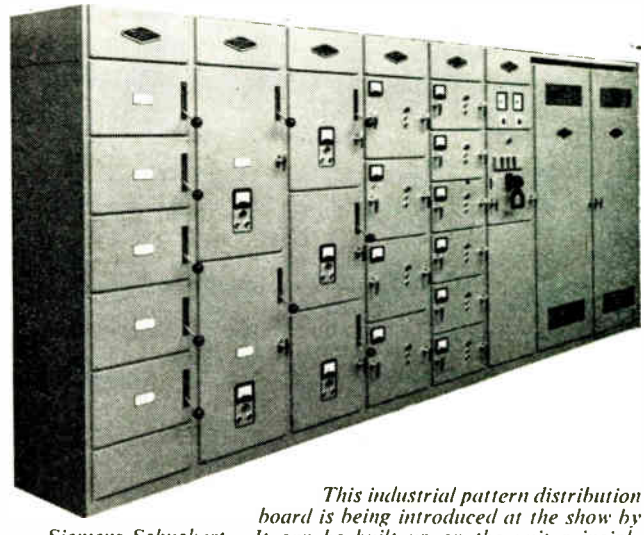
The general flavour of the exhibition is set by the 400-kV transformer, 34 ft high and weighing nearly 10 tons, which stands in the forecourt. But, although generation and distribution must necessarily be the centre of interest for electrical engineers, manufacturers of associated electronic equipment and components are fairly well represented.

English Electric is exhibiting on two stands, and ten divisions of the company are participating. Among new developments from the Control Gear Division are a 20-h.p. 'Unistat' **(57)** variable-speed d.c. drive using thyristors (illustrated) and a 2½-h.p. 'Magamp' **(58)** d.c. motor controller which uses a semiconductor amplifier driving a magnetic amplifier output stage. Also new is a transistorized automatic voltage regulator to replace contact-making regulators in operation with d.c.-excited alternators up to 2 MW. A working demonstration of the latest multi-motor control systems is being shown in conjunction with the Industrial Machines Department.

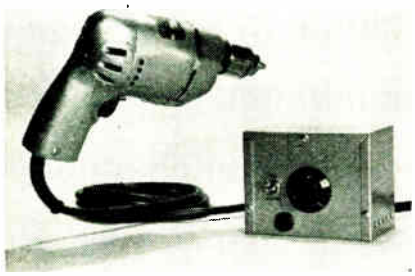
Automatic control equipment is also a major feature of the Laurence, Scott & Electromotors' stand which displays a 16-ft long section of a switchboard for an ash and dust handling plant at Drakelow 'C' power station and a steelworks mill control panel destined for Eastern Europe. A running exhibit demonstrates a comparatively recent development which complements the company's range of a.c. and d.c. variable-speed motor control systems: it takes the form of a 'static' converter, 2,000/200 r.p.m. d.c. motor reversing drive. The motor has a separately excited shunt field and the armature circuit is fed from a full-



The English Electric 'Unistat' 20 h.p- variable-speed d.c. drive



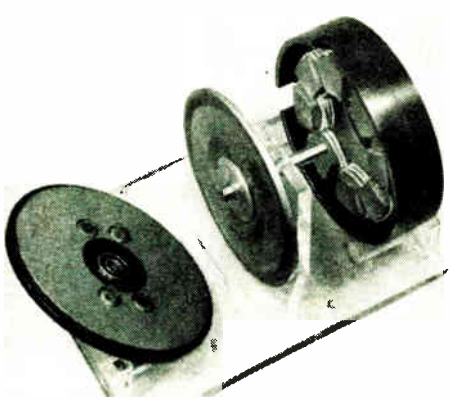
This industrial pattern distribution board is being introduced at the show by Siemens-Schuckert. It can be built up on the unit principle and the iron-clad enclosures can be mounted in a framework for wall or floor fixing **(59)**



Using a thyristor, this Pye 'Smooth-speed' regulator makes it possible to obtain shunt motor characteristics from a series motor (60)

power variable voltage thyristor-control system with dual outputs for reversal, this also providing electrical braking features. A conventional closed-loop automatic speed-control system, utilizing a tachogenerator and stabilized reference arrangement, is included to obtain an accuracy of $\pm\frac{1}{2}\%$ referred to maximum speed.

Pye Printed Motors are showing their range of permanent-magnet printed-circuit d.c. servo motors **(61),** made in this country under licence from S.E.A. of Paris. The disc-shaped p.c. armature (see photograph) contains no iron, resulting in low inertia and negligible inductance. Because of the good dissipative qualities of the armature, very high current pulses may be applied with no limitation of the pulse torque output by magnetic saturation. A separate commutator is



The Pye printed-circuit motor

not used: the brushes bear directly on to the armature conductors. There is no magnetic interaction between the body of the armature and the magnets, and this, together with the large number of conductors, gives a smooth torque down to zero speed with no 'cogging'. Gearless drives are possible, thus eliminating backlash and improving the response rate of the load. The armature has low impedance, making the motor especially suitable for semiconductor circuits.

Prominently featured on the Bakelite stand this year are several new products **(62).** These include two completely new glass-fabric laminates, new copper-clad materials and two new epoxide paper materials. Information sheets and samples of these are available. Bakelite are also showing a recently introduced family of phenoxy moulding compounds and two grades of vulcanizable polyethylene compounds. Among other items of interest are the conventional Bakelite laminates on paper, fabric, wood and asbestos. There is also a selection of exhibits showing copper-clad grades for printed circuits, mouldings produced from phenolic, alkyd, polyethylene and p.v.c. materials, and applications of resins for use in the electrical industry.

B.I.C.C. are displaying a wide range of capacitors, cables and accessories. There are a number of new products, including a miniature, low-capacitance, semi-airspaced r.f. cable **(63)** with p.t.f.e. tubular insulation (see photograph). Capacitance is about 13 pF/ft and maximum attenuation at 200 Mc/s is 6·4 dB/100 ft.

Mullard are showing a comprehensive range of products designed to meet many applications in electrical engineering. Among the semiconductor devices being shown are a range of thyristors **(64)** (silicon controlled rectifiers) operating at currents from 4·7 A to 70 A with peak inverse voltages from 100 V to 700 V, and a range of silicon diodes rated at forward currents of 6 A to 150 A at voltages from 200 V to 1,600 V. Single- and 3-phase rectifier stacks, either in kit form or made to customers' specifications, and the recently introduced h.t. rectifier modules for transmitting and r.f. heating applications are also being shown.

Other Mullard devices on display include gas-filled valves for resistance welding and power control applications. These comprise a range of ignitrons rated up to 2 400 kVA, a range of thyratrons for use with currents up to 25 A and voltages up to 2·5 kV and a range of rectifiers rated at peak inverse voltages up to 21 kV. Working exhibits include a standard single-phase thyristor bridge controlled by a 1 h.p. motor and a thyristor-controlled ignitron operating in a resistance welding equipment.

In addition to a compact 110-V self-contaned switch closing unit, Nife Batteries are introducing two maintenance-free emergency lighting units using sealed nickel-cadmium cells.

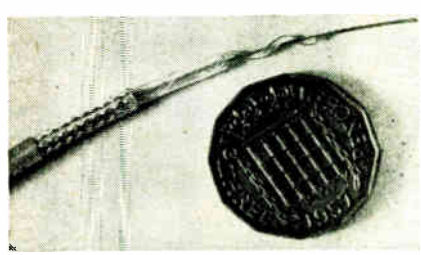
The Nife-lite 305 emergency lighting unit

The Nife-lite 305 (illustrated) is a complete lighting unit, constructed from high-impact plastic, with an automatic charger, an on/off relay and high-efficiency bulbs behind a 'Perspex' dome **(65).** The Nife-lite 1100 is an emergency power pack housed in a small steel cubicle, and includes a transistorized static on/off relay and an automatic charging circuit.

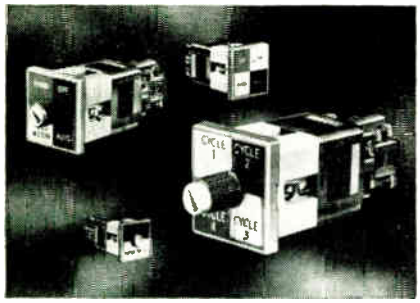
On public exhibition for the first time is the Elliott sequence control system **(66),** designed to provide a flexible method of controlling and co-ordinating a wide range of industrial batch process equipments involving a number of discrete operations in sequence.

Elliott's Trainer and Simulator Division are showing a new range of standard elements which enable the designer to build up a simulator system to a known degree of accuracy and performance, at minimum cost. The elements at present available consist of a servo-electronics board, gearbox, d.c. amplifier board, demodulator board and buffer amplifier board. They originated as part of a simulator requirement, but are equally suitable for a wide range of other applications; e.g. the teaching of servo-system theory.

Since the last A.S.E.E. exhibition Zenith have completely restyled their range of tubular rheostats and a range of 'Zenohm' toroidal rheostats is being shown for the first time **(67).** In these rheostats the brush and collector ring represent an integral component,



B.I.C.C. miniature r.f. cable



Some of the new co-ordinated manual controls being shown by Honeywell Controls. Each of these selector push-button devices can combine, in one compact, oil-tight unit, the functions of: (a) 4 indicator lamps (b) a rotary switch (c) pushbutton switches (d) four legend plates (68)

avoiding metal-to-metal contacts and thus obviating 'scuffing'. Also on display are a dust- and hose-proof 'Variac' and (illustrated) a portable 'Variac' rated at 2·1 kVA and fitted with both an ammeter and a voltmeter.

Static control techniques in action provide a novel and impressive display by Allen West & Co.: messages on a moving carriage across the front of a static switching unit have the various processes of formation and presentation controlled by standard logic modules. Letters stored in a series of hoppers are, by means of a master tape controller, delivered and sequenced to spell out each message. After the message has been transported and displayed at the front of the stand, the letters are automatically sorted back into their respective hoppers by means of photo-electric cells which read the code on the back of each individual letter. The process is then repeated with further messages. Delivery of the letters simulates the operation of a complex blending and sequencing plant, and the later processes demonstrate the transporting and positioning control that is the basis of industrial automation

The Zenith portable Variac

An adjoining panel of the display deals specifically with positioning control, with pushbutton selector switches to give audience participation. The demonstration of rotating positioning control is by digital technique, and of straight-line positioning control by servo and logic techniques to eliminate backlash.

One of the features of the T.C.C. exhibit is the use of capacitors for power factor correction. The demonstration item on show has a lightly loaded motor with appropriate meters showing volts, amps and power factor (which for demonstration purposes is down to 0·5 lagging). A pushbutton switch operated by the public brings into circuit for 30 seconds a capacitor correcting the power factor to 0·95 lagging and indicating a corresponding reduction in kVA.

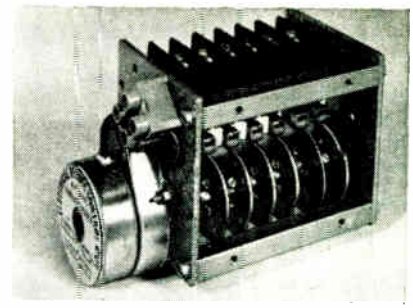
Motor starting capacitors are featured working in various equipments and, in addition, an extensive range of suppressor capacitors is on view. Also displayed are wide ranges of power and high-speed transistors, chokes, coils, fine wires and magnetic cores marketed by T.C.C. for Sprague Electric Co. of America.

Electrical Remote Control are showing both electrical and pneumatic industrial timing and control equipment. The electrically-operated equipment includes the 'Minicycle' **(69)** (illustrated), a compact synchronous cam-operated timer operating up to 50 adjustable timed microswitches in any pre-set sequence. Overall time ranges are from 1 second to 24 hours as required, switching capacity up to 440 V/10 A per switch, and operating voltages 110/230/440 V, 50/60 c/s.

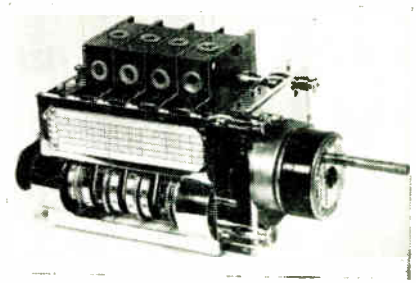
Shown (in the photograph) alongside the Minicycle is an example of all-pneumatic timing equipment in which miniature valves, pneumatic pistons and an air motor are substituted for electrical microswitches, solenoids and synchronous motor; the Elremco 'Airmat' is a sequence timer operating up to 12 or more external pneumatic control circuits, and fitted with a fully-automatic resetting mechanism. The timing accuracy is better than ±1% over air-line pressure variations of up to ±10%.

Printed Circuits Ltd. are displaying for the first time printed potentiometers, resistance units and sealed elements for space heating. Also on show are 'Plasmet' etched wiring circuits, strain gauges, cable forms, and code discs.

Among new instruments exhibited by Avo are the transistorized Multi-



Above: The 'Minicycle' electrical sequence timer Below: The 'Airmat' pneumatic sequence timer



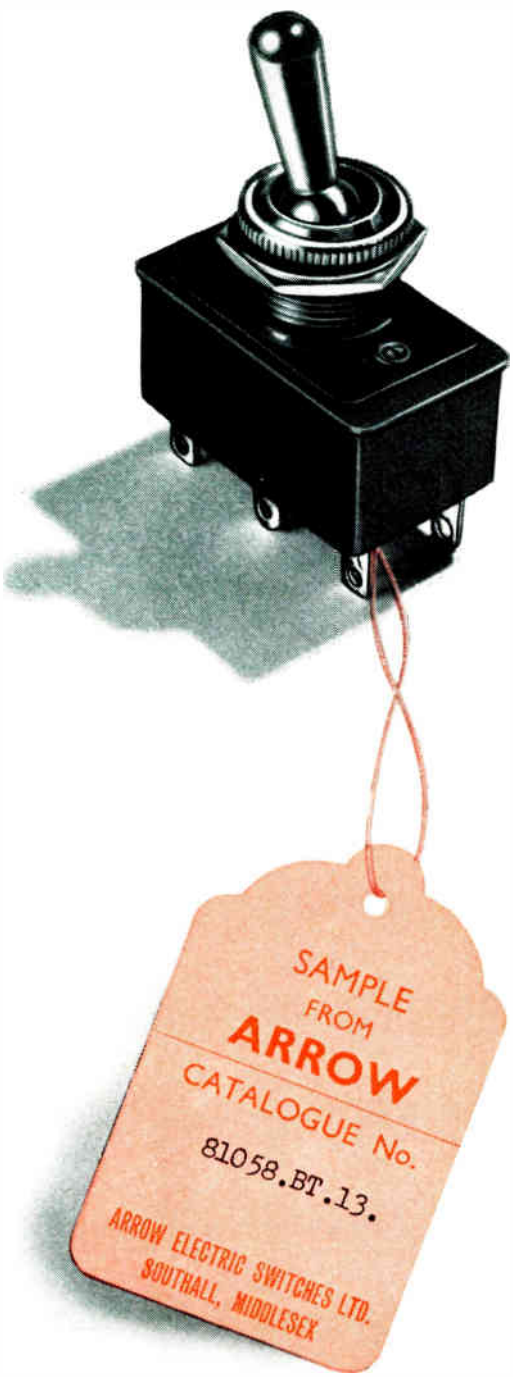
meter type CT.471A, the Precision AvoMeter, the AvoMeter 9 Mk. 2 and the zener diode selector. A comprehensive selection of AvoMeters, valve characteristic meters and transistor analysers is also on display.

Foster Transformers secondary injection testing equipment is being used to demonstrate the testing of over-current relays both with and without a filter unit to ensure a sinusoidal testing current. A model 50-kV impulse generator is shown in operation and another working demonstration is of transductor control as applied to an electric furnace.

The Electronic Apparatus Division of A.E.I. are showing an example of microwave moisture meters. These portable instruments can give quick, accurate readings of moisture content in a wide range of materials, from food to foundry sand. Other products from this division include electronic timing controllers types FU26/A1 and FU27/B **(70),** designed to control timed intervals associated with dust extraction equipment; both are adjustable two-stage timing units. Type FU26 is arranged so that when the fan motor is stopped, the timer is initiated and the several intervals required are accurately timed. The fan motor can then be restarted by the operator. Type FU27 is completely automatic, the accumulated dust being removed at preset intervals.

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

Give it the works!



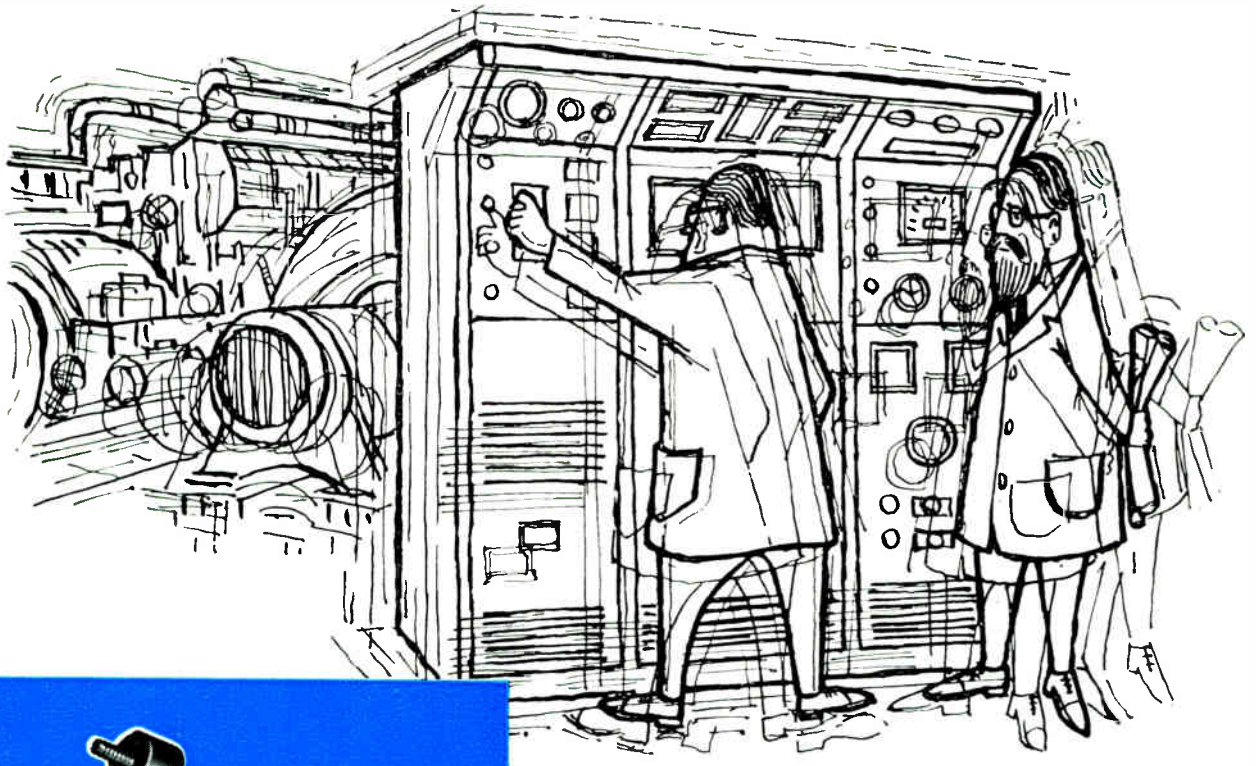
We, at ARROW,
understand the responsibility
which rests on
any Engineer's shoulders whose
job it is to specify switches.
Therefore, knowing
our products as we do,
we welcome every
opportunity to send samples
to be given 'the works',
as we are confident
of the results.
Illustrated is a small switch
specially designed for
instrument applications
where low contact
resistance is essential.
Many circuit arrangements
up to D.P.D.T. are offered.

ARROW
ELECTRIC SWITCHES LTD

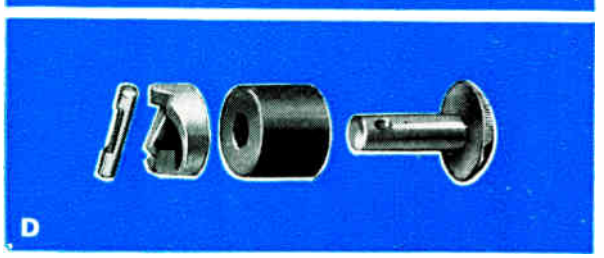
BRENT ROAD · SOUTHALL · MIDDX

Telephone: SOUthall 2442

A50



VIBRATION?



The wide use of electronic equipment in industry, often in close proximity to machinery, presents new vibration problems. Every effort should be made to eliminate the trouble at its source by the use of Silentbloc machinery mountings, bearings and couplings; but local precautions in the electronic apparatus itself are also desirable, and there is an extensive Silentbloc range of devices for this purpose. A few are described here.

A. *Bonded rubber/metal stud mountings for supporting apparatus of light weight. There is a range of sizes of various degrees of stiffness.*

B. *Ring-type resilient mountings giving extra flexibility for shock insulation of sensitive equipment. Available in sizes to suit a great variety of applications.*

C. *Instrument mountings for general service offering good insulation with a useful degree of mechanical stability. Sizes and characteristics for every conceivable purpose.*

D. *'Vibrex" panel fasteners—quick one-hand action, with or without electrical and mechanical insulation between panel and base. Easier to fit than any other panel fastener: simple drilling of panel and base; no screwing, tapping, sweating or brazing.*

MOUNTINGS • BEARINGS • "VIBREX" PANEL FASTENERS

ANTI-VIBRATION DEVICES BY

SILENTBLOC

SILENTBLOC LTD • MANOR ROYAL • CRAWLEY • SUSSEX

Telephone: Crawley 27733 *Telegrams: Silentbloc Crawley*

Andre Rubber Co. Ltd. is another Silentbloc Company

Silentbloc products are also manufactured by Silentbloc (Australia) Pty. Ltd., Melbourne

Broadway/S304

An inclined fluorescent plate within a cathode-ray tube is used to indicate the path of the electron beam. The effects on the beams of electric and magnetic deflection are thus made very clear to students.

Educational Cathode-Ray Tubes

By D. M. SUTHERLAND, B.Sc.*

* Amalgamated Wireless Valve Co. Pty. Ltd., Australia.

IN the classical experiments of Crookes and others at the end of the last century, the electron flying through the nearly empty gas-discharge tube was detected by its visible effects, the shadow of the Maltese cross on the wall of the tube, for example, so well known to students of physics. To this day such gas-discharge tube demonstrations are used in teaching. The tube described here follows this lead; but differs in that by a known artifice (e.g. Allard and Clayson, 1952) a beam of electrons is made to appear visible along its whole length, and not merely when it strikes a target at the end of its path.

Suppose we imagine a thin strip beam AB of electrons moving through a region of uniform potential (Fig. 1). If a phosphor-coated plate CD at this potential is held obliquely across the beam a strip of phosphor will be excited that virtually gives us a visible sectioning of the beam.

The strip beam may now be bent and focused, and the trace on the display electrode CD will, to all intents and purposes, behave like a visible electron beam. Manipulation of the beam can be done easily with applied magnetic fields; but it is also possible, in spite of the complicating presence of the display electrode, to produce electrostatic deflection, and to illustrate the action of an electrostatic electron lens.

Demonstration Tube

One tube for carrying this out will be described. The essential structure of this tube is sketched in Fig. 2.

A slightly converging strip electron beam is produced by a simple two-electrode gun of the Pierce type (Pierce, 1940). A long indirectly-heated receiving-valve cathode is mounted directly on to the beam-forming electrode, which is slotted, so that the electron beam passes through the corresponding slot in the anode. This method of fixing the cathode is thermally poor, but simple and robust, and the gun very easily supplies the beam current required. The open structure of the Pierce gun is an advantage in an educational tube. No great care was taken to find the proper electrode shapes (the anode is, in fact, plane) as it is only necessary to secure a reasonably thin beam carrying a few milliamperes.

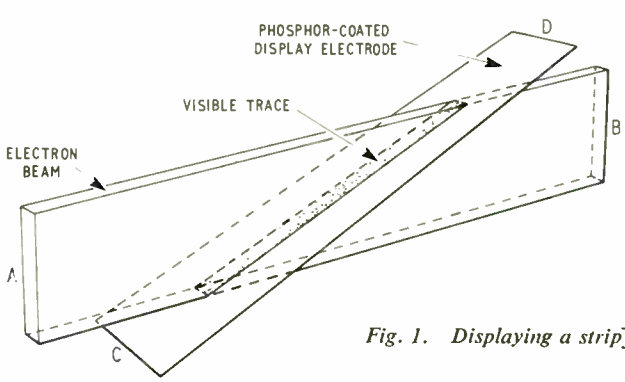


Fig. 1. Displaying a strip electron beam

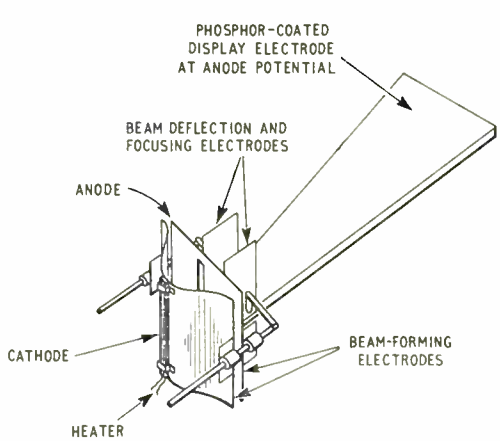


Fig. 2. The AV43 demonstration cathode-ray tube

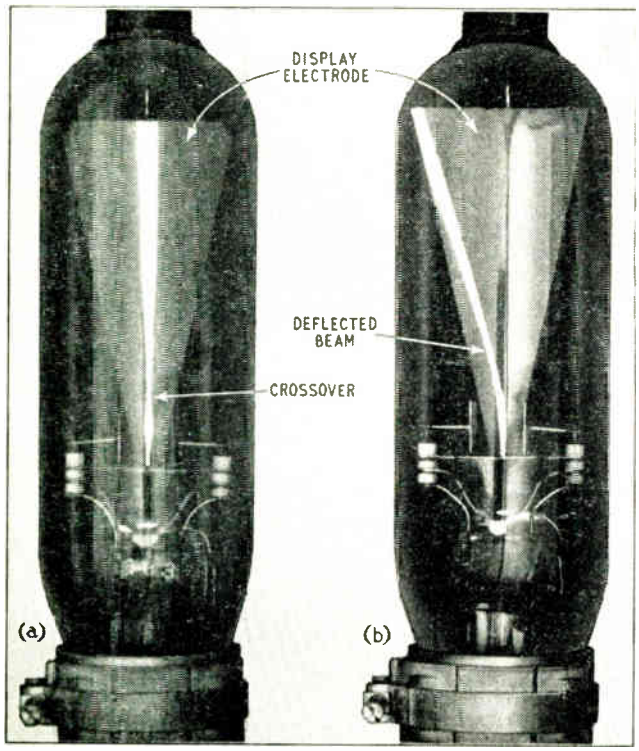
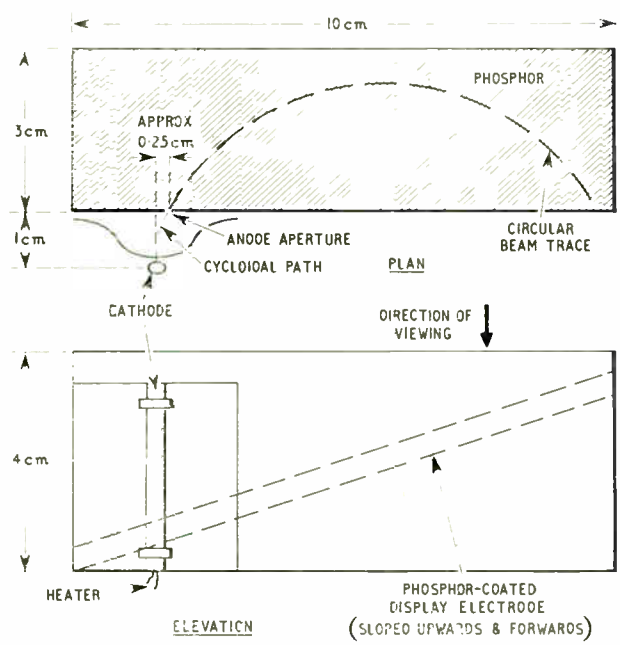


Fig. 3. Photographs of the beam trace; (a) shows a cross-over in the beam and (b) a deflected beam

A display electrode coated with willemite is attached to the anode and arranged obliquely so as to cut the beam; and two deflecting-focusing plates are mounted as shown on separate insulating supports. Willemite is a sensitive phosphor, and a brightness of the order of 30 foot-lamberts from the illuminated strip is easily obtained with a few milliamperes at 200 volts. This brightness is adequate for demonstration before a class in daylight.

Fig. 4. Tube for e/m measurement



The whole assembly is mounted in orthodox fashion in a medium-size transmitting-valve bulb and processing is generally straightforward.

If now the heater is switched on and, when the oxide cathode has reached correct temperature, a voltage of about 200 is applied across the gun, a bright strip immediately shows along the display electrode where it is under bombardment. Viewed from roughly at right angles to the display electrode it is easy to imagine that an illuminated electrode beam is being viewed directly. Fig. 3 shows two photographs of the beam. If the deflecting plates are tied together and their voltage with respect to the anode lowered, the electron lens system resulting can focus the beam to form a cross-over as in Fig. 3 (a); and a voltage difference across the deflecting plates will produce a bent beam as in (b). The beam can also show deflection by a magnetic field, using either a coil or permanent magnet held outside the bulb.

Early experience with the tube indicated that steadier results were obtained if alternating voltages were used across the gun and deflecting plates. When d.c. is used, charge build-up on bulb walls and phosphor can interfere with the display. Presumably such charges have time to leak away during the off part of the a.c. cycle. No phasing difficulties were encountered when using a 50-c/s supply for both anode and deflecting plates. There is very slight blurring when a bar magnet is used to deflect the beam; but electrostatic operation is not affected, as electron paths depend on voltage ratios only.

Possibility of Quantitative Experiments

The simple tube described above works so well that it is of some interest to enquire whether or not devices using a similar display system could be developed for the purpose of carrying out *quantitative* experiments with an electron beam.

Three possibilities will be examined. The possibilities are (a) of displaying a circular path in a constant magnetic field, with an associated e/m measurement, (b) of a quantitative beam deflection measurement, and (c) of studying the action of an electron lens.

An e/m Experiment

The aim here is to show a beam of electrons at constant speed moving in a circular path in a constant magnetic field. This offers no difficulty in principle with a tube constructed as in Fig. 4.

In this tube a simple Pierce gun of the kind described above is mounted on the side of a box-like metal anode of which the top is open and the bottom is formed by the properly-sloped phosphor-coated display electrode. The gun provides a strip beam of electrons, and with the whole device immersed in a magnetic field of the correct orientation the beam enters the box through the offset anode aperture and produces a circular trace which is viewed through the open end of the box. It is necessary to offset the anode aperture and to adjust the shaping of the beam-forming electrode slightly to allow for the displacement of the beam in its cycloidal path from cathode to anode.

This tube is for operation with direct voltages and constant fields, and the box is intended to provide a measure of shielding against bulb charge formation. It is necessary to use a thin phosphor coating and to process carefully so that non-conducting films are not formed on various parts of the tube.

With a magnetic field of about 16 oersteds, and 200 volts between cathode and anode, a circular trace is observed with a radius of approximately 3 cm. The radius is found by observing the height and chord of the arc and perform-

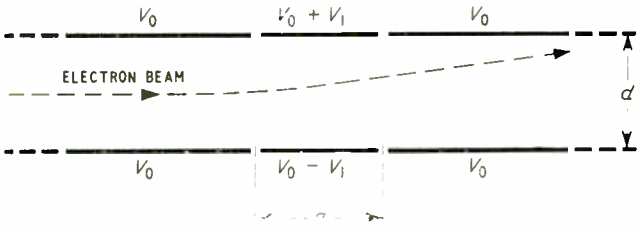


Fig. 5. Parallel-plate deflecting system

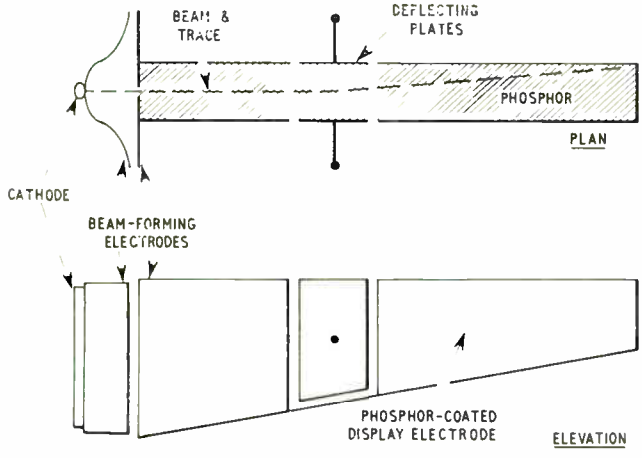


Fig. 6. Tube for quantitative demonstration of electrostatic deflection

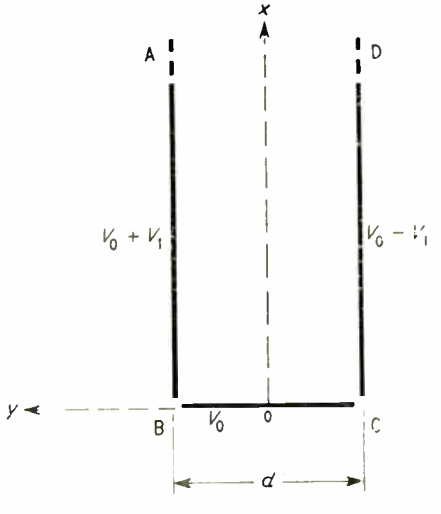
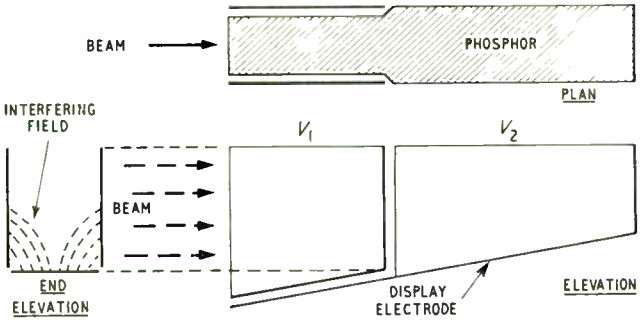


Fig. 7. End-on section through the deflecting plates

Fig. 8. Electrostatic lens system



ing a simple calculation. A determination of the ratio of electron charge to mass follows from these three values.

The magnetic field is produced most simply by a bundle of, for example, 100 turns of 22 s.w.g. copper wire, made into a simple coil 10 cm in radius, and carrying approximately 3 amps. This coil can be split to form a yoke around the display tube.

Electrostatic Deflection

The formula for electrostatic deflection usually quoted is

$$\text{Angle of deflection} = V_d a/(2V_0 d)$$

where a total deflecting voltage V_d is applied across parallel plates of width a, and distance d apart. V_0 is the average potential of the deflecting plates, the electrons being assumed to start from a cathode at zero potential. The formula is calculated assuming that fringe fields do not exist and that a uniform transverse electric field V_d/d exists along the distance a.

It is not generally realized that this formula becomes exact (for small deflections) in a system in which the deflecting plates are enclosed by guard sections as shown in Fig. 5. We can therefore use this system of plates as the basis of a display tube for a quantitative demonstration of electrostatic deflection.

A display electrode and an electron gun are provided as shown in Fig. 6.

The parallel plates and the display electrode form a deep box with an open top through which the trace of the beam is observed. With the cathode at zero volts, the guard sections and the display electrode are maintained at the maximum positive voltage V_0 and the deflecting plates are at $V_0 \pm V_1$ volts, where the deflecting voltage V_1 is a few per cent of V_0.

The question now is: how much does the display electrode interfere with the action of the deflection plates?

We are dealing with a three-dimensional system, and although solutions of Laplace's equation can be found for such systems, they are very long winded indeed, and it will be better for our purpose to adhere to two-dimensional analysis where possible. Suppose we take a vertical end-on section through the deflecting plates. This gives a figure ABCD (Fig. 7) which is treated as a section of a two-dimensional system, with voltages applied as shown. A straightforward analysis gives the deflecting electric field $(-\partial V/\partial y)$ along the axis $x = 0$, as $(2V_1/d)\tanh(\pi x/d)$. The first part of this expression, $2V_1/d$, is, of course, the electric field well inside the parallel plates, while the factor $\tanh(\pi x/d)$ describes the edge effect due to the presence of the display electrode BC at zero voltage. Since $\tanh(\pi x/d)$ rapidly approaches unity with increasing x (in fact, for $x = d$, $\tanh(\pi x/d) = \tanh \pi = 0{\cdot}996$) we can say that a distance of the order d away from the display electrode, the effect of this electrode can be neglected with error less than $\frac{1}{2}\%$.

Returning now to Fig. 6, we see that if the measurement of deflection is made sufficiently far along the display electrode so that the effective part of the beam is about a distance d or more above the display electrode as it passes through the deflecting plates, then the measured deflection will be in accord with the simple formula:

$$V_1 a/(V_0 d) \quad \text{or} \quad V_d a/(2V_0 d).$$

As a final point, we note that the structure must be deep enough so that fringe effects at the *top* will not weaken the deflection. By using the well-known calculation for the fringe field around the edges of a parallel-plate capacitor (e.g., Jeans, page 271) it is very easy to show by a simple numerical calculation that at a distance d or greater inside

the plates, the edge effect disappears to within a fraction of 1 per cent. Thus we must control the geometry of the tube so that the top part of the beam does not strike the display electrode.

We can, therefore, conclude that it is possible to construct a display tube which will give a reasonably exact demonstration of the formula $V_1 a/(V_0 d)$ for electrostatic deflection.

Two-Dimensional Electrostatic Lens Action

Although lens action can be qualitatively demonstrated with the simple tube described at the beginning of this article, it is found on examination that it is not possible to demonstrate lens action quantitatively with any straightforward structure using an oblique display electrode. It is not possible to do so in a fashion permitting direct comparison of measurement and theory, while at the same time retaining the idea of a visible trace which displays the behaviour of the beam along the whole of its path. This is because, in this case, the display electrode interferes actively. An example will make this clear. Suppose we seek to display the lens action of the slots in such a structure as shown in Fig. 8.

There is a substantial difference of voltage between V_1 and V_2 (which is necessary to secure a satisfactory degree of convergence). In this case the display electrode is connected to the second pair of plates. Although by means of similar arguments to those already used we can show that the beam can be brought to a focus at some point along the display electrode without interference from the display electrode, unfortunately the field between this electrode and the first pair of plates interferes with the *shape* of the trace at intermediate points, and quite spoils the illustrative effect sought. Without labouring the point it can be said that with the high voltage differences required to produce marked lens action there is just no voltage at which the display electrode can be maintained without interfering with the appearance of the trace in such a way as to spoil the demonstration.

We can conclude that a more sophisticated system is required than a single oblique conducting display electrode in order to demonstrate satisfactorily the path of a beam through an electrostatic lens. The same trouble is not, of course, experienced with a magnetic lens (Allard and Clayson: loc. cit.).

Acknowledgments

Thanks are due to Amalgamated Wireless Valve Co. Pty. Ltd. for permission to publish this paper.

References

Allard and Clayson, *Journ. Sci. Insts.* Vol. 29, pp. 377–8, 1952.

Jeans, 'Electricity and Magnetism' (Cambridge 1927, Fifth Edition).

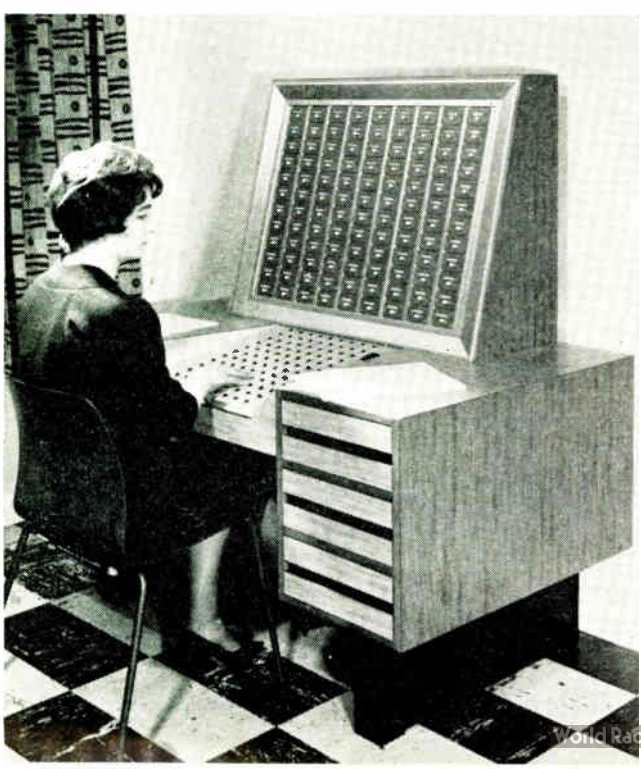
Pierce, *Journ. Appl. Physics*, Vol. 11, p. 548, 1940.

Low-Cost Statistical Analysers

To fill the gap between paper and pencil and complex data-handling systems for statistical analysis, English Numbering Machines have developed a range of analysers using electromechanical counters.

The latest and yet one of the simplest to be made is now installed at the World Record Club. This comprises 108 six-digit electromechanical counters, 108 associated press-button switches and a mains power supply to provide 24 V d.c. to the counters. By depressing a switch-button one digit is clocked-up on the appropriate counter.

The 108-channel statistical analyser



World Record Club are to use this to provide statistics for sales analysis. Each counter and button combination is coded with the number of a current record. A sales clerk records the fact that a particular record has been ordered by pressing one of the buttons. This adds a further one to the existing total.

Total quantities ordered for each record are available at any time throughout the day. At the end of a pre-set period the counters can be individually returned to zero with a reset button.

A second and more complex analyser that is finding application in laundries is one of the Series 488 units. This is a 20-channel analyser with a built-in pulse generator. Where quantities from one to twenty are to be entered, the pulse generator provides signals which cause the selected register to count at a controllable rate. The counting continues while the appropriate button is pressed.

For entering quantities up to 999, a quantity selection keyboard is added. The desired quantity is selected by numbered push-buttons before entering into the appropriate register. All registers are individually resettable to zero and add and subtract and print-out facilities are provided.

The units are being used in stock control, production control and quantitative fields.

For further information circle 71 on Service Card

PROPORTIONAL TEMPERATURE CONTROL

SINGLE TERM.
Second and third term on application.

RANGE. —200°C to + 1770°C., using I/C., Pt/Pt 10 & 13% Rh., C/A Thermocouples & Platinum Resistance Thermometer bulb.

OUTPUT ± 5 mA into 1500 ohms.

SETTING ACCURACY. 0.1% of range i.e. 10 MICRO Volts, better setting on application.

CONTROL ACCURACY.
± 0.05% possible.

LONG TERM STABILITY. 0.05% over 1000 hrs.

RELIABILITY. The design is based on magnetic amplifier techniques and there are therefore no moving or thermionic parts in the control circuits.

QUICK DELIVERY.
2-3 weeks on standard ranges.

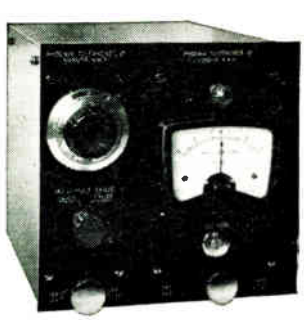
PRICE. Single term, 0–820° C/A, output ± 5 mA into 1500 ohms.

Inset below shows controller consisting of CORREX Input Unit type T 5000 & Pre-amplifier type T 5100.

Price Complete £67.10.0.

COMPLETE PROPORTIONAL CONTROL SCHEMES UP TO 180 kVA USING ALL TYPES OF TRANSDUCER.
(PRICE & DELIVERY on application)

CORREX



MODULAR EQUIPMENT

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

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

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

PROPORTIONAL CONTROLLERS
MAGNETIC INSTRUMENT AMPLIFIERS
MAGNETIC AMPLIFIER DRIVER STAGES
TRIP AMPLIFIERS (MAGNETIC)
SATURABLE REACTORS in a wide range UP TO 180 KVA.
TRANSFORMERS

Other specialised control equipment for all purposes.

PHOENIX TELEPHONES LIMITED
GROVE PARK, LONDON, N.W.9
Telephone COLindale 7243 Telegrams PHONOFENIX LONDON NW9

A.I.D. & C.E.G.B. Approved

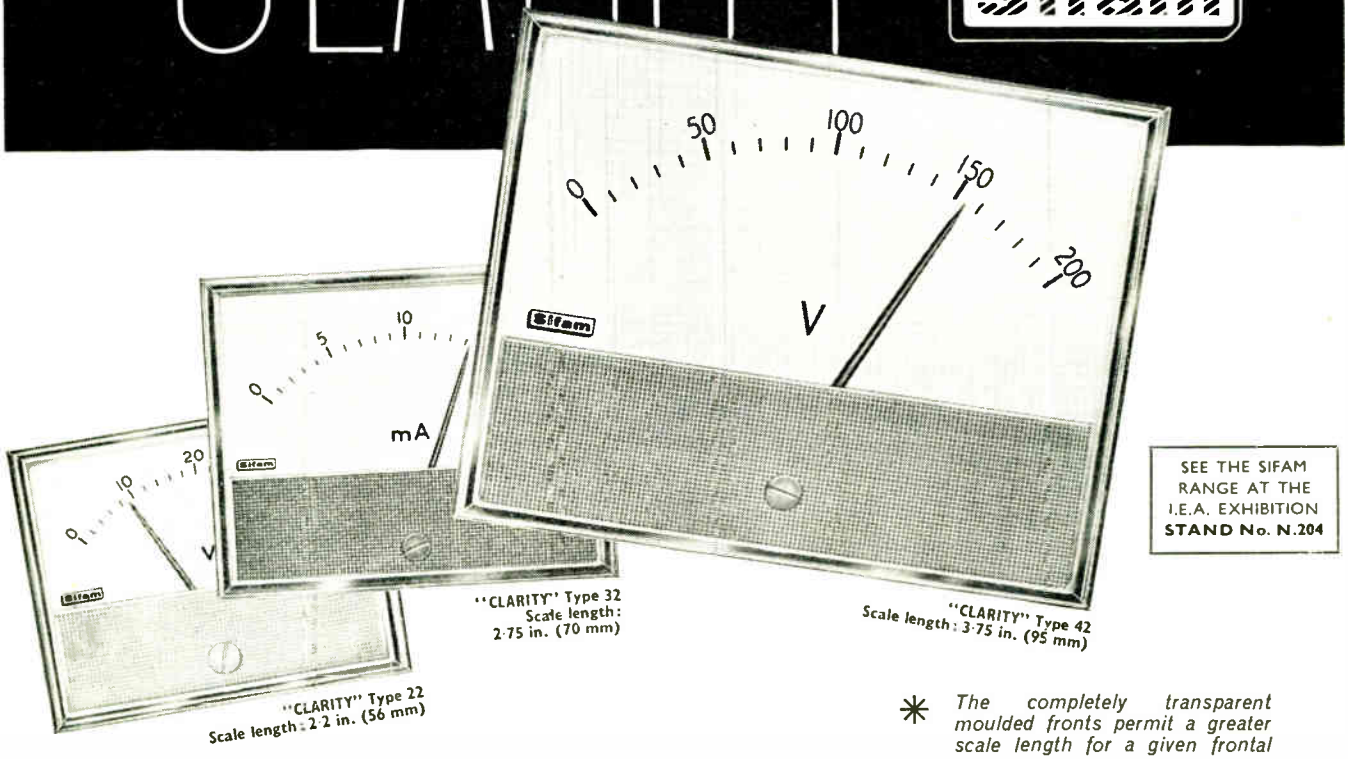
Setting new standards

for instrument presentation . . .

CLARITY

A NEW RANGE WITH A NEW LOOK FROM

Sifam



"CLARITY" Type 22
Scale length: 2·2 in. (56 mm)

"CLARITY" Type 32
Scale length:
2·75 in. (70 mm)

"CLARITY" Type 42
Scale length: 3·75 in. (95 mm)

SEE THE SIFAM RANGE AT THE I.E.A. EXHIBITION
STAND No. N.204

The new **SIFAM "CLARITY"** instruments are the result of a long period of development, for which the name **"CLARITY"** was chosen at the beginning of the programme as best expressing the most striking features of instruments designed to fulfil the demand for clean, modern and functional presentation. Designers will find the **"CLARITY"** range completely satisfactory for use in equipment following the contemporary approach to styling – particularly when considering ergonomic factors.
Scale arcs or markings can be supplied in accordance with the new British Standard recommendations or to individual requirements.

- *The completely transparent moulded fronts permit a greater scale length for a given frontal area.*
- *The lance type pointer is readily visible when the instrument is read at a distance, whilst its fine point allows accurate reading of indicated values.*
- *Interchangeable masks are available in a choice of contemporary colours to blend with customers' equipment.*
- *Elimination of solid surround provides both greater clarity and readability.*

Sifam Instruments

Let us arrange for a Sifam Technical Representative to show you the new "CLARITY" range or write for the new Data Sheet 106IC.

SIFAM ELECTRICAL INSTRUMENT CO. LTD. Woodland Road, Torquay, Devon
Telephone: Torquay 63822/3/4

HIGH RESOLUTION C.R.T.

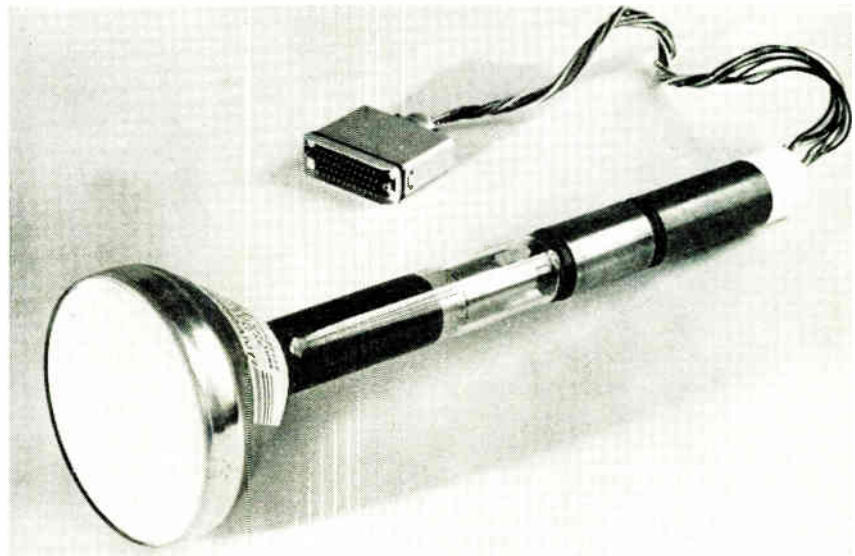


Fig. 1. The five-inch version of the Ferranti high-resolution c.r.t.

FERRANTI have developed a high-resolution cathode-ray tube which combines electrostatic focusing and low-power magnetic focusing. At 60% modulation the two c.r.ts now available (5in. type 5E/12 and 3-in. type 3C/12) achieve a minimum spatial frequency response resolution of 150 cycles/cm which is equivalent to 0·00085 in. However, tubes at present under development have achieved a spatial frequency response resolution of 200 cycles/cm (equivalent to 0·00065 in.).

High resolution c.r.ts have in the past employed relatively high-power magnetic-focusing coil assemblies which required bulky supporting equipment, and this, of course, resulted in a considerable overall power consumption. Both of these factors were further amplified by the necessity for c.r.t. final anode voltage regulation to be within ±0·1%. The new series of c.r.ts has been developed to meet a requirement for a high-resolution tube which is capable of operation in conjunction with semiconductor equipment, and which does not require bulky, complex and costly supporting circuits.

Electrostatic lenses have not previously been considered suitable for high-resolution tubes since past designs introduced an unacceptable degree of astigmatism, coma and spherical aberration. Research at the Ferranti Cathode-Ray Tube Laboratories, however, has resulted in a large electrostatic lens which, operated at cathode potential, acts as the primary lens and introduces only very little spherical aberration and astigmatism; the astigmatism is further reduced by very small correction coils mounted on the neck of the tube. Another important feature of the lens is that it permits e.h.t. variations of up to 2% without any important deterioration in focus. As it is difficult and uneconomic to produce an electrostatic lens which has an exact specified focal length, a small low-power electromagnetic lens is employed as a secondary or trimming lens.

At zero potential with respect to the cathode, the electrostatic lens is designed to have a focal length such that the focus of the electron beam occurs at a point beyond the screen of the tube. The target during manufacture of the electrostatic lens is that the distance between the focal point of the electrostatic lens and the screen of the tube should correspond to the effect of a power of 30 mA at 10 V in the coils of the electromagnetic lens. The maximum power requirement for these coils is 60 mA at 20 V. Exact focus is obtained by adjusting a resistor connected in series with the coils.

The tubes of the new series are flat faced, so a set of dynamic focusing coils is necessary if the application requires that exact focus should be maintained at the extremities of the screen. If these coils are used, they are mounted in the same assembly as the electromagnetic coils used for the adjustable trimming lens. A diagram showing the principal components and their layout is given in Fig. 2.

Coma distortion caused by misalignment of the electron

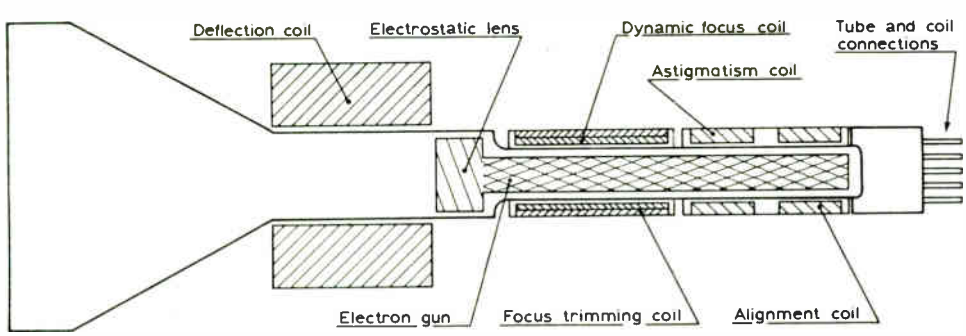


Fig. 2. Component layout of the new c.r.t.

beam with the electron lens is corrected by a set of alignment coils which, together with the astigmatism coils, form one assembly mounted over the electron gun just forward of the encapsulated pin connections. The small coil assemblies are mounted over the narrow section rear part of the gun (Fig. 2), and are designed to have an external diameter which allows a standard size deflection-coil assembly to be passed over them. The small coil assemblies may therefore be accurately positioned during test before leaving the factory; this saves the customer setting-up time when the tube is installed.

It is not always essential to use an electromagnetic focus coil in order to achieve the high resolution of this tube. If a potential capable of being varied between +300 V and −300 V is available in the associated equipment, this may be applied to the electrostatic lens of a slightly redesigned tube (via a pin connection) and adjusted so that the electron beam is focused on to the screen.

Ferranti high-resolution cathode-ray tubes of this type are to be incorporated in the recently announced transistorized radar simulators which are to be supplied to the Royal Navy and the Royal Air Force by Solartron. The tubes will also be featured in a complex high-performance airborne military radar. It is anticipated that they will find particular application in V.T.O.L. and high performance aircraft because of the saving in weight and size of the associated equipment.

Electrode ratings of the new tube are: maximum anode voltage 20 kV, maximum second anode (electrostatic lens) voltage 500 V, nominal grid voltage for visual cut-off $V_a/300$. Heater voltage is 6·3 V (heater positive or negative), maximum resistance of the dynamic focus coils is 50 Ω. Deflection is ±20° (3-in. tube) and ±30° (5-in. tube).

The tubes may be supplied with the screen thickness optimized for either 7 kV (type 1) or 15 kV (type 2) operation. A choice of four types of fluorescent coatings is also available; blue/green (type A), blue (type P), blue/violet (type Q), and blue-violet (type Q4). Type A has a persistence time of less than 1 μsec, type P is approximately 10 μsec, type Q is approximately 0·1 μsec, and type Q4 is approximately 0·2 μsec. The choices of phosphor, tube size and the inclusion of a magnetic-focusing coil result in eight basic versions.

For further information circle 72 on Service Card

Remote Control by Telephone

G.E.C. (Electronics) have introduced an automatic answering unit for use in conjunction with their range of Teledata frequency multiplex equipment.

With these units engineers can control and supervise remote plant, such as isolated and unmanned oil, gas, water or sewage pipeline pumping stations, by telephone over normal G.P.O. exchange lines. The same equipment can be used to obtain information on the operating state of the remote plant.

The first of a number of such systems (illustrated) has been installed in England on behalf of Shellmex and B.P. Pipelines Department to operate motorized valves at isolated points along an oil pipeline. Hitherto, staff have had to travel long distances daily to adjust the valves by hand; adjustments can now be made for the cost of a telephone call and emergency action can be taken within seconds.

An automatic answering unit used in conjunction with G.E.C. Teledata equipment to operate motorized valves at isolated points along an oil pipeline

Normally up to 10 supervisory channels are offered, but, by time-sharing, upwards of 50 channels can be provided. Installation of the equipment does not interfere with the normal use of the telephone at the distant station. To control or interrogate a remote station, the engineer dials the appropriate telephone number. After a ringing period of 10 seconds, the remote station announces its identity by means of a message recorded on a magnetic drum. The engineer then transmits a 'hold' signal to maintain the link, and the condition (on/off; open/shut) of the valves at the station is automatically indicated to the control centre. Changes in the station's condition are brought about by operating a control key and automatic confirmation is given when the required changes have been completed. The circuit is then cleared by releasing the 'hold' key.

The system is safeguarded against unauthorized operation by spurious signals. If the station is interrogated in error, it will announce its identity, but will clear the line if the 'hold' signal is not transmitted. A built-in sealed battery ensures 'fail-safe' operation. In the event of failure of mains supply to the station all functional relays are held at their latest settings until power is restored. The equipment operates in ambient temperatures of from −20 to +70 °C.

A unit form of construction is used so that a wide range of industrial applications can be met by the basic equipment. Other obvious applications are the remote control of electricity sub-station circuit breakers and transformer tappings and the start-up of remote emergency stand-by plant. Remote control of radio transmitters is also possible, including frequency changing and aerial switching.

For further information circle 73 on Service Card

. . . AIMING AT THE ULTIMATE IN RESISTOR TECHNOLOGY

. . . And Now
nearest to the ultimate for

MOULDED
HIGH STABILITY CARBON RESISTORS

TYPE, STYLE, RATING, OHMIC RANGE AND TOLERANCE

WELWYN TYPE	R.C.S.C. STYLE	WATTS RATING @ 70°C	MAX. VOLTAGE	N.A.T.O. STYLE	WATTS RATING @ 70 C	MAX. VOLTAGE	MIL. R. REF.	WATTS RATING @ 70 C	MAX. VOLTAGE	OHMIC RANGE @ 1", 2" & 5"
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

C85

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%	

For 10,000 hours full-load operation at 70°C, the typical change of Welwyn Moulded Insulated High Stability Carbon Resistors is:—

LOW VALUES	0.5%
MEDIUM VALUES	1.0%
HIGH VALUES	2.0%

TEMPERATURE COEFFICIENT:
In the general range of—0·025% per °C

C85

WRITE NOW FOR FULL DETAILS

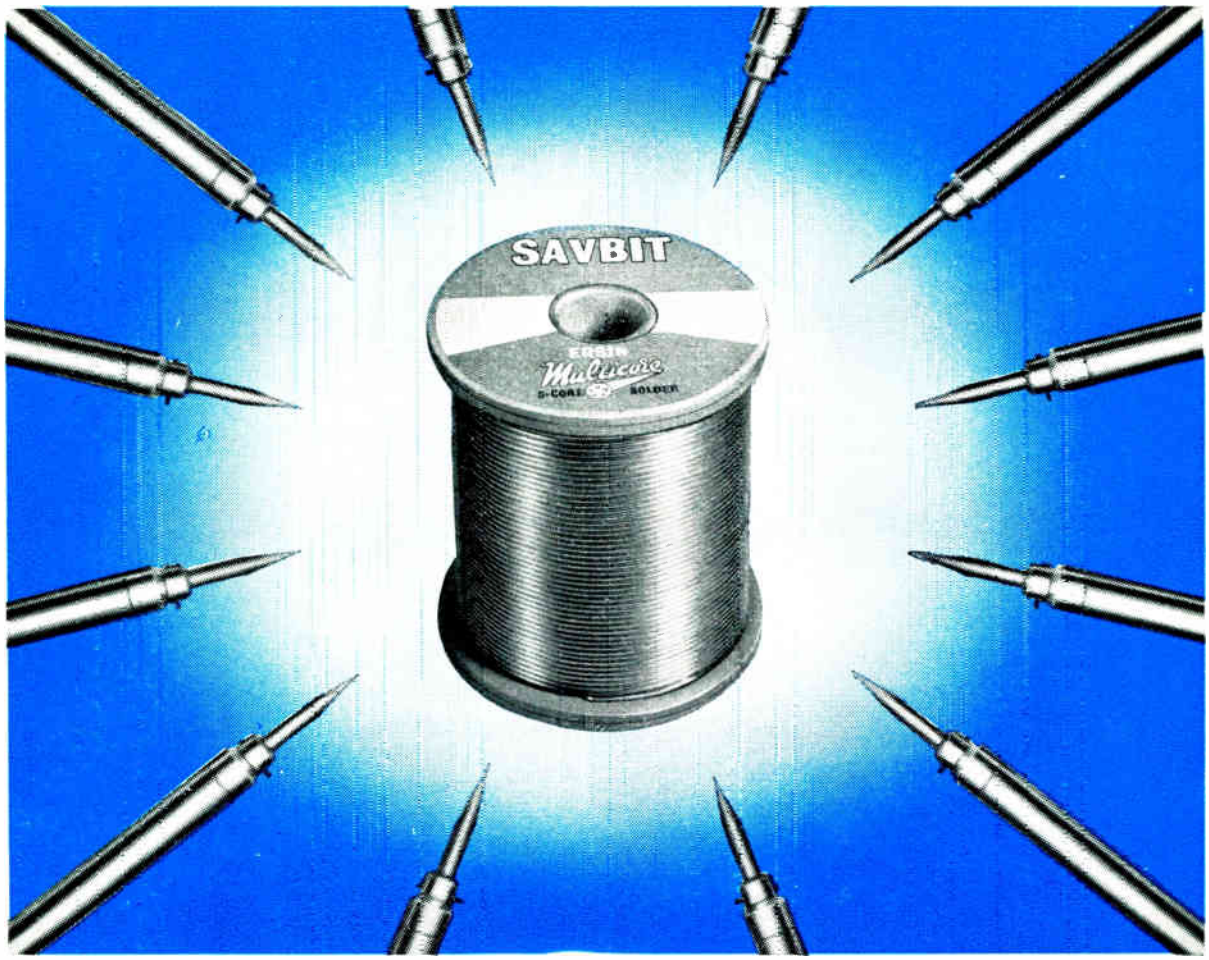
WELWYN ELECTRIC LIMITED

BEDLINGTON - NORTHUMBERLAND - ENGLAND

Telephone : Bedlington 2181-9 - Telegrams : Resistor' Bedlington.

FACTORIES IN AUSTRALIA AND CANADA

LONGER LIFE FOR SOLDERING IRON BITS



WITH ERSIN MULTICORE SAVBIT ALLOY

THE MOST MODERN OF SOLDERS....

an alloy to which a precise amount of copper is added, preventing the copper of the soldering iron bit from being absorbed into the solder alloy. The bit life is prolonged by up to ten times ensuring more consistent soldered joints and eliminating maintenance.

SAVBIT for Factories

There is a 5-core SAVBIT alloy available in gauges from 10 s.w.g. to 22 s.w.g. for any process where solder is required in bulk. Supplies to factories on 7 lb. and 1 lb. reels.

SAVBIT for Miniature Components

with its entirely non-corrosive, extra active, fast Ersin Type 362 flux. SAVBIT alloy meets all requirements for rapid soldering processes.

SAVBIT for Printed Circuits

A new 3-core SAVBIT alloy with 362P flux has less than half the flux percentage of standard Ersin Multicore Solder. An exclusive agent PENTACOL combined with the flux promotes extra rapid spread.

SAVBIT for the Handyman

used directly from the unique handy dispenser, 15' of 5-core 18 s.w.g. SAVBIT for only 2/6d. Available also in Size 1, 5/- cartons.

Samples FREE to Production Engineers. We are delighted to send free samples of any Savbit Alloy or standard Ersin Multicore Alloys to production engineers who apply for them on their company's notepaper. Please state clearly the type required.

Ersin Multicore Savbit Alloy is manufactured under sole British Licence of Patent No. 721,851 by

MULTICORE SOLDERS LTD., MULTICORE WORKS, HEMEL HEMPSTEAD, HERTS. BOXMOOR 3636

CMMS26

ERSIN Multicore SOLDER

FABRICS FOR COLOUR TELEVISION TESTING

IN the course of the investigatory work on colour television which has been in progress in many countries, several techniques have been used for estimating the overall performance of those colour-television systems which are in experimental use, including the well-known N.T.S.C. and S.M.P.T.E. colour slides. By using identical copies of the same photograph at the picture originating equipment and at the receiver, several aspects of the system performance can be judged; in particular, the fidelity of colour reproduction can be gauged, providing some elementary precautions are taken.

Colour-film and slide scanners have generally been preferred for experimental colour-television work because in several respects their performance is significantly better than that of live television cameras. However, Study Group 1 of the European Broadcasting Union's Ad Hoc Group on colour television has drawn the attention of its fellow subgroups to the inadequacy of using only photographic picture sources in television system investigations, bearing in mind the higher purities, at higher luminances, which can occur with live camera pictures.

This has led to the consideration of a standard studio test scene which could be used in much the same way as the standard test cards and photographs. It is possible, of course, to construct such a scene from common, everyday objects such as flowers and soap packets, which can readily be duplicated at the receiving sites. However, such objects do not necessarily test the system to its limits. Gelatine filters illuminated from behind can be chosen to provide a stringent test of colour reproduction but are rather inconvenient, not to say expensive, for general distribution with an accompanying light box.

Although it is possible to find reflecting substances with colours which approach the excitation purities required, they generally have rather low luminance reflectance factors and as such are not representative of normal broadcasting. It was clear that a compromise would have to be adopted for the purposes of a standard test scene, particularly as easily reproducible objects are a prime requirement for such a test arrangement. Consequently, it was decided to investigate the feasibility of having woven materials dyed in suitable colours, with a view to distributing samples to receiving sites as well as to studios.

Many organizations in the textile-dyeing industry and associated Colleges of Technology were approached and asked if they could help in the preparation of these coloured materials. Several offers of assistance were made, the first of which was by Courtaulds' acetate and synthetic fibres laboratory, who produced samples of spun-dyed acetate yarn. Such yarns probably give the highest achievable purities but are very glossy. When they are woven into cloth two things happen: the purity decreases and the gloss tends to disappear. The fastness of such yarns with soluble dyes is considered to be adequate for television test purposes, but they are not as fast as viscose yarns which have been vat dyed.

The higher purity colours which were near the hues of NTSC/SECAM/PAL reference stimuli were chosen. The preparation of such dyed yarns is a difficult technological feat, since the purity achieved is a non-linear function of dyeing time and any change in this time changes the final dominant wavelength. However, the Courtaulds' textile research laboratory produced visual matches to the chosen yarns, using a cellulose acetate poult fabric. The colours correspond very closely with the dominant wavelengths of the television reference stimuli, and the purities are remarkably high considering the reasonable reflectance values of the materials. Camera tests on the materials were carried out and they were found to be relatively easy to light, raising no particular camera problems; indeed, the variation in sheen with the angles of lighting and viewing was considered to provide a more searching technical test as well as being aesthetically pleasing. Subsequently predicted by computer were the most suitable chromaticities which could be produced with I.C.I. Procion dyes. These were applied to mercerized poplin having a non-glossy finish which may be more suitable for some purposes than the acetate fabrics.

Compared with the chromaticities of the primary colours and their complementaries in the Technicolor process, the Courtaulds' fabrics have similar purities for cyan, green and yellow, but are not so saturated along the blue-magenta-red line. In comparison with the chromaticities achievable with the highest purity paints recommended in British Standard 2660, the fabrics cover a very similar range, except for a particularly low luminance-factor red. Similarly, a comparative test against Sproson's standard colours shows that the fabrics have purities which are only substantially exceeded by objects with very low luminance reflectance factors.

In general, the new test fabrics encompass a range of chromaticities which is as wide as is likely to appear on television with any reasonable luminance factor, although they cannot, of course, compete with some self-luminous colours. The fabrics are available at 7s 6d per yard from The Television Society, Colour Television Fabrics Dept., 166 Shaftesbury Avenue, London, W.C.2.

Personal and Company News

International Systems Control Ltd., an associate company of The General Electric Co. Ltd. of England, and Thompson Ramo Wooldridge Inc. (U.S.A.) have announced a development in the U.S.A. which will reinforce the technical support of their activities in computer control in the U.K., E.F.T.A. and the Commonwealth. Thompson Ramo Wooldridge has joined forces with Martin Marietta to set up a joint company to be known as The Bunker-Ramo Corporation. The new company will carry forward and expand the work of both parent companies in designing and installing electronic control systems for industry and government.

Metal Industies Ltd. has acquired from Fiat of Turin, Italy, a 50% interest in International Rectifier Corporation Italiana S.p.A., manufacturers of semiconductors. The other 50% has been owned throughout by International Rectifier Corporation of Los Angeles, U.S.A. Waldo Thorn, director and general manager at Oxted, has been appointed managing director of the Turin company. Three appointments to the board of International Rectifier Company (Great Britain) have been announced. They are Victor D. Fenton as director and general manager, in succession to Waldo Thorn, Peter Ransom as director of engineering and Bernard J. Hadley, who becomes director of production.

Livingston Control Ltd. have been appointed distributors for STC relays and Amphenol-Borg connectors. Under agreements with both these companies large stocks of their products are held and a 24-hour delivery is a feature of this new service. This applies to postal and telephone orders. L.C.L.'s offices are at Retcar Street, London, N.19. Telephone: Archway 6251.

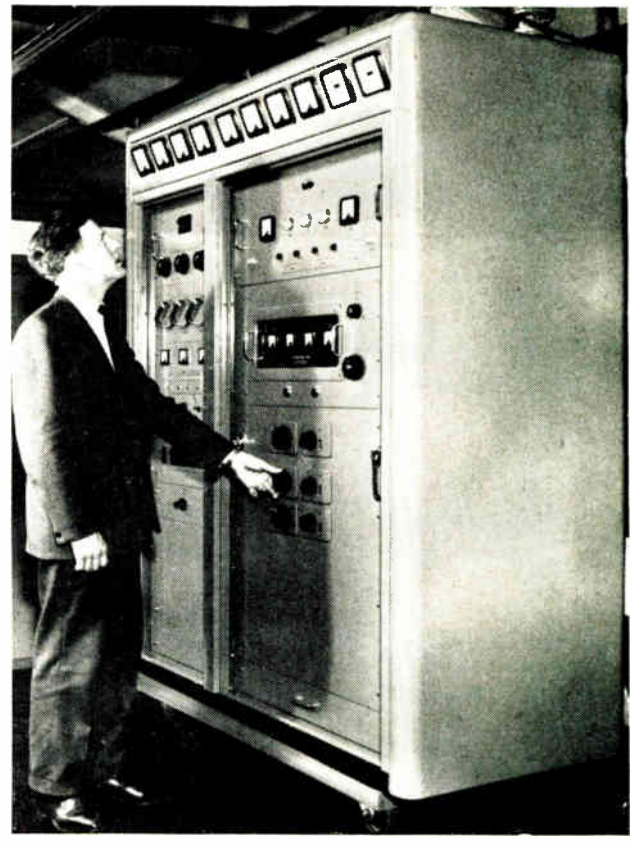
The formation of an Industrial Electronics Division is in progress at the Whitley, Coventry, Works of **Hawker Siddeley Dynamics**. The purpose of the new division is to develop the existing interests of Hawker Siddeley Dynamics in the field of electronic engineering, especially digital electronic control and telemetry systems for industrial applications. J. E. Dick has been appointed chief engineer of the division and B. P. Hough has been appointed commercial manager.

Lectropon Ltd. have been appointed sole concessionaires for Great Britain by Garlock Inc., Camden, New Jersey, U.S.A., who manufacture a range of electronic components made from Teflon, nylon, etc. These include low-loss stand-off and feed-through insulators for h.f. applications, h.f. connectors and valve bases, test points, crystal sockets, transistor sockets and copper-clad Teflon for printed circuits.

Welwyn Electric Ltd. announce the following executive appointments: R. H. W. Burkett, B.Sc., A.M.I.E.E., previously technical director, becomes director and general manager of the company. C. W. Martin, previously general manager, becomes a member of the board as director of manufacture. J. Browning, M.A., chief engineer, becomes a member of the board. R. Steven, B.Sc., sales manager, becomes commercial director.

Rapid expansion of business has led to the installation of a new 10-line PBX at the Ruislip, Middlesex, plant of **SGS-Fairchild Ltd.** As a result the telephone number of the company has changed and is now Viking 2141. The Telex number, Micrologic RLP 22194, and cable address, Micrologic Ruislip, remain unchanged.

Arthur Marks and Dennis Marks have resigned from the board of **AB Metal Products Ltd.** Henry J. Kroch has been appointed managing director.



The 'Ace High' communications network extends through nine NATO countries. This photograph shows one of 45 tropospheric scatter power amplifiers which have been supplied to Supreme Headquarters Allied Powers Europe (SHAPE) by Pye of Cambridge. These 1-kW amplifiers have been installed in 'over-the-horizon' stations in Italy, Greece, Turkey and Cyprus. Pye have also supplied 61 r.f. dummy loads, each capable of absorbing 15 kW of power

The sound engineer at the Bavarian National Theatre now has all the music of the spheres and the roar of the sea at his disposal. From his box he can mix and store all required sound effects with the aid of a sound system designed by the Siemens-Schuckertwerke, and broadcast them as required over 42 loud-speaker arrays

For further information circle 74 on Service Card

A.P.T. Electronic Industries Ltd. announce that a majority interest has been acquired in Cybernetic Developments Ltd. The business formerly carried on at 103 Southwark Street, S.E.1, will be dealt with from Chertsey Road, Byfleet, Surrey, where A.P.T. have their factory and offices.

Meter-Flow Ltd., a subsidiary of S.E. Laboratories (Holdings) Ltd., have finalized details for the marketing in England and the Commonwealth of variable area flowmeters and tank level indicators manufactured by Ludwig Krohne of Duisburg, West Germany. Meter-Flow will also market the Krohne range of magnetic flowmeter heads.

N. Saunders Metal Products Ltd. have opened an additional factory at Enessa Works, Edwin Road, Twickenham, Middlesex. Telephone: Twickenham 2261. Primary purpose of the new plant is to produce the latest 'Dumatic' printed-circuit board drilling machines and other special purpose machinery. The main administrative offices have also been moved to the above address.

English Electric Valve Co. Ltd. has recently appointed G. R. Watson, A.M.I.E.E., as a sales engineer for its television camera tube products. The appointment has also been announced of M. P. Mandl as assistant sales manager.

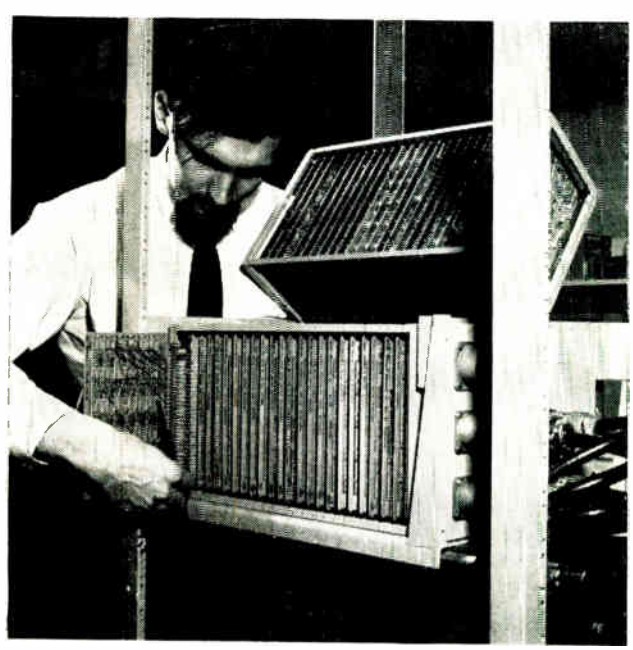
Richard D. O'Brien, vice-president of U.S. Industries, Inc., has been appointed group officer responsible for the two subsidiaries of U.S. Industries in Britain, namely **U.S. Industries Inc., Great Britain, Ltd.,** and **U.S. Industries Inc. Engineering Ltd.,** of Warrington, Lancs. He has been elected to the boards of both these companies.

A. C. Menzies, controller of research and development at **Hilger & Watts Ltd.,** is relinquishing his executive duties. He will, however, remain a director and act as a consultant to the company. J. R. Stansfield, M.A., F.Inst.P., has been appointed general manager, research and development.

W. Philip Rowley, M.B.E., M.Brit.I.R.E., has been appointed manager of the telecommunications division of the **Ultra Electronics Group,** and Major-General E. S. Cole is to be defence consultant, concerned with the co-ordination of military projects, and liaison with associated overseas companies.

C-E-I-R (U.K.) Ltd. announce that they are moving their offices and computer service bureau to 30/31 Newman Street, London, W.1.

Prof. Carlo L. Calosi has been appointed a managing director of **A. C. Cossor Ltd.** Prof. Calosi is a vice-president of the Raytheon Company, in charge of European operations, and has a notable history of personal achievement in the electronics field.



As the speed and density of aircraft increase, long-range secondary-radar, which is the early-warning device for modern air traffic control systems, becomes even more important. However, these systems must have equipment which unscrambles the coded secondary-radar information, such as an aircraft's identity and height. Elliott-Automation has developed a decoder for this purpose utilising the high-speed logic of the Elliott 502 computer; this picture shows a decoder being commissioned

For further information circle 75 on Service Card

The shape of things to come? This Pye video telephone was demonstrated at a recent exhibition in London. Up to ten extensions can be used with the system; signals are routed through a fully automatic exchange which can be equipped to carry up to five simultaneous audio, visual conversations with normal telephone privacy

For further information circle 76 on Service Card

In view of the rapid growth of the Sealectro organization in this country, it has been decided to change its status from that of a branch of the American corporation to that of a British limited liability company which will remain a wholly owned subsidiary of the Sealectro Corporation. The new company, **Sealectro Ltd.**, with G. S. Westbrook, hitherto group general manager, as managing director, is now handling all export business outside the United States; this represents more than 50% of current production.

The B.B.C. announces the appointment of **F. Masterman** as engineer-in-charge at the B.B.C. Monitoring Service, Caversham Park, near Reading, to succeed C. J. W. Hill, A.M.I.E.E., A.C.G.I.

E. R. Ponsford, deputy managing director and one of the founders of the **Solartron Electronic Group Ltd.**, has been appointed managing director. This will enable John E. Bolton, deputy chairman, to concentrate on the policy aspects of Solartron's expansion programme. The increasing tendency for electronic systems, sub-systems and practice to become inter-related has resulted in the recent formation of a Military Systems and Simulation Division.

J. F. James has recently joined **Sperry Gyroscope Co. Ltd.** as engineering superintendent (radar), to be responsible for the company's various radar activities. These are being co-ordinated at Sperry's Stonehouse Establishment.

Distributors have been appointed by **Sperry Components and Systems and Industrial Groups** in Australia, Israel, Norway and South Africa. This follows the recent appointment of overseas distributors for France, Holland, Italy and Sweden.

Electro Dynamic Construction Co. Ltd. are transferring their Control Gear Division from the works at Bridgwater, Somerset, to a new factory alongside the original factory at St. Mary Cray, Orpington, Kent.

To meet demands of their expanding operations in Northern England, **Honeywell Controls Ltd.** are moving their Manchester office from its present location in Northenden Road to Wythenshawe. The address of the new office is: Civic Centre, Wythenshawe, Manchester 22, Lancs. Telephone: Mercury 3214-20. Cable: Minnreg, Manchester (Telex: 66509).

An agreement has been signed by Hughes Aircraft Company of the U.S.A. and **Redifon Ltd.**, under which Redifon will manufacture under licence the Hughes 'Manpack,' a single-sideband 15-W h.f. transmitter-receiver covering the 2- to 12-Mc/s range in 10,000 digitally-switch-tuned frequencies, and weighing only 20 lb.

As from 1st March, SASCO—**Stewart Aeronautical Supply Co. Ltd.**—will be operating from Gatwick Road, Crawley Sussex. Telephone: Crawley 28700 (10 lines), Telex 87131. The new address for associate companies, Radionic Products Ltd. and Electrocon Ltd., will be Stephenson Way, Three Bridges, Crawley, Sussex.

J. C. King, M.Sc., M.I.Mech.E., F.R.Ae.S., at present manager, Aircraft Equipment Division, English Electric Co. Ltd., has been appointed managing director of **General Precision Systems Ltd.** He succeeds W. Makinson, M.Sc., F.R.Ae.S., A.M.I.E.E., who has resigned to take up the appointment of joint managing director of the **Pullin Group Ltd.**

For reasons of ill-health, **Sir Arthur fforde** has resigned his post as chairman of the B.B.C. With the approval of the Queen, the vice-chairman of the Corporation, Sir James Duff, is to be appointed chairman for the time being.

G.E.C. (Electronics) Ltd. has advanced its programme of divisional organization by establishing an Industrial Division at North Wembley. H. M. Tyndall has been appointed manager. The new division is concerned with a wide range of activities in the field of electronic equipment for industrial applications.

Howard Allison has recently joined the sales staff of **Newmarket Transistors Ltd.** and has taken up his duties as sales engineer responsible for the Midlands.

The appointment of J. S. Ross to the post of chief chemist is announced by **Oxley Developments Co. Ltd.**

As a new manufacturing venture, **Plessey** is to make neutron generators for the British market. This follows a licensing agreement with Kaman Nuclear, a division of Kaman Aircraft Corporation, U.S.A.

Obituary

H. M. Dowsett, one of the early pioneers of wireless, died on 27th January. Born in 1879, he first met Marconi in 1897 and two years later joined the Wireless Telegraph and Signal Co., a forerunner of The Marconi Co. He assisted in the fitting and sea trials of H.M.S. Europa, the first practical sea trials of wireless in the Navy.

He remained concerned with wireless all his life and in 1931 became research manager of The Marconi W.T. Co. Ltd. and in 1932 became editor of *Marconi Review*. In 1935 he was principal of the Marconi School of Wireless Communication. He retired in 1939 after 40 years' service with The Marconi Co.

Electronics at Birmingham University

The department hitherto known as the Department of Electrical Engineering at the University of Birmingham has now changed its name to the Department of Electronic and Electrical Engineering. When the department was founded in 1905, electronic engineering virtually did not exist. With the development of the thermionic valve and its use first in communication systems and later in control and industrial systems and in computers, and now with the advent of numerous other electronic devices and systems, electronic engineering has become a vigorous subject advancing at a phenomenal rate. This is reflected in the department's present activities, which are dominantly electronic in research and postgraduate work generally, where 60 of the 68 postgraduate students are concerned with electronic engineering.

Subjects of special prominence in the programme are radar and sonar systems, communications (electrical and acoustic), electronic circuits, ultrasonics, solid-state electronic engineering, and control systems. In the undergraduate teaching, the 'heavier' side of electrical engineering is kept in balance with electronic engineering since many of the fundamental studies apply equally to both; but the vast majority of the students take electronic subjects in preference to 'heavy' subjects when options are provided. While it is appreciated that many professional engineers regard 'electrical' as including 'electronic', the public at large does not, and it has been thought wiser to make the department's name more accurately reflect its interests.

Plessey Expand

Plessey-UK Ltd. have announced the formation of a new subsidiary company, with an initial operating capital of £50,000, to extend its manufacturing and trading interests. The new activity will embrace a comprehensive range of timers for both domestic appliance and industrial applications. The name of the new company, formed jointly with International Register Company, of Chicago, U.S.A., is Plessey-Intermatic Ltd., of which 75% of the shares are held by Plessey. Plessey-Intermatic Ltd. will have the exclusive manufacture and sales rights in Europe and the British Commonwealth for all the existing and future products of the American company, one of the world's largest manufacturers in the timing mechanism field.

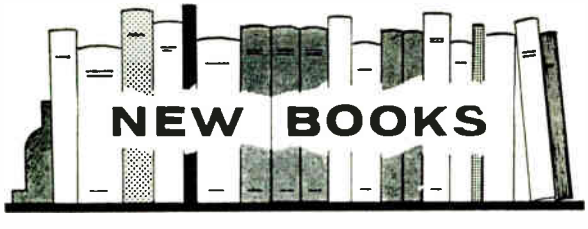
Also as part of a programme to expand its world-wide manufacturing resources, The Plessey Co. Ltd. has acquired, for £1¼ million, the share capital of the Instrument Manufacturing Corporation of South Africa Ltd., a leading producer of industrial and scientific instruments and communications equipment. The South African company has modern factories which, with the one now under construction, extend to some 200,000 sq ft and employ some 550 people at Plumstead, Cape Province. The Instrument Manufacturing Corporation of South Africa Ltd. was formed in 1957 from a consortium of companies brought together to manufacture and exploit commercially the Tellurometer electronic system of distance measurement developed by the South African Council for Scientific and Industrial Research. Since its formation IMC has expanded rapidly and now produces microwave measuring instruments for land, airborne and nautical use.

T. H. Pritchard, managing director of Garrard Engineering Ltd., has joined the board of Plessey Overseas Ltd., the organization responsible for co-ordinating the manufacturing activities of the Plessey Group.

Industrial Calculations

A company, known as Industrial Calculations, has been formed to provide a specialist service for the solution of the technical problems of engineering firms. This service is primarily intended for companies who find it uneconomical to employ full-time experts in all fields in which they encounter difficulties.

Industrial Calculations offer free initial consultation to assess the problem, advise on the probable time of completion and estimate the total cost. Where applicable both digital and analogue computers are available for the solution of problems. Consultations may be arranged by writing or 'phoning 6 Ormond Avenue, Hampton-on-Thames, Middlesex: Telephone, Kingston 2853 or Molesey 2324.



Basic Electronics, 2nd Ed.

By ROYCE GERALD KLOEFFLER, MAURICE WILSON HORRELL and LEE E. HARGRAVE, Jnr. Pp. 643 + ix. John Wiley & Sons Ltd., Glen House, Stag Place, London, S.W.1. Price 80s.

The first 200 pages deal mainly with conduction phenomena in materials and the principles of transistors and valves. A chapter on transistors as circuit elements then follows and this includes equivalent circuits. The small-signal amplifier is then treated mainly in terms of the transistor, but bringing in the valve as its dual. Succeeding chapters cover large-signal amplifiers, oscillators, modulation and detection.

Electrical conduction in gases is treated and then thyratrons, and mercury-vapour rectifiers and ignitrons. Power supplies and pulse techniques are also covered.

Transistor Inverters and Converters

By THOMAS RODDAM. Pp. 240. Published for *Wireless World* by Iliffe Books Ltd., Dorset House, Stamford Street, London, S.E.1. Price 42s.

For the purposes of this book an inverter is a device which supplies an a.c. output when supplied with a d.c. input, whereas a converter is one which provides a d.c. output from a d.c. input. A converter is thus in its function a d.c. transformer. In most cases, a converter is an inverter plus transformer, rectifier and smoothing system. It is natural, therefore, that the bulk of the book should be about inverters.

Although it is possible to construct transistor inverters for outputs up to 1 kW, it is more usual to employ

thyristors at the larger outputs, and the author regards the main application of transistor inverters to be to outputs of 1–100 W. As might be expected in view of the title, thyristor inverters are not treated.

The inverter is, of course, basically a power oscillator. A square-waveform is often generated and the core material for the coils is often driven into saturation. The design of an inverter which is efficient and reliable becomes quite a complex operation when voltage and current peaks, so destructive of transistors, are taken into account.

The author discusses the design very fully and in a substantially non-mathematical way. Little beyond simple algebra is used, and not a great deal of that. The operation of inverters is explained clearly and the important points are well brought out.

Analysis of Linear Time-invariant Systems

By WILLIAM M. BROWN. Pp. 339 + xiv. McGraw-Hill Publishing Co. Ltd., Shoppenhangers Road, Maidenhead, Berkshire. Price 91s.

This book can well be described as a mathematical one illustrated by electrical circuits. It is a book on two-sided Laplace transforms and throughout the emphasis is on the mathematics. It is intended for senior graduates and certainly the book will not be intelligible to anyone who is not already at the least a fairly competent mathematician.

Satellite Communications Physics

Edited by RONALD M. FOSTER, JR. Pp. 88. Bell Telephone Laboratories, 463 West Street, New York 14, U.S.A.

This little book is intended for high-school students, and in the U.S.A. teachers and students may obtain free copies from local Bell Telephone companies. It is in two parts; the first explains the reasons why it is desired to use satellites for communication purposes, the second deals with six specific problems and how solutions have been found. It is a most interesting booklet.

Analyse des Réseaux Électriques à Tubes et à Transistors

By ARNOLD KAUFMANN, BOGDAN GRABOWSKI and JEAN THOUZERY. Pp. 211. Editions Eyrolles, 61 boulevard Saint-Germain, Paris Ve, France. Price F40.35.

The first part of this book deals with topology and this gives some idea of the level of treatment. The bulk of the book deals with the analysis of valve and transistor circuits. Determinants and matrices are freely used and there are many pages of almost solid mathematics.

Manufacturers' Literature

Phase Angle Meter. A 4-page leaflet describing the characteristics of an instrument manufactured by Baur, of Austria, which enables the mutual phase position of two voltages or currents to be read directly in degrees without adjustments or calculations. Power factor can also be indicated directly. Available from the U.K. agents—
Croydon Precision Instrument Co., Hampton Road, Croydon, Surrey.

For further information circle 77 on Service Card

English Electric 1964 Valve Data. A 46-page catalogue listing and giving details of the current range of industrial valves and tubes produced by the
English Electric Valve Co. Ltd., Chelmsford, Essex.

For further information circle 78 on Service Card

Quality Control. Outlined in this well-illustrated 18-page publication are the quality control schemes which have been introduced on the STC Capacitor Division's production lines to ensure high reliability at a reasonable cost. A general introduction to quality control is included.
Standard Telephones & Cables Ltd., Components Group, Capacitor Division, Brixham Road, Paignton, Devon.

For further information circle 79 on Service Card

General Radio Counter Brochure. Frequency counters using Numerik bright-light indicators are described in this 4-page brochure. In addition, there are details of a solid-state data printer, a digital-to-analogue converter with high-speed storage, and a photo-electric pick-off which can be connected directly to a counter for speed measurement.
General Radio Co., West Concord, Mass., U.S.A.

For further information circle 80 on Service Card

Electronic Timer. An inexpensive time sequence control instrument, with versatile switching facilities and an inherent stability of better than ±0·5% of the preset periods, is described in this 4-page leaflet.
*Copley Haddon & Co. Ltd., Ferndale, Gipsy Lane, London, S.W.*15.

For further information circle 81 on Service Card

Paper Tape Handling Conventions. The E.E.A. have prepared a further 4-page guide on the handling of punched paper tape, written primarily for the data-processing field. Adoption of the conventions listed is recommended to increase the efficiency of operators handling punched paper tapes associated with computer systems and ancillary equipment.
*Electronic Engineering Association, 11 Green Street, Mayfair, London, W.*1.

For further information circle 82 on Service Card

Quartz Crystal Units. The electrical behaviour of quartz crystal units, both in oscillators and as individual components, is described in some detail in this 16-page booklet. There is a section devoted to the advantages obtained by using glass-encapsulated crystals as well as a glossary of terms and the specifications laid down for such units. A separate 12-page data booklet on Mullard all-glass quartz crystal units is also included.
*Government and Industrial Valve Division, Mullard Ltd., Mullard House, Torrington Place, London, W.C.*1.

For further information circle 83 on Service Card

Electrolube Products. This 8-page booklet gives, in concise form, a technical introduction to Electrolube, details of their product range, a comprehensive list of typical applications and specification data.
Electrolube Ltd., Oxford Avenue, Slough, Bucks.

For further information circle 84 on Service Card

EMI PET (Polyethylene Terephthalate) Capacitors. This 7-page booklet lists full details of the ranges of these new high-reliability capacitors. They are now available for operation at voltages from 200 to 5 kV d.c.
E.M.I. Electronics Ltd., Hayes, Middlesex.

For further information circle 85 on Service Card

BICC Bicelflux (self-fluxing) Enamelled Winding Wires. The first seven pages of this 16-page publication No. 474 deal with general properties of Bicelflux wire. The remainder give comprehensive physical data in table form.
*British Insulated Callender's Cables Ltd., 21 Bloomsbury Street, London, W.C.*1.

For further information circle 86 on Service Card

Solartron Data Logging Applications. Illustrated and briefly described in this 16-page folder are three typical Solartron data logging systems. They include a 400-channel digital recording system, a 300-channel strain gauge logger and a 100-channel input pressure logger.
The Solartron Electronic Group Ltd., Farnborough, Hants.

For further information circle 87 on Service Card

GETTING THE MEASURE OF NOISE

DAWE Type 1419A OCTAVE-BAND SOUND-LEVEL METER

U.K. LIST PRICE: £160

Fully meets B.S 3489 requirements for Industrial Sound-Level Meters and I.E C recommendations for Octave Band Filters.

Sound-Level Range	24dB to 140dB in 10dB steps with A, B and C weighting curves to I.E C and B.S.
Filters	Band — Cut-off Frequencies Low-Pass 31.5c/s and 90c/s 125c/s 90c/s 180c/s 250c/s 180c/s 355c/s 500c/s 355c/s 710c/s 1000c/s 710c/s 1400c/s 2000c/s 1400c/s 2800c/s 4000c/s 2800c/s 5600c/s High-Pass 5600c/s 8kc/s
Response Relative to Weighting Curve C	Filters +0.5 to −2dB within centre half of an octave (typically ± 0.5dB except 125c/s band) −2 to −6dB at nominal cut-off frequencies (typically −3dB ± 0.5dB except 125c/s band) −35dB min at frequencies one octave below and above cut-off frequencies (typically −40dB)
Microphone	Rochelle-salt crystal diaphragm type microphone. Temperature range 0 C to 45°C. Maximum relative humidity 85%.
Meter	Calibrated from −6dB to +10dB
Output	Full scale deflection of the meter corresponds to approximately 1V into a resistive load of 20k Ω
Power Supply	Three dry cells Type PP4 Ever-Ready or equivalent, or external mains-operated power unit which can be supplied as an accessory
Weight	Only 7lb (3kg)

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

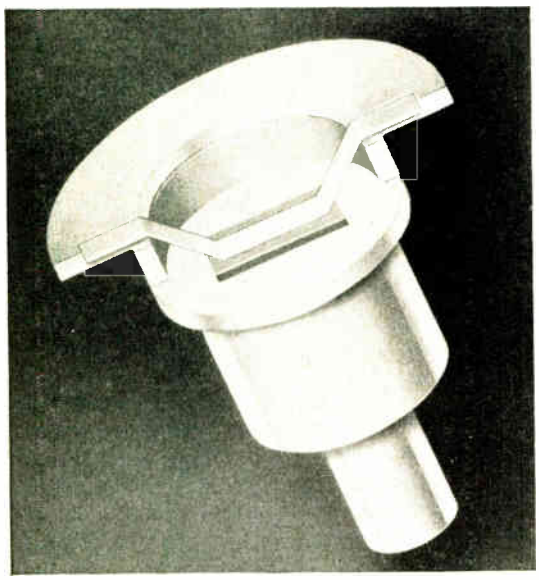
DAWE

Full technical data from:—

DAWE INSTRUMENTS LTD., WESTERN AVE., LONDON, W.3 Tel: ACOrn 6751

A member of the Simms group of companies

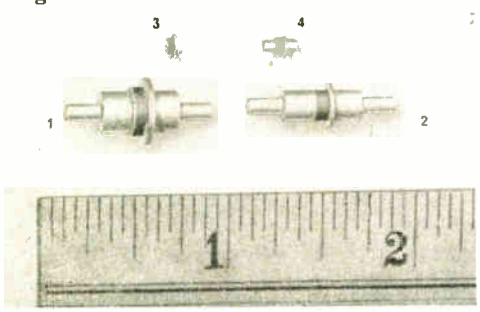
NEW RCA SILICON POWER VARACTORS OFFER BREAKDOWN VOLTAGES TO 200V, DISSIPATION TO 12 WATTS



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.

New diffused-junction, silicon epitaxial developmental varactors are designed for high-power applications in the VHF and UHF bands

- Low Leakage Current...no greater than 10 microamp at reverse breakdown voltage
- Low Package Inductance...three to four times lower than conventional cartridge diodes
- 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°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°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. Series	"A" Series		
V510	1-2.5	2.5-5	25	125
V511	1-2	2-4		150
V512	1-2	2-4		175
V513	1-2	2-4		200
V520	1-2.5	2.5-5	50	125
V521	1-2	2-4		150
V522	1-2	2-4		175
V523	1-2	2-4		200

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

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

THE MOST TRUSTED NAME IN ELECTRONICS

RCA GREAT BRITAIN LIMITED, Sales Division, Lincoln Way, Windmill Rd., Sunbury-on-Thames
ASSOCIATE COMPANY OF RADIO CORPORATION OF AMERICA. Telephone: Sunbury 5511

New range of AEI HALL EFFECT DEVICES now includes

FIELD PROBES

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

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

MULTIPLIERS

Typical applications:
Analogue computers, Wattmeters and volt-ampere meters, Carrier-suppressed modulators, Squaring, Harmonic analysis.

DC-AC CONVERTORS

Typical applications:
Low input impedance DC amplifiers, Regulated DC power supplies.

RF MODULATORS

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

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

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

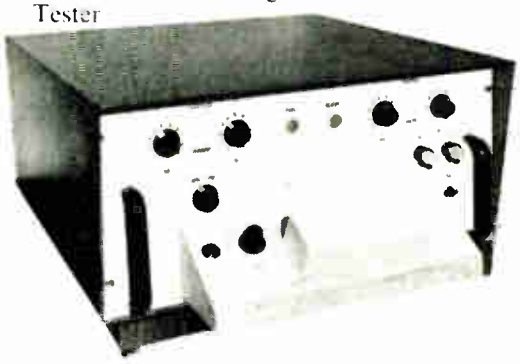
WRITE TO: POWER PROTECTION & METER DEPT, AEI SWITCHGEAR DIVISION, TRAFFORD PARK, MANCHESTER 17, or your nearest AEI office.

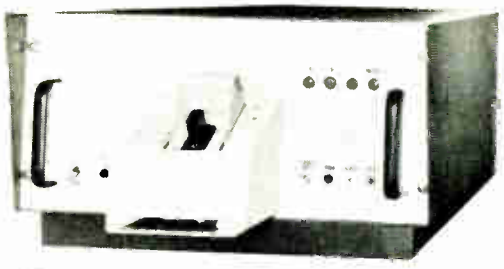
AEI **Associated Electrical Industries Limited**
Switchgear Division

AVEL INSTRUMENTATION

International INSTRUMENTS ELECTRONICS AUTOMATION Exhibition
LONDON 1964 IEA OLYMPIA 25-30 MAY
WE ARE EXHIBITING ON STAND No E 265

Model 20
Low Current Leakage Tester





Model 10
LV CEO,R,S Tester

Automatic Semiconductor Test Instruments

FAIRCHILD
SEMICONDUCTOR
(INSTRUMENTATION)

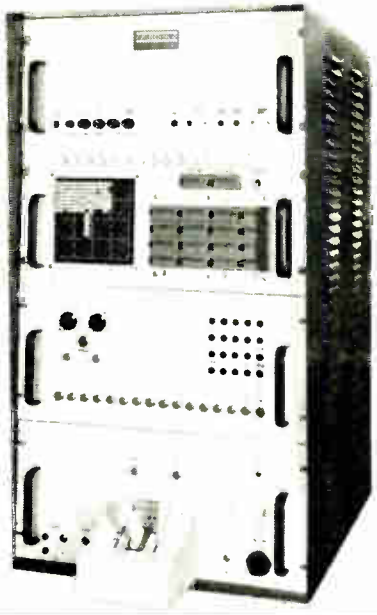
Other Models Available:—

Series 100
Diode Sorter

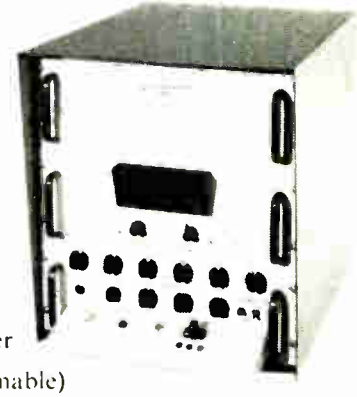
Series 200
Transistor Sorter

Series 500
Multiparameter Tester

Series 900
Card Programmed Semiconductor Data Logger



Series 250B
Transistor-Diode Tester
(Programmable)



Model 50
Direct Reading Pulsed Beta Tester
(Programmable)

NOW MODULAR AMPLIFIERS

Many other models available.

Aveley Electric Limited

Distributors in United Kingdom for:

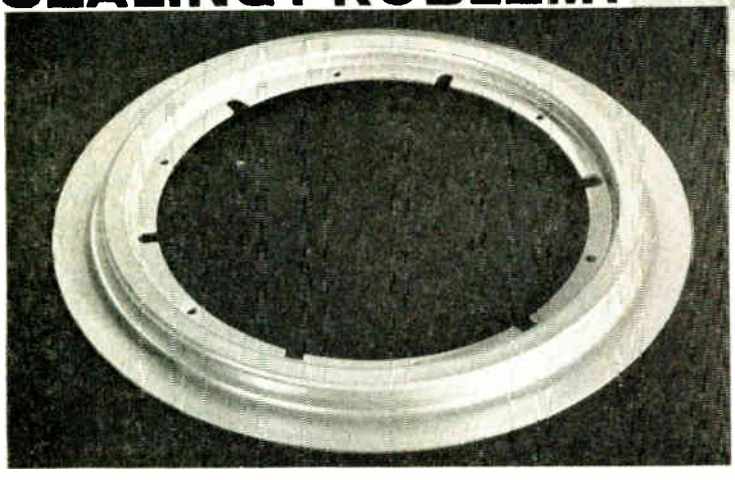
Measuring instruments of quality

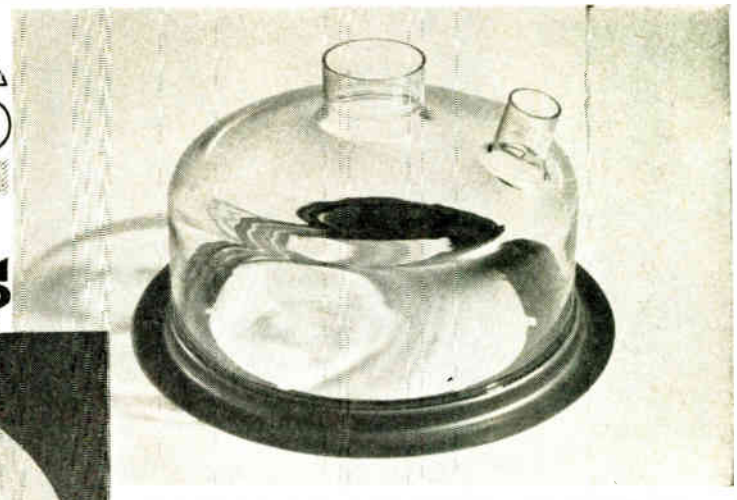
SOUTH OCKENDON·ESSEX
TELEPHONE SOUTH OCKENDON 3444
TELEX 24120 AVEL OCKENDON

For Further Information Write or Phone

For further information circle 246 on Service Card

HAVE YOU A GLASS TO METAL SEALING PROBLEM?





For this 9 inch diameter glass to metal sealing ring

MULLARD LTD

use TELCOSEAL 1, one of the five glass sealing alloys manufactured by

TELCON METALS LTD

These are available as strip up to 6" wide (normal production) in thicknesses down to 0.008", but widths of 10", 12" and 18" can be specially produced. All alloys can be supplied in the forms of drawn wire and rod. For further details, please apply to:

TELCON METALS LTD

P.O. Box 12 · Manor Royal · Crawley · Sussex · *Telephone:* Crawley 28800 · *Telex:* 87248 · *Telegrams:* Telcon, Crawley

MEMBER OF THE BICC GROUP OF COMPANIES

For further information circle 247 on Service Card

An essential book for research workers and designers . . .

MICROWAVE DATA TABLES

by A. E. Booth, M.I.R.E., GRADUATE I.E.E.

This book forms an accurate and labour-saving aid for computations involving basic microwave quantities which occur continually in design and development work on waveguides and similar transmission lines, such as decible relationships, guide and free-space wavelengths, voltage standing-wave ratio, and voltage or power reflection coefficients. Printed on stout paper and strongly bound to withstand constant usage in design office or laboratory, it contains 26 tables comprising over 23,000 separate computations. The figures in the tables have been computed on a Pegasus electronic digital computer to the limit of practical measuring accuracy.

27s. 6d. net

by post 28s. 8d.

Over 23,000 separate computations

from leading booksellers

Published by

ILIFFE Books Ltd.,

Dorset House, Stamford Street, London, S.E.1

For further information circle 248 on Service Card

Wherever your laser research program is pointing . . . communications, medicine, metallurgy, weaponry . . . Meller's tremendous inventory of stock single crystals is available to supply your laser needs instantly.

All configurations: plain flat and parallel ends, TIR, Brewster's angle.

All types: Ruby rods to 12" □ 2% neodymium doped super-quality glass □ .5% neodymium doped calcium tungstate to 5" □ .1% samarium or .5% neodymium doped strontium fluoride □ .5% neodymium or .1% uranium doped barium fluoride □ calcium fluoride doped with .5% neodymium or .1% samarium or .05% dysprosium (up to 6") or .1% uranium.

Request current stock lists and prices from DALE ELECTRONICS, LTD., 109 Jermyn St., London S.W. 1, England.

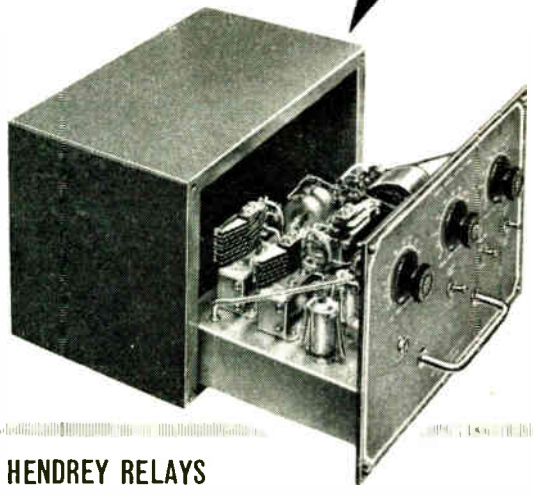
MELLER

Adolf Meller Company, Providence, Rhode Island, U.S.A.

Synthetic Sapphires • Laser Crystals • Alumina Powders

FOR HIGH-SPEED WELDING

See the Hendrey Range on Stand No.
KK8 *(first floor)*
A.S.E.E. Exhibition Earls Court, March 18-25th.



HENDREY RELAYS

WELDING TIMER Type D.4266

A non-synchronous three stage timer controlling weld time, forge time and off time — facilities are provided for single spot or stitch welding with a maximum speed of 300 welds per minute.
Designed for use with resistance welding machines for high speed spot and stitch welding of jet pipes and other aircraft components.

Weld Time — Short ...	3-120 cycles
Weld Time — Long ...	116-220 cycles
Forge Time	6-75 cycles
Off Time	3-200 cycles

Maximum speed stitch welding — 320 spots per minute.

Supplies: 230 volts 50 cycles with tappings at 200, 220 and 240 volts, or 440 volts 50 cycles with tappings at 420 and 430 volts.

Hendrey Relays

HENDREY RELAYS LIMITED
390-394 BATH ROAD, SLOUGH, BUCKS. *Burnham 609/611*
Telegrams: "Hendrelay," Slough

MANUFACTURING ELECTRICAL ENGINEERS CONTROL AND LABORATORY APPARATUS A.R.B. & M.O.A. APPROVED DESIGN AND INSPECTION

KEEP COUNT

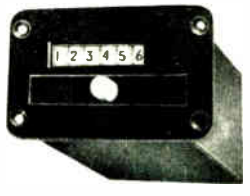
with ENM Electrical Impulse counters

Any measurements of quantity, size, time, weight, speed, temperature, fluid-flow, when converted to electrical impulse, can be recorded and printed.

Model 481
Six figures Add only or add and subtract. Manual, Semi-Automatic and Fully Automatic printing on paper roll, card or card sets.
Up to 3000 counts per minute (add) 2600 (add and subtract).
Electrical reset to zero, or non-reset.
Panel Size: 3.75 in. (95.3 mm.) x 8.30 in. (210.8 mm.).

1 2 3 4 5 6
Actual Printing Size

Model 443
Six figures—Add only or add and subtract. Manual or Electrical Reset—or non-reset.
Standard Models—up to 2100 counts per min.
High Speed Models—up to 3000 counts per min.
Panel Mounted only.
Panel Size: 1.8 in. (46.0 mm.) x 2.75 in. (69.0 mm.)



1 2 3 4 5 0
Actual Indicating Size

Write for fully illustrated data sheets and information regarding your particular counting applications.

ENGLISH NUMBERING MACHINES LTD
DEPT. E.10, QUEENSWAY, ENFIELD, MIDDLESEX. TEL: HOWARD 2611. TELEX: 24725

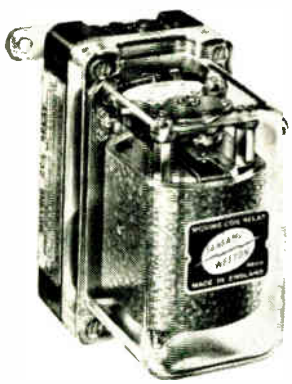
For further information circle 251 on Service Card

WESTON

MOVING COIL

RELAYS

COVER A WIDE RANGE OF APPLICATIONS

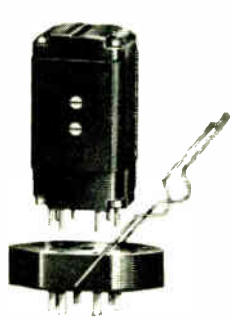


MODEL S 170
for control applications

The Model S 170, permanent magnet moving coil relay. Combines extreme sensitivity with high precision. It is eminently suitable for control applications when a relay operating within close tolerances is necessary. The minimum signal current is 5 mic A. d.c.; shunts and series resistors can be incorporated for currents and voltages up to 5 A and 250 V d.c.

MODEL S 124
a miniature alarm relay with "hold-on" contacts

The Model S 124 is of the permanent magnet moving coil type and can be supplied to operate on currents as low as 2 mic A. d.c. High contact pressure is ensured by magnetic attraction between the contacts; these will "hold-on" until reset manually or by remote electrical control. Front-of-panel and flush mounting relays are available.



MODEL S 115
a miniature switching relay

The Model S 115 functions as an "on-off" switching relay and is supplied for operating currents down to 50 mic A. d.c. Single and double coil windings are available. The relay can be mounted in any position and is magnetically self-shielding. The space occupied on the chassis is only 1½ in. x ¾ in.; weight, 1¾ oz.

For full details of the Weston range of relays, please write to:—

SANGAMO WESTON LIMITED
ENFIELD · MIDDLESEX

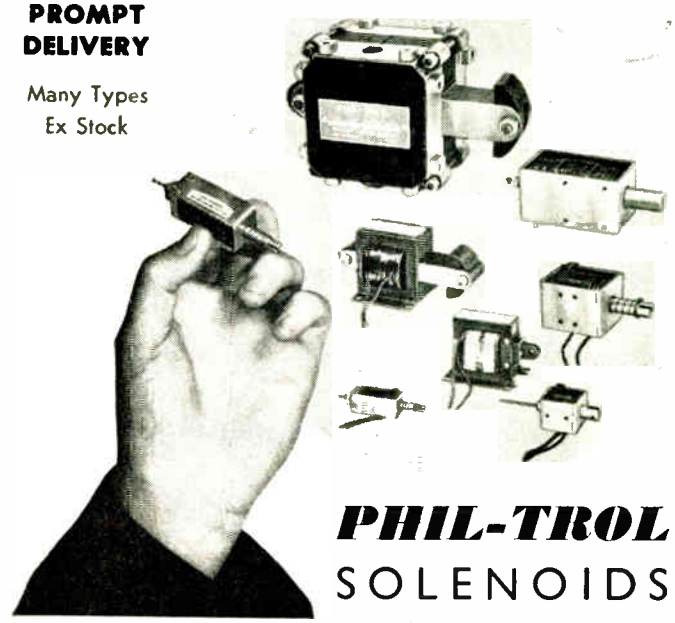
Telephone: Enfield 3434 (6 lines) & 1242 (6 lines).
Grams: Sanwest, Enfield Telex 24724

SW/1185

For further information circle 252 on Service Card

PROMPT DELIVERY

Many Types Ex Stock



PHIL-TROL SOLENOIDS

Type 45 with spring return and thrust as shown in the hand is one of the most popular of the Phil-trol range—can be arranged in banks with ⅜" spacing suitable for typewriter keys, etc. Phil-trol offer a complete range of AC and DC miniature, medium and large solenoids, Push or Pull, spring return and C.O. switched models if desired.

Send for leaflet No. 108a and complete price list.

PHILLIPS CONTROL (G.B.) LTD.

Dept. K7, Farnborough Rd., Farnborough, Hants

Telephone: Farnborough 1120 *Grams & Cables: Philtrol, Farnborough, Hants*

For further information circle 253 on Service Card

An important book—the first fully comprehensive work to appear in this field

ultrasonic flaw detection in metals

Theory and practice

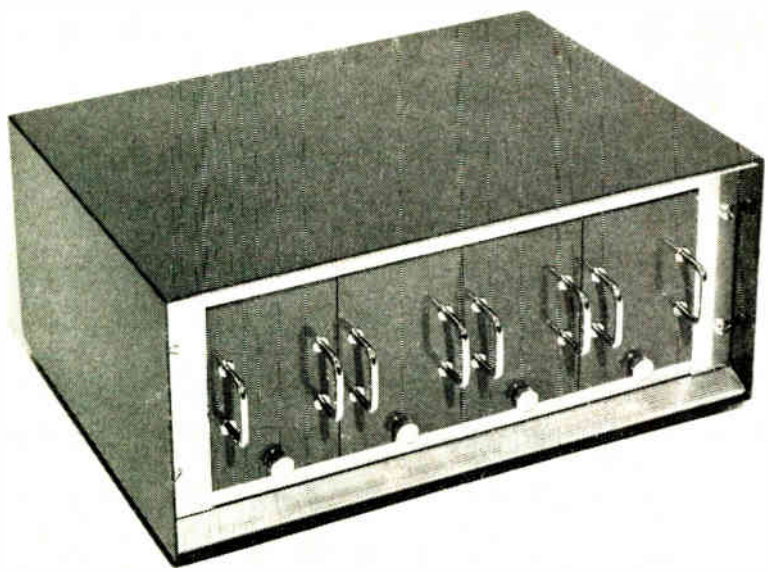
B. Banks, A.M.Inst.W., Hon.F.N.D.T.S.
G. E. Oldfield, A.Met., A.I.M.
H. Rawding, A.N.D.T.S.

This book covers what is now one of the most important branches of the new science of non-destructive testing. The use of ultrasonics extends from the examination of material before initial working to the subsequent periodic examination of components and structures after installation to detect flaws caused by such factors as metal fatigue or irradiation. Invaluable to all engineers connected with quality production and, above all, gives the Test Inspectorate the "know-how" which otherwise would take many years of personal experience to acquire.

63s. net by post 64s 297 pp. 168 illustrations

obtainable from leading booksellers

Published for WELDING AND METAL FABRICATION by
ILIFFE Books Ltd.
Dorset House Stamford Street London S.E.1



a case of good design

Type 604 This extremely attractive case is shown here fitted with type MCF/41 Modular Chassis Unit. Normally supplied with a 19" x 7" x 10 swg front panel. *Price: £6.13.4d.*

Good design demands: a really attractive appearance combined with practicability — at an economical cost. These three essentials are "built-in" to more than 100 standard Imhof instrument cases. To prove the point, we show here a typical example from their range — look at the lines! Look at the price! The standard of manufacture and finish is, of course, of a superb quality that will satisfy the requirements of the most discerning. Send today for Imhofs' 48 page catalogue on Instrument Cases — it contains full dimensional details of their range and is lavishly illustrated in full colour

IMHOFS

ALFRED IMHOF LIMITED

Dept. No. IE/3 Ashley Works Cowley Mill Road Uxbridge Middlesex

Telephone Uxbridge 37123 Telex No. 24177 Telegrams IMCASE-UXBRIDGE-TELEX

Agents in Algeria Australia Belgium Denmark Finland France Germany Holland Italy Malaysia Morocco New Zealand Nicaragua Northern Rhodesia Norway Portugal South Africa Southern Rhodesia Sweden Switzerland Thailand Tunisia U.S.A.

W3

INDUSTRIAL ELECTRONICS

Press date for the April 1964 issue is first post 24th March 1964

CLASSIFIED ADVERTISEMENTS

Advertisement Rates. *6d. per word, minimum charge 6/-, each paragraph charged separately. Remittances payable to "Industrial Electronics", Dorset House, Stamford St., S.E.1. Series discount of 15% is allowed for 12 consecutive insertions.*

Box Numbers *are available at an additional charge of 2/- to defray cost of registration and postage. Replies should be addressed Box No. 0000, c/o "Industrial Electronics", Dorset House, Stamford Street, London, S.E.1.*

Semi-Display *advertisements with centralized lines £1/15/- per single column inch,* **Display** *advertisements £2/10/- per single column inch—no additional charge for Box Numbers. The Publishers are not responsible for clerical or printers' errors although every care is taken to avoid mistakes.*

SITUATIONS VACANT

SENIOR TELEVISION ENGINEER UGANDA

Applications are invited from candidates with a good educational background and the Higher National City and Guilds full Technological Certificate; extensive experience in the operation and maintenance of a modern 5 K.W. vision transmitter and associated F.M. sound transmitter; and the ability to train and control a local staff.

The officer appointed will be required to take complete charge of an upcountry station which normally takes the network programme but will occasionally have to originate simple local programmes.

The appointment will be for one or two tours at candidate's option, each of from 21-27 months in duration, with a salary in the range £2,025–£2,328 plus a GRATUITY of 25% of total emoluments. Free family passages. Free Medical attention and furnished quarters provided at moderate rentals. Generous leave and education allowances.

Apply to Director of Recruitment, Department of Technical Co-operation, Eland House, Stag Place, Victoria, S.W.1., quoting RC 237/153/010.

[2048

WAR OFFICE, Shoeburyness, requires TECHNICIAN for preparation and writing of a wide variety of technical publications ranging from Standard Operating Procedures to a handbook o Range Instrumentation. Subject matter includes description, operation and first-line repair of electronic and electro-optical apparatus in use in the Instrumentation Areas.

QUALS. Recognised engineering apprenticeship; at least 5 years' experience of electronic and/or photo/optical Instrumentation. O.N.C. or equiv. SALARY: £1,059–£1,208 p.a. (National). APPLICATION forms from the Manager (PE. 1315), Ministry Labour, Professional & Executive Register, Atlantic House, Farringdon Street, London, E.C.4.

[2046

SERVICES OFFERED

Precision Sheet Metal Work for the Radio & Electrical Trade. Chassis, Panels, Brackets, etc. Power Press Capacity up to 100 tons. Press brake capacity up to 105 tons 8ft. x 7/32in. All spray and stove finishes. A.I.D. approved. — The Kaymet Company, Kaymet Works, Sylvan Grove, London, S.E.15. Telephone: NEW Cross 6644.

[2036

Try OWEN ADAMS for quick and regular deliveries of PRINTED CIRCUITS. Design, photographic and sub-assembly facilities also available. Owen Adams 160 Worplesdon Road, Guildford. Telephone Guildford 2653.

[2047

MISCELLANEOUS

PHOTO-ELECTRIC CONTROLS

for industry

Send for catalogues

HIRD-BROWN LIMITED
FLASH STREET, BOLTON
Telephone 27311

[2027

SCRAP METAL

Non-ferrous Scrap Metals, all grades, Swarf, Off-cuts, etc., purchased at highest rates.

H. Barnett Ltd.,
Victor Road, London, N.7.
Est. 1865 ARChway 5461

[2041

CAPACITY AVAILABLE

AIRTRONICS LTD.

for coil winding assembly and wiring of electronic equipment, transistorised sub-units.

4 Ashmead Road, London, S.E.8
Telephone: Tideway 2249

[2043

PATENTS

Patent No. 766033 entitled "Improvements in or relating to Piezo-Electric Crystals" is for sale or licence. For details apply to CHATWIN & COMPANY, Chartered Patent Agents, 253, Gray's Inn Road, London, W.C.1.

[2051

CONTROL AND INSTRUMENT ENGINEERS

The B.I.C.C. Research Organization has vacancies in its Control and Instrumentation Department for electrical, mechanical, electronic and servo engineers. Applications are invited from graduates (or equivalent) and from younger engineers approaching graduate status.

Current projects include speed and tension control of materials from fine wires to heavy cables, data acquisition methods for factory use, and a range of original non-destructive testing techniques.

The Laboratories are well equipped and in a modern air-conditioned building and important fringe benefits include good staff restaurants and social amenities.

The appointments are progressive and after a short period of probationary service would be to the permanent and pensionable staff of the Company.

BICC

Applications should be made to the
Personnel Officer
British Insulated Callender's Cables Limited
38 Wood Lane, Shepherds Bush
London, W.12

ELECTRONICS ENGINEER

British Nylon Spinners Limited has vacancies in the Instrument and Electronic Section of the Experimental Engineering Group for young Physicists, Electrical and Electronic Engineers. Applicants should have good qualifications and be capable of devising new methods of control and instrumentation.

The current problems involve microwaves, digital electronics, strain gauges, servomechanisms, synchronous motors, heat transfer and optics. One vacancy exists for a candidate with a special interest in components.

The Section is supported by a large workshop, an advanced scientific photographic service, an analogue computer and a wide range of commercial electronic equipment.

Modern techniques, with a bias towards semi-conductor circuitry, are constantly in use. Facilities are available, also, for producing printed circuits within the Section.

Engineers are encouraged to publish papers and maintain contact with Universities.

Assistance is given to married men moving into the area. Superannuation and profit sharing schemes operate.

Please write, quoting E.61, to

The Personnel Manager, British Nylon Spinners Limited
Pontypool, Monmouthshire

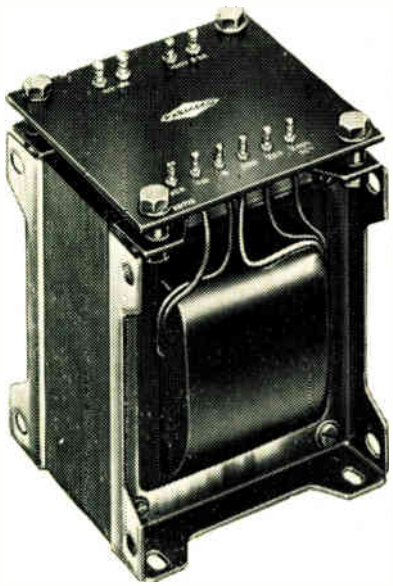
Index to Advertisers

Printed in Great Britain for the Publishers, Iliffe Electrical Publications Ltd., Dorset House, Stamford Street, London, S.E.1, by The Chapel River Press Ltd., Andover, Hants. Distributed in U.S.A. by Eastern News Company, 306 West 11th Street, New York, 14

For further information circle 202 on Service Card

PARMEKO

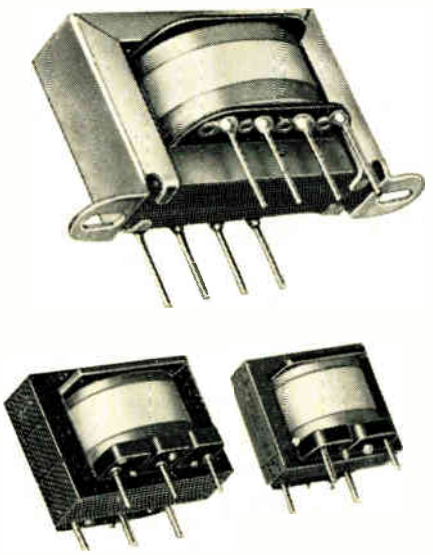
TRANSFORMERS AND CONTROL AMPLIFIERS



5092 series Transformers and Chokes

A simple open frame assembly and the use of low-cost, non-loss laminations have enabled Parmeko to keep production costs for the 5092 series to a minimum. Ideal for general purpose applications, transformers and chokes in this series have facilities for upright or horizontal mounting. A terminal panel is incorporated and studs for inverted mounting can be provided as an optional extra.

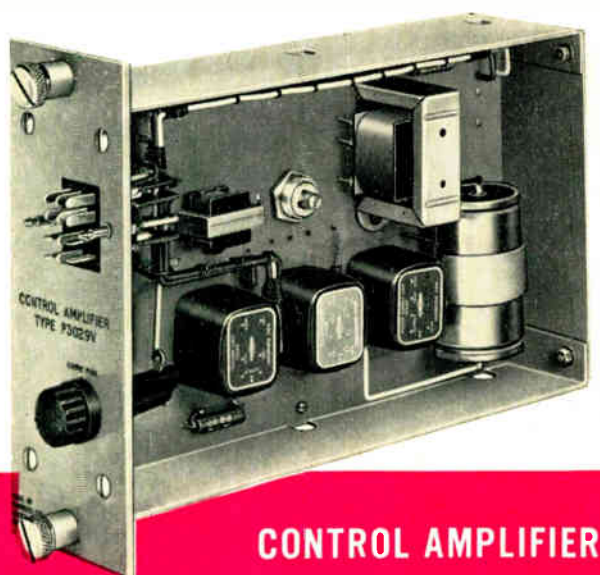
Write for List No. 210 giving full technical specifications.



Transformers for transistor circuit applications

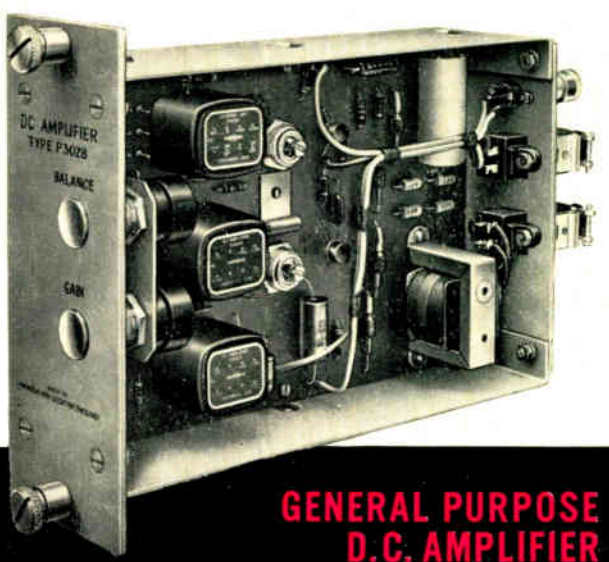
Illustrated here are just three from the wide Parmeko range of transformers for transistor circuit applications. New designs are continually being produced by our research and development departments for use in computers, control systems, guided missiles and switching circuitry among many other applications. Quotations will gladly be submitted for specific design requirements.

Write for list No. 270 giving full technical specifications.



CONTROL AMPLIFIER

This amplifier provides in one unit all the requirements for controlling silicon controlled rectifiers. It consists of three basic Parmeko potted circuit elements arranged to provide a reference supply, a D.C. error integrating amplifier, and a phase shifting gate firing circuit. These combined facilities make it ideal for use in equipment for such applications as motor speed control, power supply regulation, and alternator voltage regulation. Write for List No 790 giving full technical specifications.



GENERAL PURPOSE D.C. AMPLIFIER

This unit answers the need for a low cost D.C. amplifier with good stability, accuracy and reliability. Two types are available, providing push-pull or single-ended output. Both make use of a well-proven transistorised chopper technique and incorporate Parmeko potted circuit elements. All components are generously rated, giving almost indefinite life under normal operating conditions. Write for List No 800 giving full technical specifications.

PARMEKO LIMITED · PERCY ROAD · LEICESTER · ENGLAND

Telephone Leicester 32287 . Telegrams Parmeko Leicester