INDUSTRIAL ELECTRONICS

JULY 1963 5s 0d

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SUB-MINIATURE COAXIAL CABLES

for miniaturized electronic equipment

These extremely small coaxial radio frequency cables offer great savings in size and weight. Overall diameters are, for instance, less than 0.1 inch.

The cables are of particular interest to designers of miniaturized electronic equipment, both ground and airborne.

Technical information is available on request.

BRITISH INSULATED CALLENDER'S CABLES LIMITED, 21 Bloomsbury Street, London, W.C.1

INDUSTRIAL ELECTRONICS

incorporating *ELECTRONIC TECHNOLOGY*

Volume 1 Number 10 July 1963

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continued overleaf

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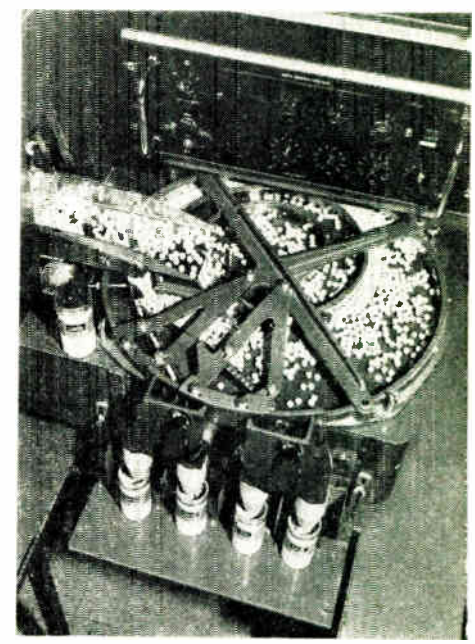
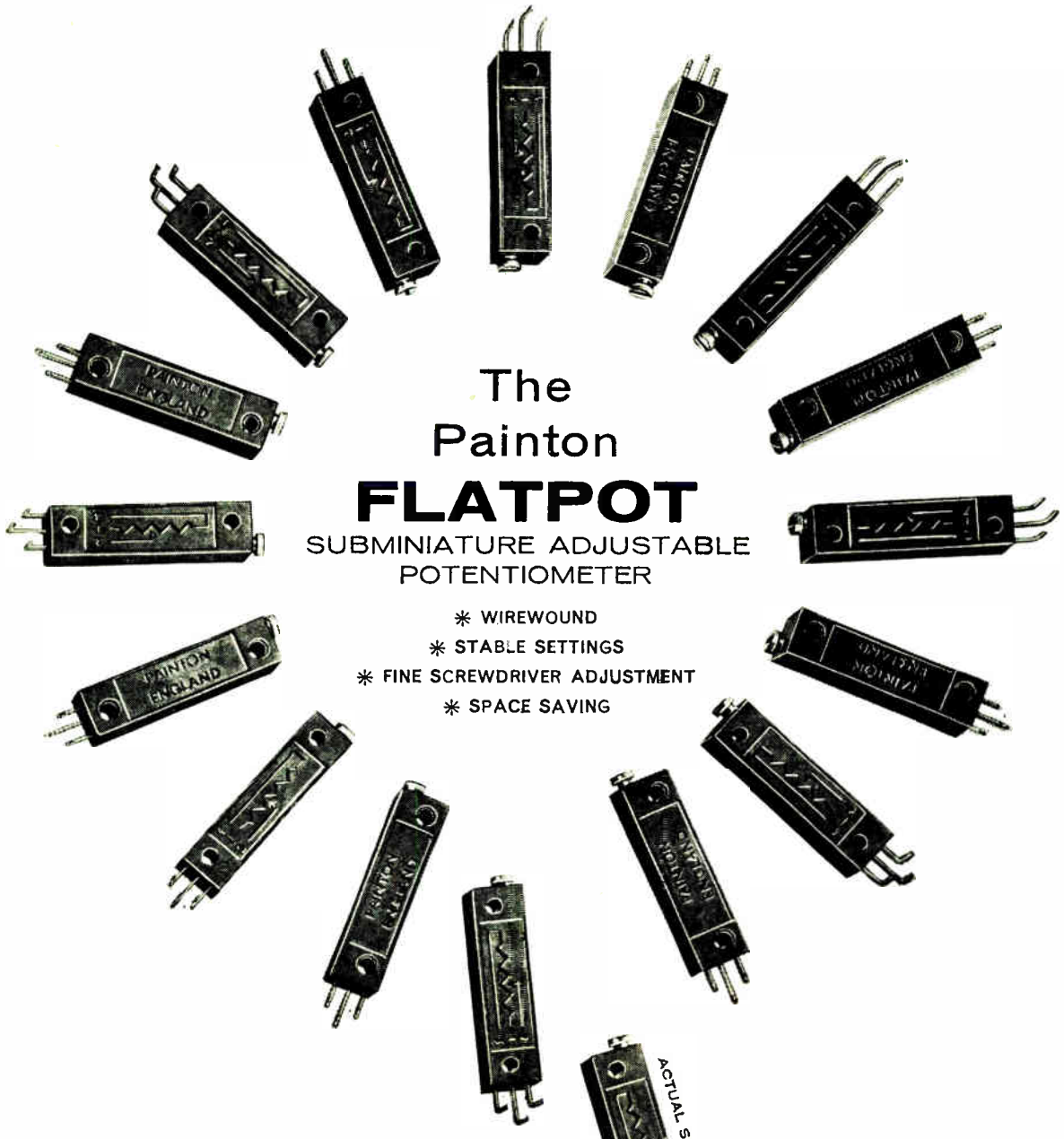


OUR COVER

This illustrates one of the many applications of electronic counters in industry. Here a Triumph batch counter is being used at the Horsham plant of Ciba Laboratories to control the filling of containers with pre-determined numbers of tablets at a rate of over half a million a day. Elsewhere in this issue electronic counters are described and a number of other applications given.

Next Month

The industrial applications of ultrasonic cleaning will be discussed in an article in the August issue. Other articles will deal with modular servo-system elements, with electronic methods of colour registration in printing, and with an experimental system for the machine transcription of shorthand.



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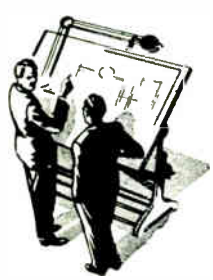

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Broadway 5115

ADVERTISER'S ANNOUNCEMENT

THIN-FILM CIRCUITS TO INDIVIDUAL SPECIFICATIONS

Mullard announce manufacturing service for industry

The wide interest in thin-film microcircuit techniques has encouraged Mullard to set up a special manufacturing service to produce 'tailor-made' thin-film circuits to customers' specifications. This service will enable designers of computer, communications, and industrial equipment to obtain the benefits of integrated components using the thin-film technique—in particular, high reliability, small size, and low cost—without having to design around existing microcircuits.

As part of this manufacturing service, a booklet is now available outlining the advantages and versatility of the thin-film technique, and providing information to enable the systems engineer to design his circuit to take full advantage of the capabilities of the technique.

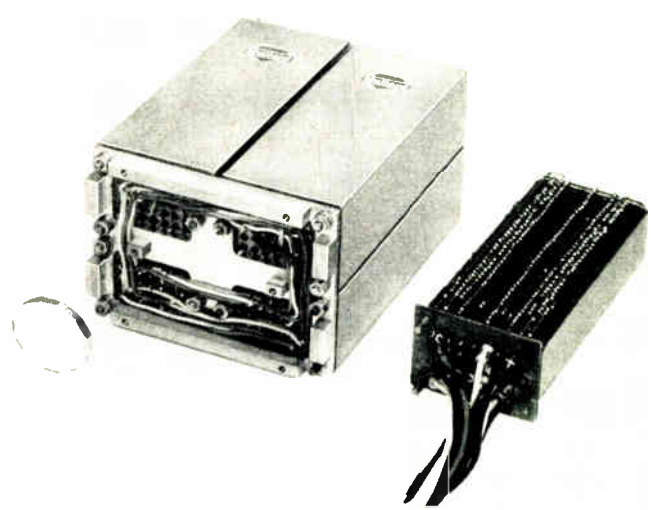
Microcircuits can be used with advantage not only in applications where space and weight are at a premium, such as military and aviation applications, but can also make considerable savings when used in conventional applications. A reduction in size of 50 to 100 times can be made in comparison with the conventional miniature form, enabling a reduction in cost to be made in housing, ventilation, and other ancillary services. The high reliability of the microcircuit is inherent in the technique of using deposited thin films, and the cost at present is comparable with that of the conventional miniature form. As production increases, however, it is expected that equipment manufactured from microcircuits will be comparable in cost with that manufactured by *any* production method.

In a microcircuit, resistors and capacitors and their interconnections are deposited as a continuous thin film on a glass substrate. Transistors and diodes are fitted to the substrate and the lead-out wires soldered into the circuit.

The range of resistors generally required is from 10Ω to 50kΩ, but the technique can be used to produce higher values. The tolerance of individual resistors on the same substrate is only ±2% and advantage can be taken of this in the design of many circuits. The range of capacitors generally required is from 10 to 5000pF, although other values outside this range can be easily produced.

Individual microcircuits that have been designed and manufactured include logic gates, shift registers, high speed counting circuits, 65Mc/s video amplifiers, and crystal-controlled oscillators. It is from the experience gained in producing these circuits and complete systems such as the integrator illustrated, that Mullard can offer the fullest assistance to designers wishing to exploit the thin-film technique in their equipment.

For a copy of the Mullard booklet 'Thin-film Circuits' and for further details of the manufacturing service, use the reader reply card of this journal. (See reference number opposite).



Thin-film digital integrator containing 3438 transistors, diodes, resistors, and capacitors in 17in³—specially developed by Mullard for R.A.E., Farnborough.

What's new from Mullard

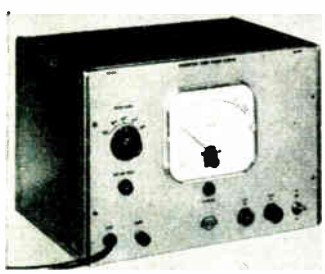
MORE COMPACT VACUUM PUMP CONTROL UNIT

A considerable number of improvements have been incorporated in the restyled WPS-1 Penning pump control unit as a result of the wide experience gained in the use of ultra-high vacuum devices.

The new unit is only half the size and half the weight of the original, and the chassis layout has been completely redesigned. The new arrangement of controls makes the unit ideal for both bench and rack mounting.

Measurement of pressure

Pressures in the range 2×10^{-2} to 10^{-8} torr are indicated by a direct-reading meter. A single logarithmic scale covers the whole range, but the meter can also be switched to expanded scales covering the range in single decades. This makes the unit



particularly useful as a leak detector. Provision is also made for the connection of a line recorder if continuous monitoring is required.

Compatible range

A typical pumping system would consist of the sorption priming pump VAP-10, Penning pump VPP-5 controlled by the WPS-1, and the ionisation gauge IOG-12 controlled by the WPS-3. These units are structurally compatible so that a compact and comprehensive system may be formed.

NEW 100A AND 150A RECTIFIER STACKS

Four bridge rectifier stacks have been added to the Mullard range. Two units are for 100A single-phase operation, and two for 150A three-phase operation.

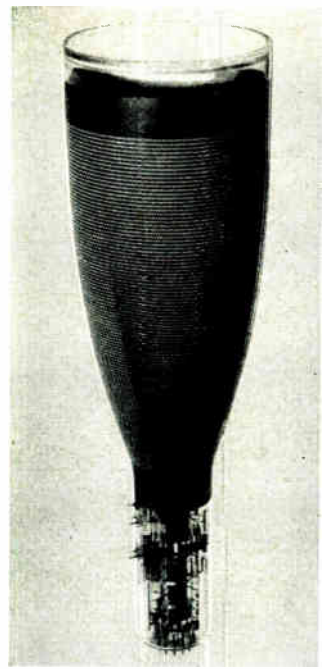
With these additional types, Mullard now have a range of fifteen rugged and reliable bridge rectifier stacks, with power ratings from 2·5 to 57kW.

New Instrument Tube

Cuts Oscilloscope Design Complexities

The introduction of a 5in high-performance split-beam oscilloscope tube enables the oscilloscope designer to make substantial savings in size, cost and power consumption.

This tube, the E13-10GH, uses a new beam splitting system that



enables a dual trace to be produced without the disadvantages inherent in conventional systems. The new system overcomes the problems of asymmetric deflection and d.c. drift by splitting the beam with the accelerating anode preceding the deflection system. This anode contains two apertures which are accurately aligned with the two deflection centres. Precision assembly enables the deflection centres to be only 2mm apart so that both electron beams are virtually axial.

Complementary P-N-P and N-P-N Transistors

Simplify Circuit Design

The introduction of two pairs of complementary p-n-p and n-p-n germanium alloy-junction switching transistors will simplify the design of many circuits. In particular, only one supply voltage is required. The two pairs introduced are the ASY26 and ASY28, with a typical gain of 50, and the high-gain types ASY27 and ASY29, with a typical gain of 100. The transistors use the TO-5 encapsulation. A leaflet giving details of circuits employing complementary techniques is available.

These transistors can be supplied to J.E.D.E.C. registration, types 2N1302 to 2N1309 inclusive. The GET880 series of germanium alloy-junction transistors featuring isolated TO-5 cans is also available for linear and r.f. amplifier applications.

PRECISION STEPPING CONTROL

A new approach to stepping control in a wide variety of applications is now possible with the introduction of Mullard stepping motors. The applications of the motors include pulse counting, programme switches, positioning applications, and variable drives for recording instruments.

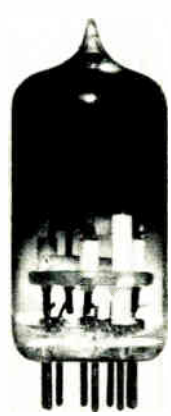
Three types of motor are available at present, producing torques of 35, 100, and 300 g.cm. The maximum number of steps per second varies from 150 to 350. A range of complementary gear boxes is also available with gear ratios between 25:6 and 260 000:1.

Mullard stepping motors have a permanent magnet rotor with twelve pole-pairs, and two centre-tapped stator windings. The step rotation is produced by alternately reversing the field produced by each stator winding, the direction of rotation being determined by the switching sequence. An electronic switch can be supplied to drive the motor from a pulse train. Step rotations of 7° 30′ (that is, 48 steps per revolution) and 3° 45′ can be obtained.

TRIGGER TUBE CAN OPERATE ON HALF-WAVE RECTIFIED MAINS SUPPLY

A cold cathode trigger tube is now available which has an even better performance than the highly successful Z803U, accepted for many years as the best available trigger tube for use in timing and relay control applications. This new tube, the Z806W, can be operated at a higher anode supply voltage enabling it to be used directly from a half-wave rectified mains supply.

Other improved characteristics are the tighter tolerance and greater stability on the trigger ignition voltage—the stability on the trigger ignition voltage over the life span being better than 1·5V (approximately 1%). This and the other improved characteristics enable simpler and more stable circuits to be designed around this tube. The trigger



recovery characteristic has also been improved, providing reduced backlash in dynamic control circuits.

Reader Enquiry Service

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

The Audio Signal Generator in use at Erg Industrial Corporation Ltd., as a high stability frequency source for tuning precision filters.

Close-up view of the open frequency scale.

10-120,000 c/s with stability!

S121 HAS PRECISE FREQUENCY AND AMPLITUDE CONTROLS

FREQUENCY SELECTION

Audio Signal Generator S121 has a unique dial display, enabling any frequency from 10 c/s to 120 kc/s to be selected rapidly and simply without the use of scale multiplying factors. Three separate frequency controls provide vernier adjustment, discrete steps or range switching by a factor of ten. *This arrangement gives an effective scale length of 13 feet.* Thus the instrument is at once suitable for detailed investigations of filter characteristics, rapid checks on frequency response over any selected band and overall performance measurements on wide-band audio systems. The extended frequency range is of particular value where negative feedback amplifiers are involved.

ACCURACY AND STABILITY

An outstanding feature of the S121 is that alteration of the frequency setting does not necessitate re-adjustment of the attenuator controls. The desired level can be set to an accuracy of better than ± 0.5 dB and the setting is maintained to within ± 0.2 dB over the entire frequency range. Long-term amplitude stability is of a similar high order. The output frequency is accurate to ± 1 per cent and is stable to ± 0.1 per cent. The open scale enables any frequency setting to be repeated with very fine discrimination.

WIDE RANGE

The Oscillator incorporates a screened attenuator, providing adjustment in 1-dB steps from -70 dB to $+10$ dB on a reference level of 1 mW in 600 ohms (i.e. from 250 μV to 2.5 V r.m.s.). The unusually wide range of this attenuator, which can be switched from an unterminated condition to an internal 600-ohm termination, caters for all input sensitivities normally associated with audio-frequency equipment. To facilitate operation of the S121 when it is to be used as a bridge source, a high-level output is provided, giving continuous control from 0 to 30 volts (output impedance varies from 10Ω to 3kΩ). The 600-ohm and high-level outputs are both available over the full range of 10 c/s to 120 kc/s.

LOW DISTORTION

Negative feedback applied over the oscillator-amplifier combination ensures that the waveform generated is of extreme purity. The total harmonic content is less than 0.2 per cent over the major part of the range; hum and noise are negligible. Since no frequency mixing or beating is employed the instrument does not suffer from any of the disadvantages often associated with such techniques.

CIRCUIT FEATURES

Overall feedback is employed from an amplifier and applied, through a Wien Bridge circuit, to grid and cathode respectively of the first amplifying stage. Feedback to the grid, which is taken from the C-R side of the bridge, is effectively positive and establishes the frequency of oscillation. Feedback to the cathode, via the thermistor, is effectively negative and serves the dual purpose of maintaining a stable amplitude of oscillation and reducing the level of all harmonics. Separate attenuators are fitted for the high-level and 600-ohm outputs.

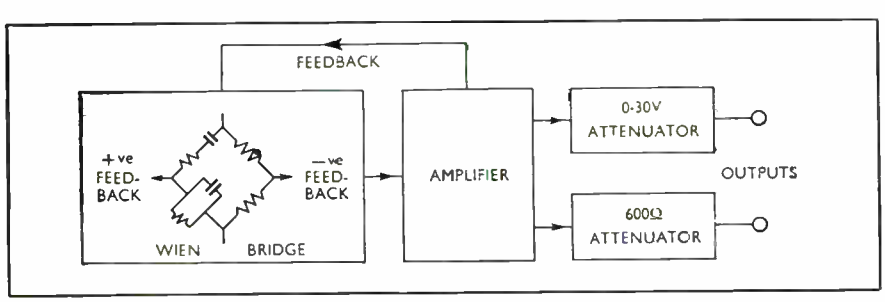
BALANCED OUTPUT

A transformer, type T121, is available as an ancillary item, converting the 600-ohm unbalanced output from the Oscillator to 600-ohm and 150-ohm balanced outputs, both centre-tapped to ground. The transformer, which is fully screened electrostatically and magnetically, makes the S121 immediately suitable for tests on lines or equipment with balanced input circuits.

APPLICATIONS

The S121 is in widespread use where an a.f. source of the utmost reliability is needed. With Waveform Analyser A321 it forms an accurate and versatile arrangement for the measurement of distortion. The same two instruments are also ideal for use as a tuned bridge source and detector. With A.F. Voltmeter M121 and, where necessary, the T121 Transformer, the Oscillator completes a high-grade Transmission Measuring Set (TMS).

For full details on any of the instruments, or a demonstration, please write or telephone to:—



WK40

SOLARTRON

POWER SUPPLY
TYPE AS 1164·2

A tool for progress in every Industry

SOLARTRON

For further information circle 215 on Service Card

REGULATED TRANSISTOR POWER SUPPLIES

The Solartron series of precision engineered Power Supplies are a range of compact and versatile units for use in laboratory or production applications. These are designed to a standard which invites comparison of their common features with any other Power Supplies available today.

STABILISATION RATIO

Percentage reduction of mains input fluctuation is greater than 1000:1 over the range of ± 7½% of nominal setting.

INCREMENTAL VOLTAGE SETTING

Three decade switches simplify output voltage selection and ensure perfect repeatability down to 100 mv. Accuracy ± 2%

TRANSIENT RESPONSE

Wide band control amplifiers maintain a very low effective dynamic output impedance under fast transient loading conditions.

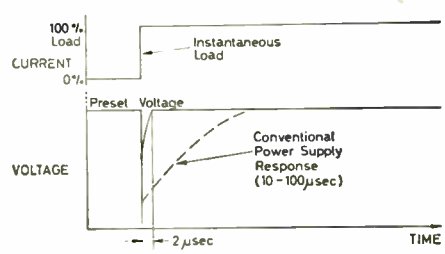
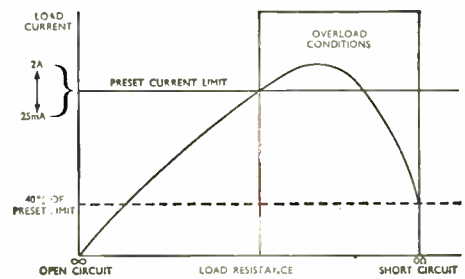


Fig.1. TRANSIENT RECOVERY

OVERLOAD PROTECTION

A fast electronic proportional control system limits output current to any one of six preselected values, thus protecting both supply and load circuit completely. Automatic resetting to normal characteristic at the end of overload condition allows reactive loading transients to be handled without interruption of D.C. output.



CLEAN D.C. OUTPUT

Ripple and noise components on output are held to 1 mv PEAK to PEAK.

FLEXIBILITY

AS 1164.2 twin power supply may be operated in SEPARATE, SERIES OR PARALLEL modes at the turn of a switch, without sacrifice of performance.

ISOLATED OUTPUTS

D.C. outputs are completely isolated and may be operated at ± 250 volts with respect to chassis.

VOLTAGE OVERSHOOT

No significant "over voltage" transient occurs on the output during switching of either mains input or output voltage setting.

REMOTE SENSING

An optional remote error sensing facility is provided on outputs in excess of 1 AMP to eliminate volt drop in connecting leads.

REVERSE VOLTAGE PROTECTION

The supplies are protected against any excessive reverse voltages which might be generated by the external load circuit.

Type	Voltage Range	Current Range
AS 757.3	*O-50V*	*O-1A*
AS 870.3	*O-30V*	*O-3A*
AS 1164.2	*O-30V Twin*	*O-1A Twin*

Detailed information will be gladly sent on request and Solartron Engineers are available to discuss applications. Write to:

THE SOLARTRON ELECTRONIC GROUP, LTD. (Instrument Division)
Victoria Road, Farnborough, Hants.
Telephone: Farnborough (Hants) 3000
Telex: 8545 Solartron Fnbro
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MC & PS 146

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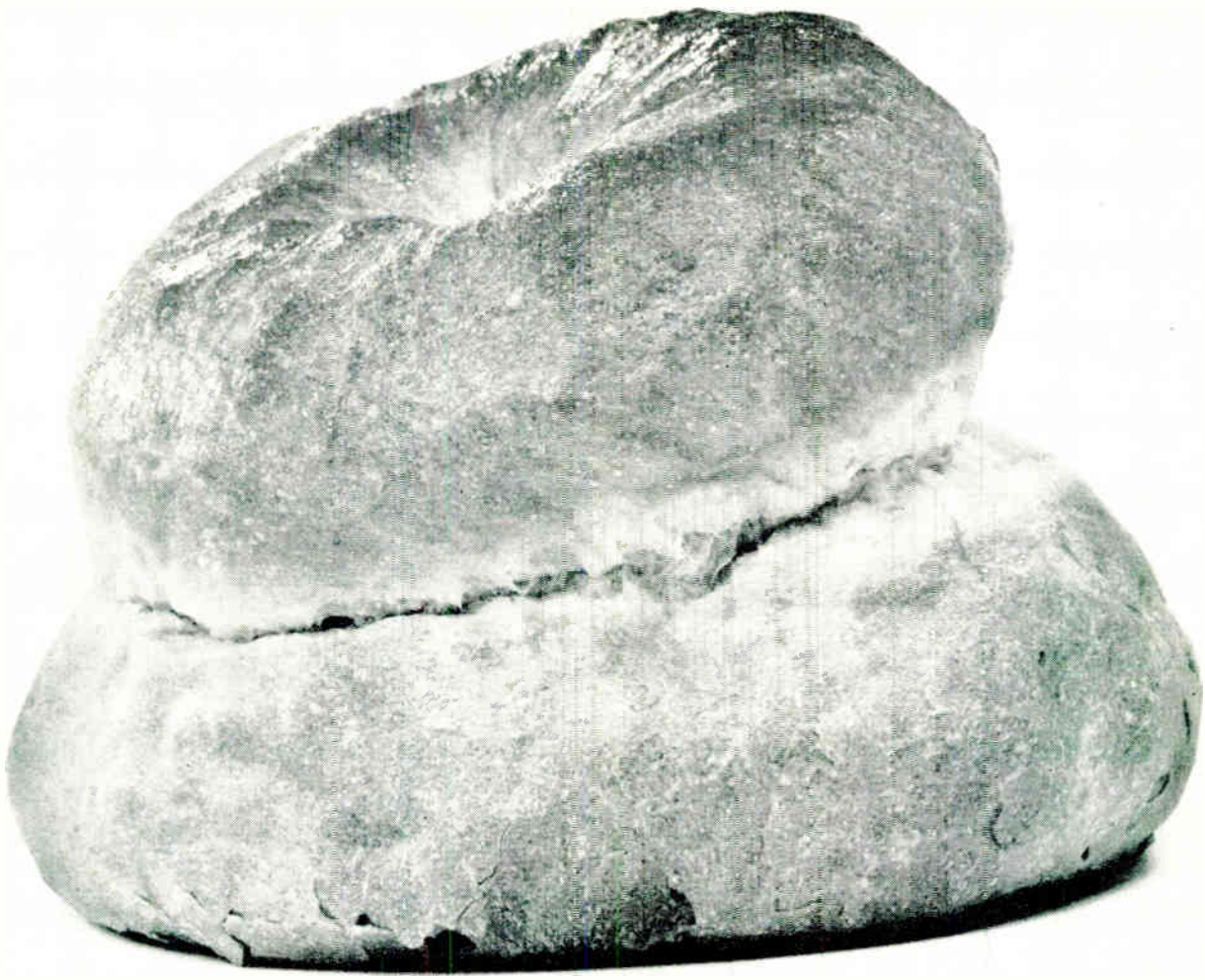

Processed

Two Elliott computers—the 503 and the 803. Price range: £20,000 to £200,000. Between them, they cover the chief scientific and industrial applications. First, the 503. Built to meet the increasing demand for high speed computers for use in research and development. The 503 has no competitor as a replacement for older/smaller/slower installations. And its low price puts it within reach of organisations that now use computing centres. The National-Elliott 803 is the smaller machine, from which the 503 has been developed. With over 120 already delivered, the 803 is far and away the most successful British computer. The two systems are compatible—programs written for the 803 can be used on the 503. Elliott's provide Autocode, ALGOL 60, and over a hundred library programs—and an active users' association provides for exchanges of application programs. If you're thinking about a computer, call early on Elliott's who can do much of your thinking for you.

The Elliott 503 *100,000 operations per second. 8192 word magnetic core store. 3½ microsecond cycle time. Up to 131,072 word auxiliary core store. Input by 8-channel punched paper tape at 1,000 characters per second. Typewriter controlled. Incorporates time-sharing of peripheral data-transfers. High-speed input and output devices include punched card input/output, magnetic tape and line printer. Interrupt facilities.*

ELLIOTT **computing division**

ELLIOTT BROTHERS (LONDON) LIMITED
ELSTREE WAY BOREHAMWOOD HERTFORDSHIRE ELSTREE 2040
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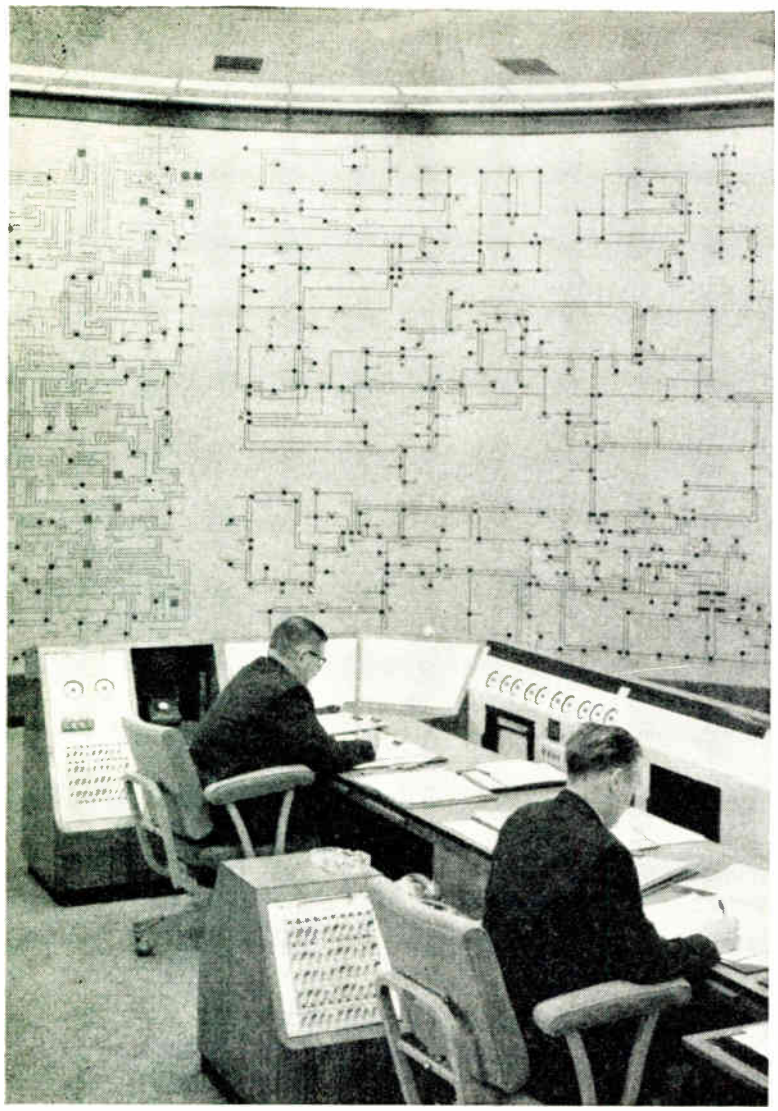
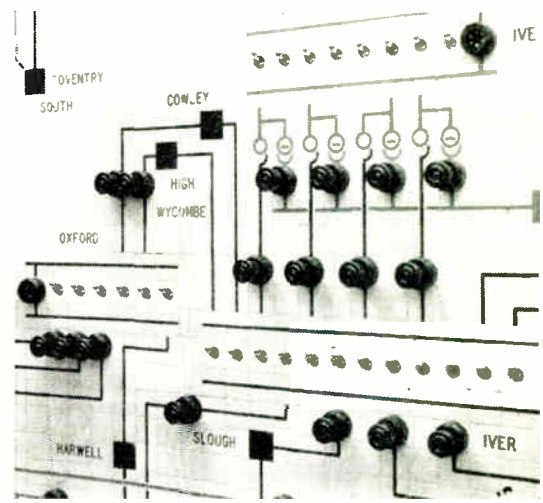


STC at Bankside House



Detail of control panel showing STC Mosaic diagram composed of 1 in. tiles.

This is the Central Electricity Generating Board's National Control Room, Bankside House, London, aptly described as 'The Nerve Centre of the Nation's Power'. From the Switching and Loading Desk, designed and manufactured by STC, control engineers keep a constant watch on the Mosaic wall diagrams which give an up-to-the-minute picture of Britain's power supplies.

The Diagram panels are built of one inch square mosaic, plastic tiles. Two networks are displayed on the panel in the Control Room photograph, the Diagram on the extreme left being the Line Outage Calculator which depicts the 275 kV and 132 kV Systems in diagrammatic form. Its function is to determine the effects of any abnormal conditions within the system. The second network is the 132 kV System which is shown by lines and symbols engraved on the mosaic tiles. Each of these tiles can be removed easily by hand. Thus, when a line is out of service, the engraved tiles can be removed and blank tiles inserted in their places—a facility which illustrates the flexibility of STC Mosaic Diagram Panels.

STC also provide Diagrams for electrical generation, transmission and distribution, hydro-electric projects, gas and water supply schemes, tramway control rooms, industrial processing, coal handling plant, vehicle loading systems, water cooling systems, catchment area display, printing presses, railway electrification and fire and security schemes.

Write, 'phone or Telex for brochures D/RC 8, D/RC 18, D/X 12.

Standard Telephones and Cables Limited

INTEGRATED ELECTRONIC SYSTEMS DIVISION

Burleigh House · Great Cambridge Road · Enfield · Middlesex

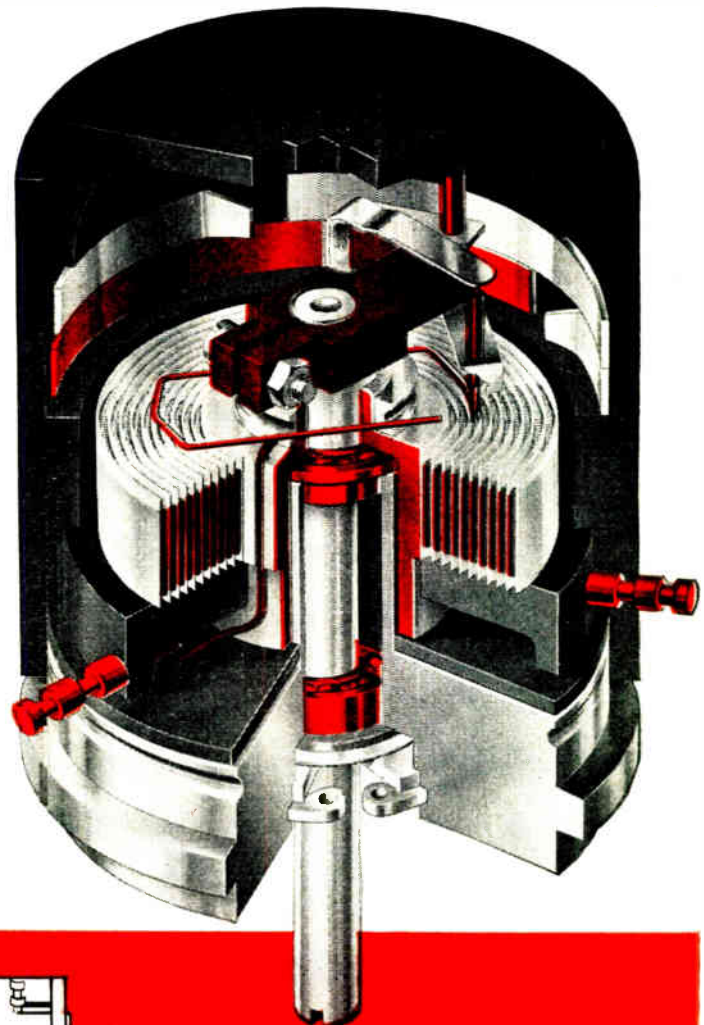
Telephone ENField 5343 · Telex 21409

63/15R

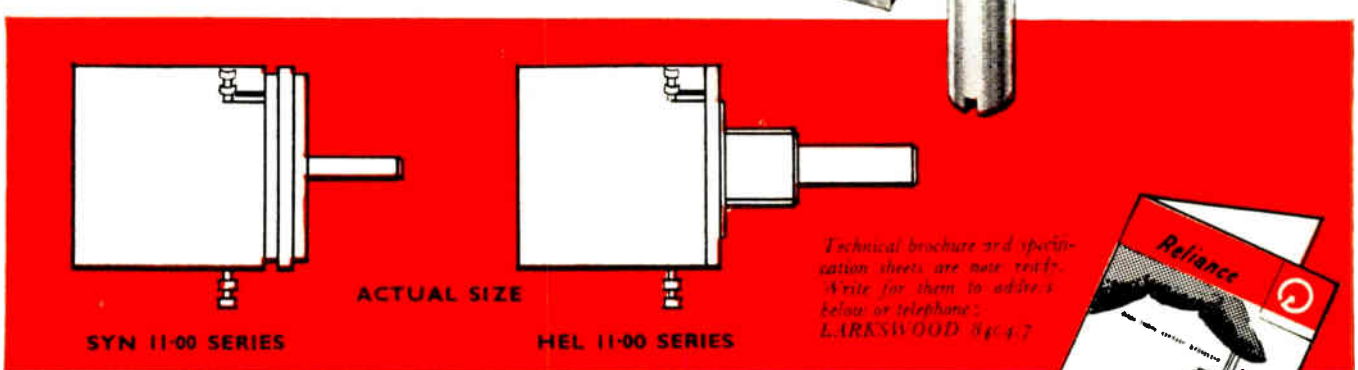
The first major advance in potentiometer design for years ...

After many years of research and development Reliance now announce an entirely new concept in the design of multi-turn wire wound potentiometers. This, combined with new manufacturing techniques provides extremely low inertia, low torque, high law accuracy and multiple tapping facilities for non linear functions. The unit is available in two distinct separate versions:

1. SERIES SYN 11-00 A Synchro Mounting Unit incorporating precious metal winding and precision ball races.
2. SERIES HEL 11-00 A ⅜" diameter Bush Mounting version, plain bearing with standard resistance windings, still retaining high electrical characteristics.



- ★ RESISTANCE RANGE: 20 ohms—150 K ohms.
- ★ LINEARITY: ±0.1% or ±0.25% absolute as required.
- ★ TAPPING ACCURACY: ±0.1%.
- ★ MOMENT OF INERTIA: 0.0004 gm. cm. sec².
- ★ STARTING TORQUE: Synchro Mounting Version 3 gm/cm. or better.
  Bush Mounting Version 1 oz.in. nominal.
  or Sealed Version 2 oz.in. nominal.
- ★ ROTATION LIFE: > 1,000,000/360° sweeps.
- ★ NUMBER OF TURNS: Any number up to 10.



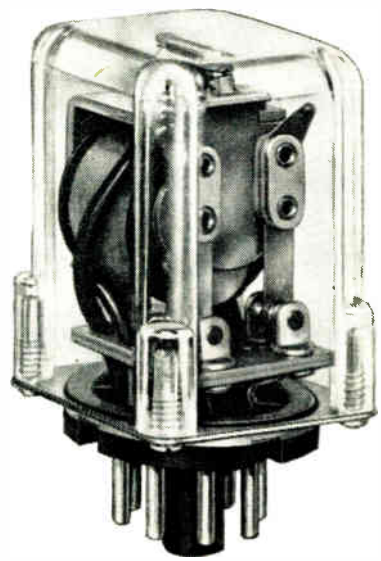
Relcon TAKES THE LEAD IN POTENTIOMETERS

RELIANCE CONTROLS LIMITED, RELCON WORKS, SUTHERLAND ROAD, WALTHAMSTOW, E.17

Telephone No. LARkswood 8404/7 · Telegrams: Reltrol, London, E.17 A MEMBER OF THE BOOKER GROUP OF COMPANIES

THE MOST ECONOMICALLY PRICED RELAY OF ITS TYPE!

The Thorn Pygmy Power Relay is designed for use in remotely controlled automation units. It is absolutely invaluable where rapid assembly, interchangeability, minimum dimensions, and economy are required.



THE THORN PYGMY POWER RELAY

✳ 2 pole and 3 pole changeover contacts ✳ Plugs into I.O. and B.11A bases ✳ Transparent cover - keeps out dust and allows inspection ✳ Weighs 4½ oz and projects only 2″ above base ✳ Mechanical life of over 10,000,000 operations.

TECHNICAL DATA

Switching Current: 2 pole 5 amps maximum at 250 volts AC, 3 pole 2 amps maximum at 250 volts AC.

Maximum Surge Current: 2 pole 10 amps, 3 pole 5 amps

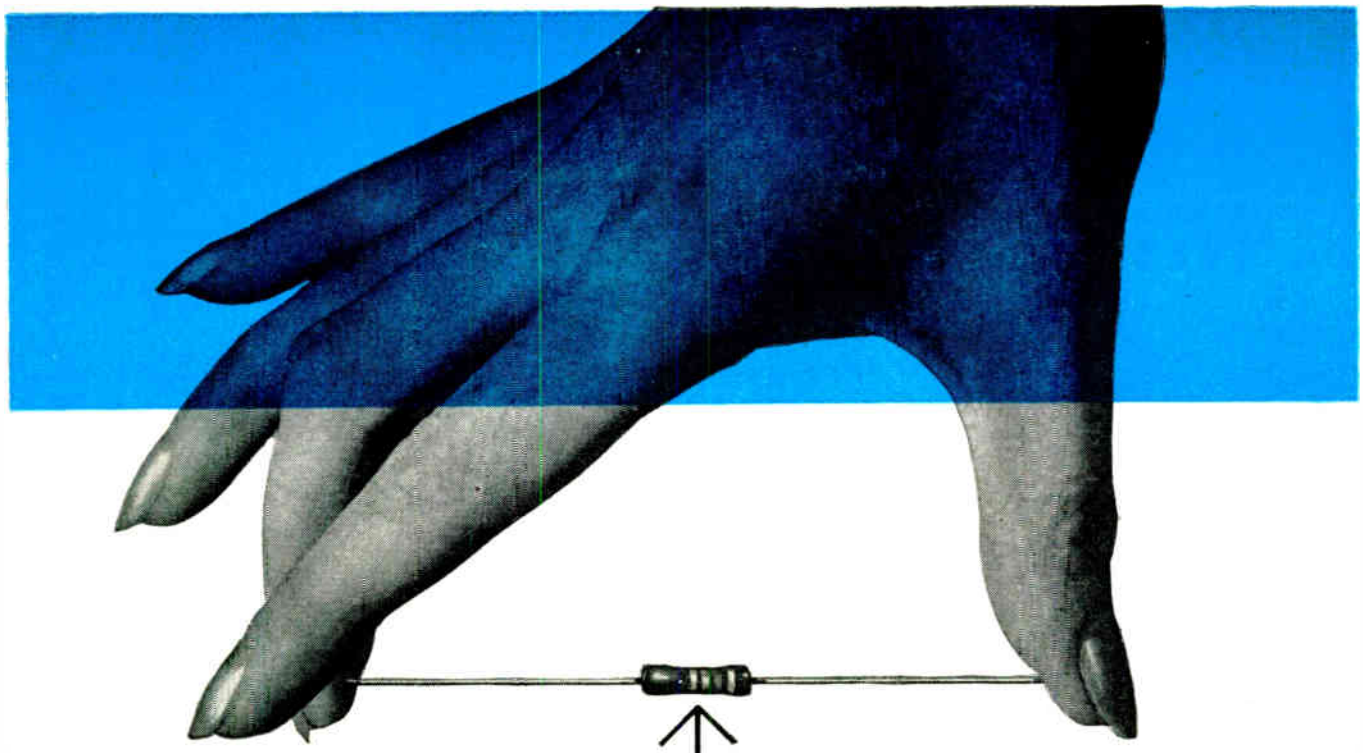
Operate Time. 8 milliseconds approx.

Release Time: 6 milliseconds approx.

Overall Dimensions: 1·38″ square by 2·54″

Coil Voltage: 240 volts DC. Also available for 6, 12, 24, 48, 60, 110 volts either AC or DC

THORN ELECTRICAL INDUSTRIES LTD., SPECIAL PRODUCTS DIVISION, GREAT CAMBRIDGE ROAD ENFIELD, MIDDLESEX. TELEPHONE ENFIELD 5353



one resistor range meets all your needs

Electrosil Metal Oxide Film Resistors have a resistance track which is fired on to a glass substrate at red heat and is virtually impervious. This gives resistors which have much greater stability than others both on the shelf and in the circuit.

SEMI-PRECISION	SIZE	GENERAL PURPOSE
N55 1% 1/10W	1/4" x 3/32"	C-07 2% 5% ¼W
NJ60 1% ¼W	3/8" x 5/32"	CJ20 2% 5% ½W
NJ65 1% ½W	9/16" x 13/64"	CJ32 2% 5% 1W

RESISTANCE RANGES HAVE NOW BEEN EXTENDED. WRITE TODAY FOR FULL DETAILS.

Electrosil
LIMITED

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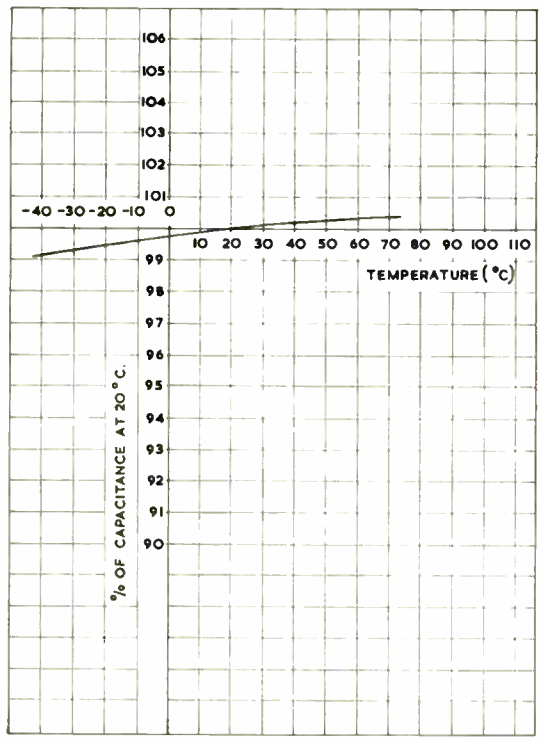
MINIATURISATION BY A FACTOR OF TEN!

TYPE ML30 'METALAC' TUBULARS

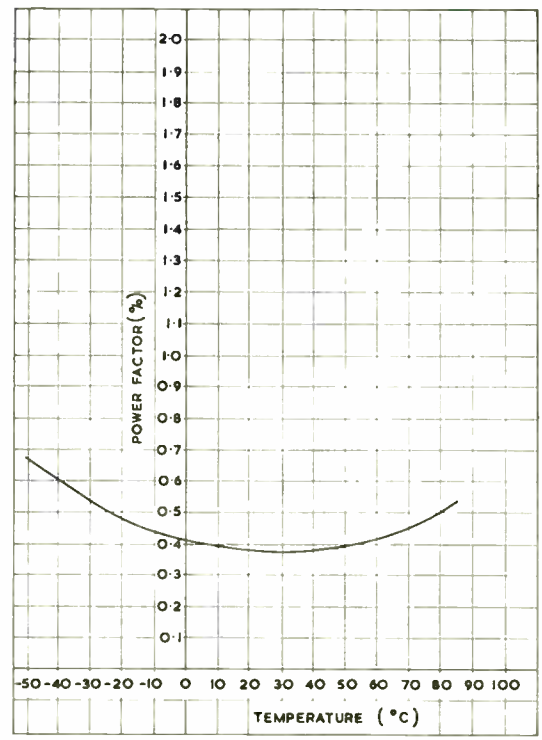
New methods of metallising, winding and processing ultra-thin dielectric material have enabled Hunts to develop these revolutionary metal cased tubulars. *(Illustrations are actual size)*

TEMPERATURE CHARACTERISTICS

CAPACITANCE v TEMPERATURE (IKcs)



POWER FACTOR v TEMPERATURE (IKcs)



STANDARD RANGE

0.5 µF to 10 µF

WORKING VOLTS

63 v D.C.

TEST VOLTS

1½ times Wkg. Volts

DIMENSIONS

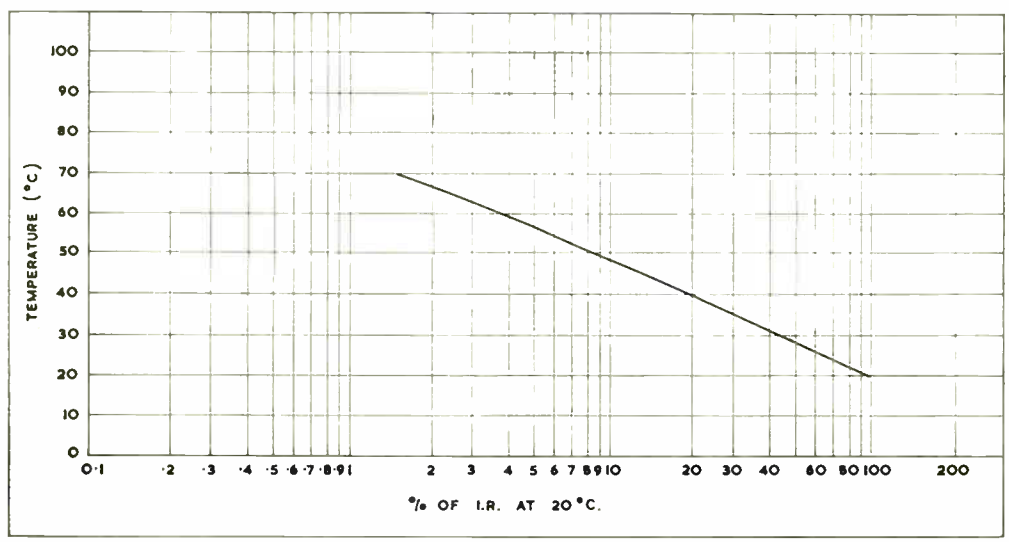
$\frac{13}{16}$ x $\frac{1}{4}$ inches to

$1\frac{11}{32}$ x $\frac{11}{16}$ inches

ABRIDGED SPECIFICATION

Temperature Rating −55°C to +70°C. max. Insulation Resistance Greater than 50,000 ohm-farads measured at the working voltage at 20°C. ±5°C. Humidity Classification H6 (To Specn. DEF 5011)

INSULATION RESISTANCE v TEMPERATURE



REGISTERED TRADE HUNTS MARK CAPACITORS

Detailed information freely available from

A. H. HUNT (Capacitors) LIMITED

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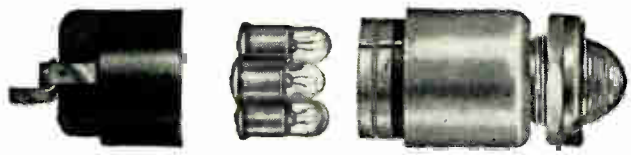
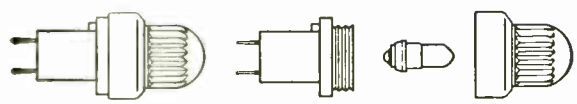
Factories also in Surrey, Sussex and North Wales

THREE COLOUR INDICATOR



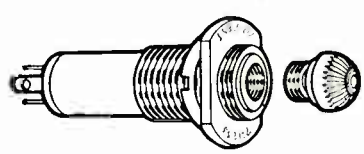
These red-amber-green indicators contain 3 lamps which glow individually via coloured filters through a common lens. The lamps are Atlas Midget Panel Lamps operating at 6, 12 and 28 volts. This indicator has very compact dimensions and can be installed into a single panel hole with fixing ring and lock nut. Exceptionally reliable, these indicators are invaluable for many signalling applications. Supplied complete with three S6/8 cap filament lamps. Overall dimensions (including earth tag) 2.230″ x .812″ dia.

SUB-MINIATURE LAMP AND HOLDER



A sub-miniature lampholder that allows easy lamp replacement from the front: a lamp that combines an output of about 1 lumen at the maximum rated voltage of 6v. Together they represent an outstanding design achievement. Life expectancy of the lamp is 10,000 hours at 6v, when derated to 5v the average should be in excess of 60,000 hours. The lampholder conforms with R.C.S. 11 in respect of damp heat and tropical exposure tests (H.1.). Temperature range of —40°C to + 70°C (operating). One hole fixing is by a speed nut (supplied). Lenses, meeting B.S. 1376 are in red, green, amber and blue. Clear also available. Overall dimensions (including tags) .900″ x .394″ dia.

PRESS-TO-TEST SWITCHES



Three or five-terminal versions available; the latter providing 34 circuit variations. Solder tag or screw terminals to choice. All bases will take dimmer, flat top indicator or indicator caps; full range of colours available. The switches are vibration-proof and maintain predetermined contact pressures.

MULTI-SOCKET INDICATORS

Ideal for use in computors and illuminated read-out devices. Produced in strips of twelve sockets with ½″ or ¼″ centres. An 'easy-mount' single socket, similar to the indicator strip is also available and can be used separately or in conjunction with multi-socket strips. Lamps are available for 6, 12 or 28 volts, 35–45mA, with a burning life of 3,000–5,000 hours. Plastic nylon caps are obtainable in white, red, yellow and green; they fit directly over the lamp and eliminate the need for prismatic jewels.

THORN

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DIV/11

STC COMPONENTS REVIEW

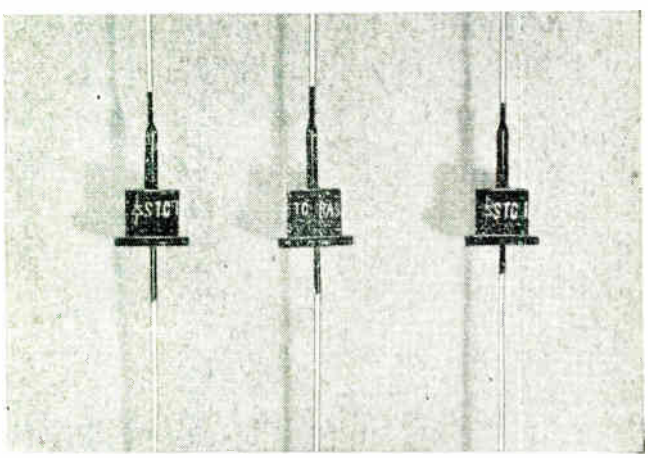
JULY, 1963

SILICON AVALANCHE RECTIFIERS

now in production

The ability to absorb reverse voltage transients is the feature of the new RAS300 series of Silicon Avalanche Rectifiers, the first available on the UK market. The rectifiers have a nominal rating of 1 ampere but they can dissipate reverse transient energy at a rate of 4 kilowatts without damage.

This development represents a giant stride forward, since it overcomes the major disadvantage inherent in all silicon rectifiers — extreme sensitivity to over voltage transients. Until now, circuit designers have had to tackle this problem by using either capacitative/resistive networks or selenium rectifiers to absorb surges, whilst the device manufacturers have endeavoured to increase the transient voltage rating of the device by increasing the turnover voltage of the junction.



Actual size

Most rectifier applications require units capable of withstanding transients in excess of 1 000 volts. Since the energy content of these transients is often unknown, users adopt surge diverter methods to protect the rectifier. However, RAS300 rectifiers have at least fifty times the surge absorption capability of conventional types, which makes added protection unnecessary. The avalanche property of the new rectifiers has a voltage limiting effect and, consequently, these rectifiers can be more efficient than conventional devices when operated in series. Voltage sharing resistors are no longer required and, in many applications, equalizing capacitors can be reduced or dispensed with, simplifying high voltage stack construction.

Development is continuing to extend the avalanche properties to other STC silicon rectifiers. A higher forward current unit, the RAS500, will be available shortly to bring these advances into the medium power field.

Write, 'phone or Telex for Data Sheets and prices to STC Rectifier Division, Edinburgh Way, Harlow, Essex.

NEW SILICON EPITAXIAL PLANAR DIODES FOR FAST SWITCHING

UP TO 30V PIV

The BAY31 and BAY36 are new silicon epitaxial planar high performance diodes. They are specially designed for use in logic circuits working at frequencies of up to 10 Mc/s. Exceptional ruggedness and standardized dimensions make these diodes eminently suitable for use on printed circuit boards.

- LOW COST
- HIGH SPEED
- HIGH FORWARD CONDUCTANCE
- LOW REVERSE LEAKAGE CURRENT
- PLANAR EPITAXIAL CONSTRUCTION
- RUGGED DESIGN
- DO-7 OUTLINE

Actual Size

CHARACTERISTICS (AT 25°C)

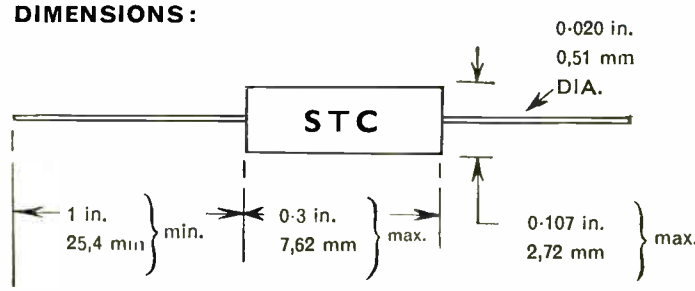
I_R	(Max) at −10V	100nA
V_F	(Max) at 30mA	1·0V
*t_{rr}	(Max) to 1mA	5·0ns

*(I_F = 10mA, V_R = −10 V, R_L = 100 Ω)

MAX. RATINGS

V_R	(mean, peak or transient)	15V	(BAY 31)
V_R	(mean, peak or transient)	30V	(BAY 36)
I_F	(mean)	100mA	
I_F	(peak)	200mA	
P_{tot}		200mW	
T	(operating)	100°C	

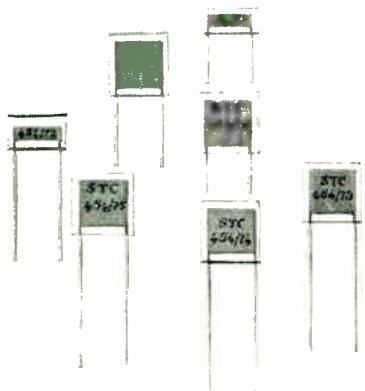
DIMENSIONS:



Write, 'phone or Telex for advance Data Sheet to STC Transistor Division, Footscray, Sidcup, Kent. Telephone FOOtscray 3333. Telex 21836.

MINIATURE SILVERED MICA CAPACITORS

MODULAR DESIGN



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

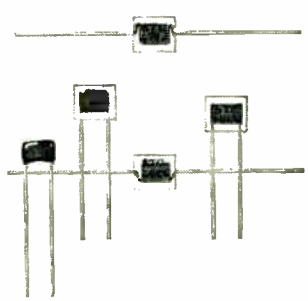
Range 454-LWA-71 to 77, shown above, covers from 4 pF to 40 000 pF (at 125V d.c.) in seven mould sizes of constant length 0·49 in. (12,5 mm).

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 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. Also available for 125V and 750V wkg. The range has been extended to include the new subminiature size shown above.

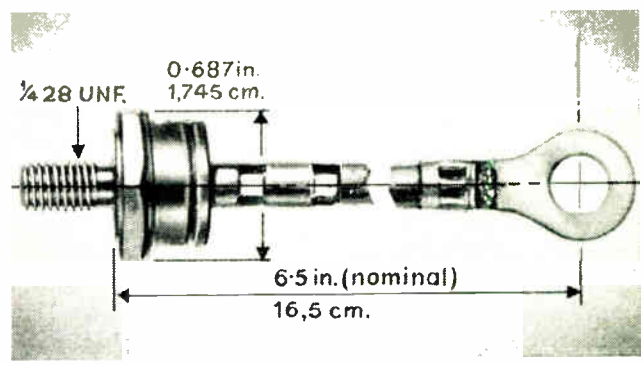
Write, 'phone or Telex for Data Sheets to STC Capacitor Division, Brixham Road, Paignton, Devon, or London Sales Office, Footscray, Kent. Telephone FOOtscray 3333. Telex 21836.

25 AMPERES SILICON RECTIFIERS with dual polarity

Available from Stock

STC RS600 Series silicon rectifiers are rated at 25 amperes at 125°C stud temperature with crest working voltages from 100 to 600V. They are available with a choice of stud polarities to facilitate the assembly of diodes with heat sinks.

RS600 diodes conform to VASCA outline SO.32A and are flexible lead versions of VASCA outline SO.13, JEDEC DO-5 and IEC 1-104.



RS600 MAXIMUM RATINGS (125°C stud temperature)

Average forward current	25A
Surge current (5 milliseconds)	500A
Crest working reverse voltage	up to 600V
Non-repetitive peak reverse voltage (one cycle)	up to 800V
Storage temperature range	−60°C to +150°C
Mean dissipation	30W

RS600 ELECTRICAL CHARACTERISTICS (max. values)

Average reverse current at 125°C stud temperature and at rated voltage and current	1·5 mA
Forward voltage drop at 25 A d.c.	1·1 V

Diodes and heat sinks, assembled into stacks, are available in all circuit configurations.

Write, 'phone or Telex for Data Sheets and prices to STC Rectifier Division, Edinburgh Way, Harlow, Essex. Telephone Harlow 26811. Telex 81146.

COMPONENTS REVIEW

COMPLETE NEW RANGE OF
POWER TRIODES for industrial RF heating

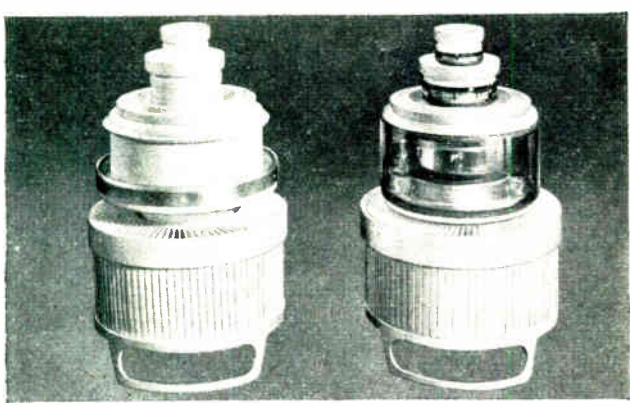
The design of these valves continues the STC philosophy of low mu, high mutual conductance valves for r.f. heating oscillators. This yields high circuit efficiency, low drive requirements and a large safety factor on grid dissipation. This last feature is especially important since circuit design does not always afford complete compensation for change in load impedance with corresponding change in grid drive.

A choice of anode cooling techniques is available for all types — forced air (J codes), water with integral coiled water jacket (R codes) or vapour (Z codes).

Also, a choice of metal/glass or metal/ceramic envelope construction is available for all types. The use of ceramic ('C' codes) permits a considerable increase in maximum operating frequency.

Water cooled valves are to be made available with a choice of connexion of water pipes above or below the valve mounting flange. The former is usually essential when the valve is mounted in a tuned cavity but, for lower frequency induction heating sets, connexion from the underside is often more convenient.

1



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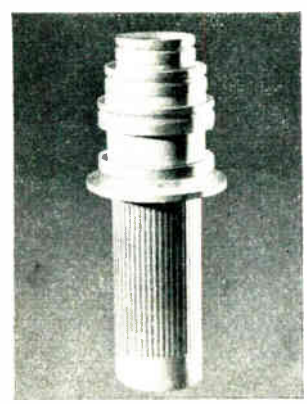

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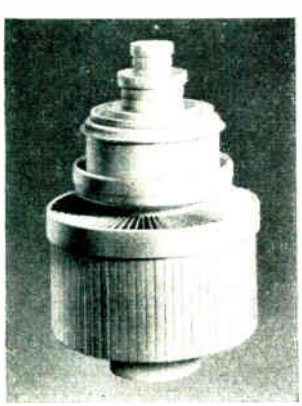

6

7

ABRIDGED DATA

	3J 187E	3R 187E	3J0 187E	3J 203E	3R 203E	3JC 203E	3J 223E	3R 223E	3JC 223E	3RC 223E	3ZC 223E	3R/262E	3RC/262E	3ZC/262E
Typical Output kW	5	5	5	12	12	12	25	25	25	25	25	40	40	40
f max Mc/s	120	120	220	50	50	220	30	30	100	100	100	30	80	80
μ	12	12	12	12	12	12	12	12	12	12	12	12	12	12
gm	22	22	22	32	32	32	32	32	32	32	32	60	60	60
V_a kV	5	5	5	6	6	6	6	6	6	6	6	6	6	6
P_a max kW	3	3	3	6	6	6	10	12	10	12	12	24	24	24
Cooling	Forced Air	Water	Forced Air	Forced Air	Water	Forced Air	Forced Air	Water	Forced Air	Water	Vapour	Water	Water	Vapour
Illustration	2	7	1			5			6				4	3

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

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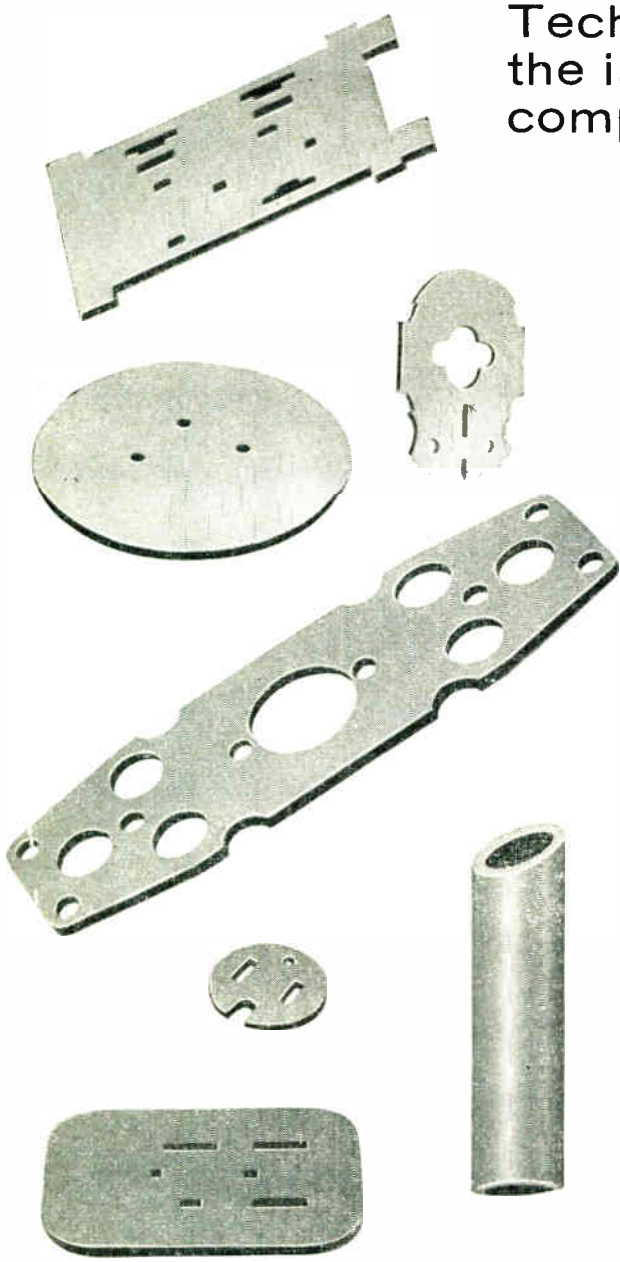

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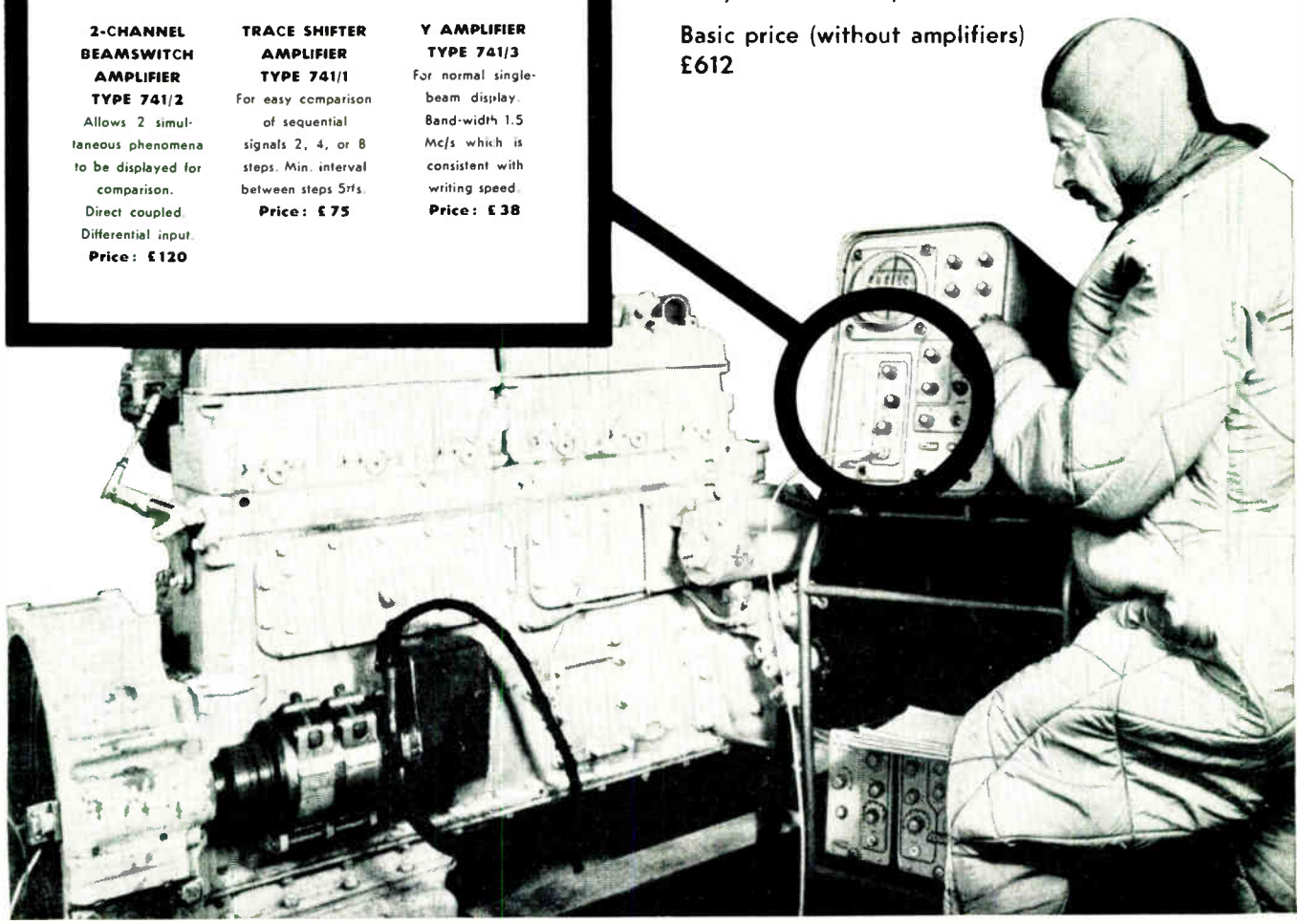

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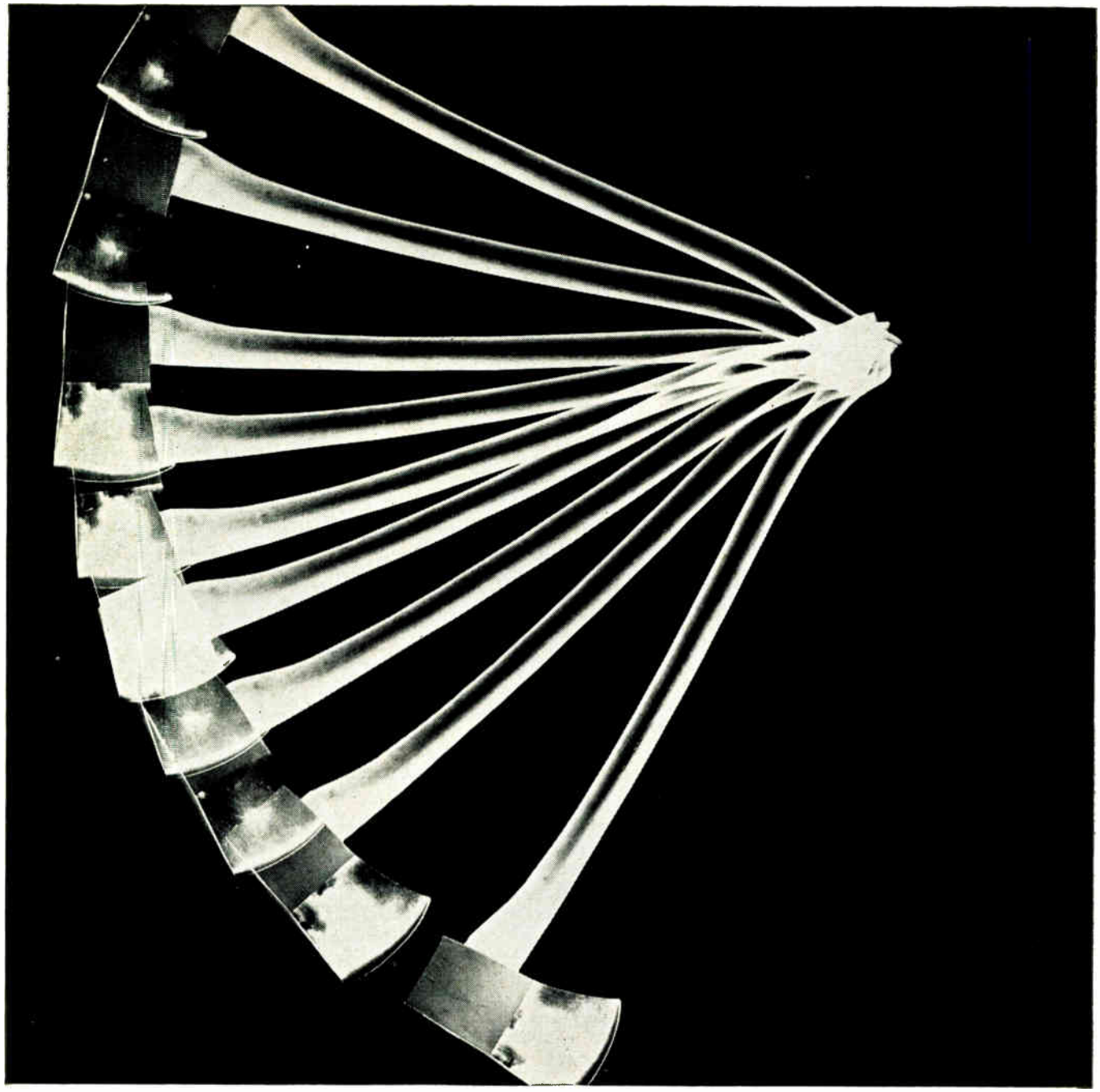


Cheapest way to chop

DC to AC — with an AEI Synchronous Chopper. It fits a standard B9A 9-pin thermionic valve holder, is suitable for feeding both high resistance and transformer-coupled low impedance circuits, its low noise level allows a 1 microvolt signal to be detected. Typical applications are: recording thermo-couple and ionisation chamber outputs; drift correction in analogue computer amplifiers; general instrumentation. Stability is high, operational life is long. Available in two models: CK3 for 50 c/s; CK4 for 100 c/s.

CK3 & CK4 SYNCHRONOUS CHOPPER

WRITE FOR DETAILS AND TECHNICAL DATA TO: AEI INSTRUMENTATION DIVISION, INSTRUMENT AND METER DEPARTMENT, TRAFFORD PARK, MANCHESTER 17

AEI **Associated Electrical Industries Limited**
Instrumentation Division

S/M302

Comment

The importance of training and teaching in a technical industry like ours is now widely recognized. A great deal of work is being done on mechanical aids to the teaching/learning process, and in this issue we include an article which describes some of these modern training aids. Most of them do not in any way depend on electronics for their operation, but they all have application in the electronics industry in the teaching of electronics and its associated skills.

A feature of many aids is the provision of tests for the student so that he may check his progress and make sure that he has understood the lesson. There is no limit to the complexity of the questions which the machine can ask, but it is very necessary that the student's answers should be simple. The student can really only select his answer from a number of standard replies built into the machine, such as 'Yes, No, Right, Wrong'.

Some consider that the type of test in which the student is asked to say which of half-a-dozen statements is right is inherently a poor one. We agree that it is likely to be so if the student is presented with the statements all together, for it can happen that he knows the ones which are wrong without knowing the one which is right. It is easy to overcome this, however, by presenting the statements one at a time in sequence and requiring the student to say of each one whether it is right or wrong. In a batch of statements, too, there should be more than one that is right.

It seems to us that these training aids do meet a definite need and we think that as time goes on a lot more will be heard of them. We think it important, however, that too much stress should not be placed upon the machine itself. However good the machine may be it will not have the desired effect if its programme of instruction is ill conceived. In the end, all depends on a good programme.

One of the oldest training aids in the world is a book. We all know that two books may cover precisely the same ground but one may be easy and the other difficult because one is well and the other badly written. Just as the value of a book depends on the goodness of the writing, so the utility of a training aid depends on its programme.

Radio Astronomy

We talked last month about research and said that team work is now usually necessary. A good example came to our notice shortly after. Not so many years ago radio astronomy was for the individual, now it involves the Ministry of Public Works and Buildings to erect a telescope and the University of Cambridge to operate the equipment and carry out the research.

The cost of the new telescope is £450,000 and it is being erected at the Mullard Radio Astronomy Observatory near Cambridge. It has been designed by Professor Ryle and his colleagues at Cambridge University, and the cost is being defrayed out of a grant of £542,000 from the Department of Scientific and Industrial Research.

There are three aerials each comprising a 60-ft paraboloid the contour of which is maintained accurately within $\frac{3}{10}$ in. The dishes have two motions so

that they can be trained on any part of the sky; the main motion is about an axis parallel to that of the earth so that the earth's movement can be simply counteracted. All three dishes are mounted in the same straight line. Two are fixed half a mile apart, the third runs on a half-mile railway track of 44-ft gauge. The tolerances on this track are $\frac{1}{10}$ in. vertically and $\frac{1}{8}$ in. horizontally in half a mile! Each aerial weighs 118 tons.

The telescope is expected to have a resolution of $1\frac{1}{2}$ minutes of arc which is equivalent to a 5,000-ft aperture aerial. Such an aerial would be quite impracticable for it would cost something like £400M. The use of three aerials and a scanning technique makes the equipment a practical proposition but it makes it necessary to process the signals in a computer to extract from them the required information. This is, of course, also necessary with the existing smaller telescopes installed at this site.

The construction of the telescope has involved major problems of civil and mechanical engineering because of the extraordinarily fine tolerances on everything. Little information about the electronic side of the installation has so far been made available. In spite of 60-ft dishes, the signals produce only about 0·001 μV and Mullard are developing a parametric amplifier with a gain of 20 dB and a noise factor of only 1 dB.

The interest of the new telescope, which is unlikely to become operational for about a year, is at this stage in the combination of civil, mechanical and electronic engineering all pressed to the utmost to achieve something that has never been done before.

But why is it being done at all? The main reason is, of course, the pursuit of new knowledge about the universe and this is truly fundamental research. Naturally it will also afford training in research methods.

Colour Television Demonstrations

Since 16th April the field trials of 625-line television on u.h.f. organized by the B.B.C., the Post Office, the I.T.A. I.T.C.A. and the Radio Industry, have included colour transmissions on the Secam system, for comparison with the N.T.S.C. system on which transmissions have been made since last November. At present transmissions on the two systems are made simultaneously on Channels 34 and 44; towards the end of June comparative tests will also be made with the P.A.L. system.

During the period 8th to 16th July a series of demonstrations of the three colour systems is to be given in London to members of the European Broadcasting Union and members of the O.I.R.T. (representing the broadcasting organizations of Eastern Europe). The demonstrations will include pictures transmitted on each of the three systems and received on both colour and monochrome sets, and will show how the systems compare in performance when operating in the presence of various forms of interference and distortion.

It is planned to hold a meeting of the E.B.U. later this year to review the results of these and other demonstrations, and it is hoped that it will then be possible to make a recommendation on the choice of system.

While it has been suggested that further tests may delay the introduction of a colour television service in the U.K., we think that these comparative tests of the three systems are necessary and commendable.

Radio and Electronic Component Show

We ourselves noticed a much livelier atmosphere about this year's Component Show and we now learn that it had a record attendance. There was a total of 48,902 visitors of whom 2,600 were from overseas. This is a 40% increase on the 1961 exhibition. It is estimated that orders and enquiries to the value of £10M were negotiated.

It was, perhaps, a model of what an exhibition should be. In spite of the attendance it was never unduly crowded, the exhibits were well displayed and, for once, stand numbers were evident!

Printed Wiring and Circuits

How many people distinguish between printed circuits and printed wiring? It seems to us that very few do and that most people regard the terms as synonymous, but usually prefer 'printed circuits'. However, the meanings of the terms are not the same. With printed wiring only the connections between the components are printed. With printed circuits one or more of the components are printed as well as the wiring. So a printed circuit contains printed wiring, but printed wiring is not a printed circuit.

Indium Phosphide

We are reporting new developments in lasers almost every month. This time we have to put on record that laser action has been obtained with indium phosphide. I.B.M. have announced operation of this material as an injection laser at 9,030 Å. Short pulses of coherent light are obtained when the laser is cooled to 77 °K. Pulsed action is obtained with current densities of 6,000 A/cm².

Counters are now widely used in industry. This article explains how they work and describes some of their less obvious applications.

Industrial Applications of Electronic Counters

By M. W. G. HALL, A.M.Brit.I.R.E.

ELECTRONIC measurements may in general be displayed in one of two forms, either as an analogue or a digital presentation. The most important instrument in the analogue class is now the measuring oscilloscope which is to be found in almost every industrial laboratory and is often used in the production area for process setting-up and monitoring. The second class, the digital display type of instrument, is now becoming much more common and the electronic counter is likely to become a most important tool to the industrial engineer. With this instrument any variable which may be expressed as a function of frequency or time or as a number of pulses may be monitored, recorded and hence controlled.

Facilities and Operation

The instrument may vary in the facilities provided and thus its price can range from as low as £150 or so for the simplest low-frequency counter to over £1,000 for the most sophisticated high speed counter/timer. In general, however, all possess a layout similar to that shown in Fig. 1. The input pulses, or the cycles of the frequency being measured, are applied to a chain of cascaded decade counting units for an accurate period of time determined either by external start and stop pulses or derived internally. Where the latter is the case, a second chain of decade units divides down pulses from a highly stable and accurate crystal oscillator. This facility at once enables accurate time measurements to be made since these precise timing units may themselves be applied to those decade counting units which are equipped with the readout devices. To realize the full accuracy of the instrument when measuring low frequencies it is common to measure the periodic time —sometimes, in fact, providing 10, 100 or 1,000 period average by dividing down the input frequency in otherwise unused decades in the time-base group before application to the stop and start gates.

Usually, both automatic and manual 'reset' and 'count' controls are fitted—often with a variable display period control.

The read out devices may take the form either of a columnar display of neon tubes or filament lamps illuminating figures; a large character in-line readout formed by

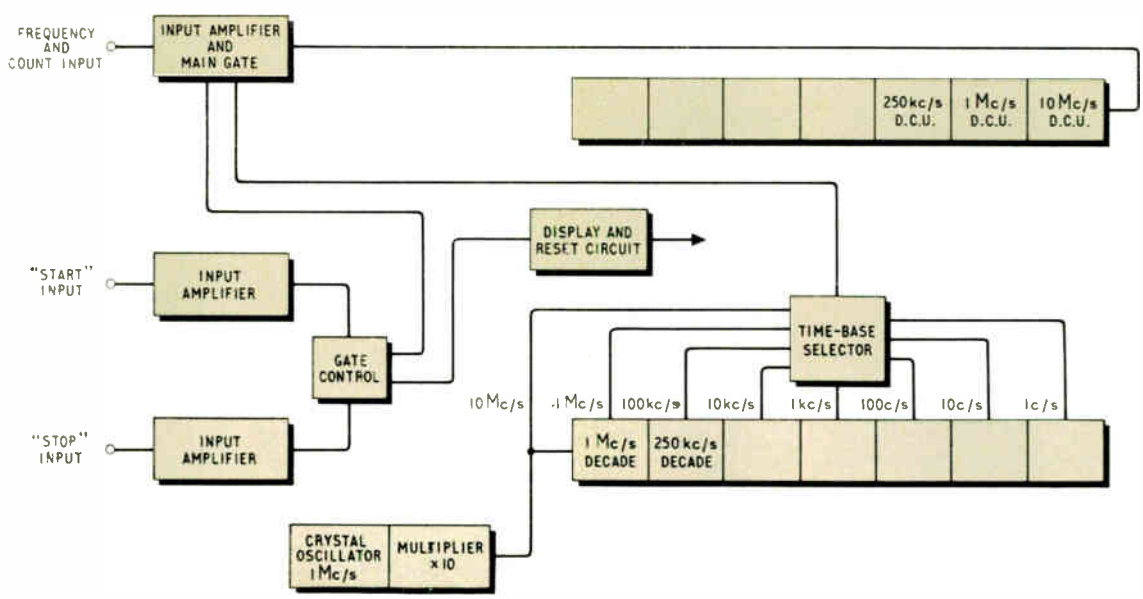


Fig. 1. Block diagram of counter. D.C.U. is an abbreviation for decade counting unit

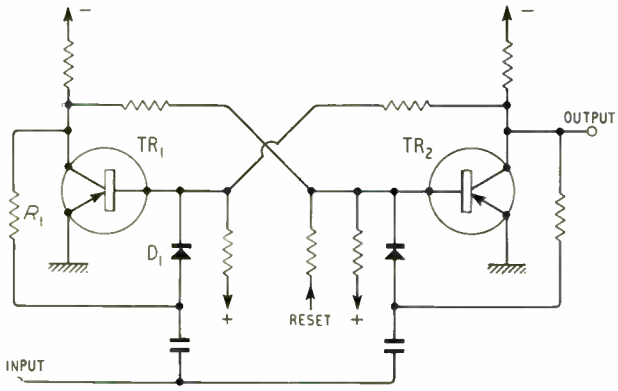


Fig. 2. Circuit of bistable multivibrator which is the basis of most counting circuits

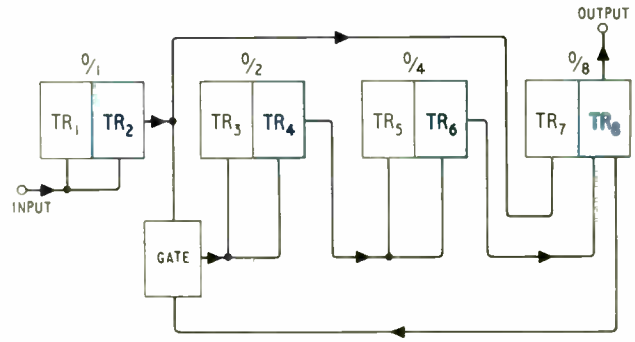


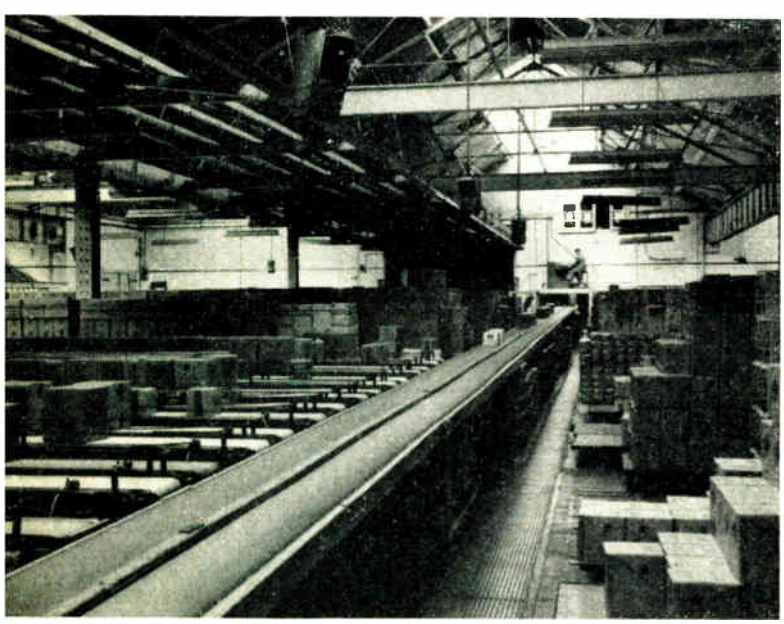
Fig. 3. A decade counting unit can be made from four bistable multivibrators like the one in Fig. 3 and a gate

gas-filled numeral tubes or filament lamp projection units, or perhaps by moving-coil meters (which may in fact also provide an in-line readout by a projection mechanism). The decade counting units usually consist of bistable multivibrators of the form shown in Fig. 2.

The multivibrator will be familiar to most engineers but a brief explanation may not be out of place. Assuming that initially TR_1 is off and TR_2 on, then the collector of TR_2 will be near 0 volts. A positive-going input pulse will be directed to the base of this transistor since the drive diode D_1 in the base circuit of TR_1 is biased off through R_1, the collector of TR_1 being near the negative supply rail voltage. TR_2 is then cut off and the action transferred to TR_1 which goes hard on, this process being mutually accelerative until the other stable condition is reached. The condition at the output terminal is thus either zero or the negative supply rail voltage.

Four such units can be connected and with suitable feedback it can be arranged that a count of 10 is achieved. One such system is shown in Fig. 3.

In this system the first three flip-flops are cascaded in a conventional manner, the final flip-flop being two-line

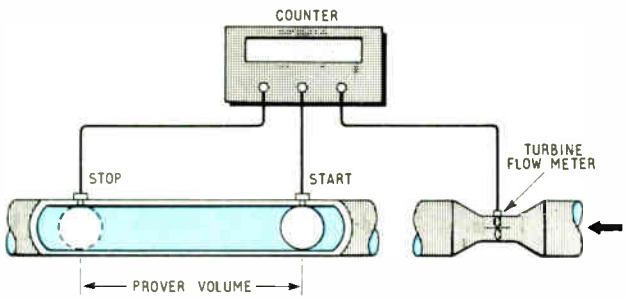


A common industrial application of counters is in counting packages on conveyor belts. An Allen West counter can be seen with its operator at the far end of the belt

TABLE 1. SOME TYPICAL APPLICATIONS AND TYPES OF TRANSDUCERS

Function	Type of Transducer
(a) Frequency Meter	
Flow-metering	1. Magnetic induction with small revolving runner inside a tubular element
Measurement of steel strip thickness by the ratio of ingoing and outgoing velocities	2. Coaxial magnetic transducers (used with toothed wheels on extensions to deflector roll shafts)
Tachometry, r.p.m. of engines, turbines, machinery shafts etc.	3. Magnetic pick-up, variable reluctance, photo-cells (or photo-transistors)
Control of machinery shaft speed, hunting etc.	4. As 3
Weighing	5. Digital potentiometer, shaft encoder etc. converts angular rotation to digital form.
Length measurement of paper, textiles etc.	6. Photo cells etc. with slotted discs on roller shafts
Strain gauge measurement etc., tensile or compressive stress	7. D.c. signals applied to voltage/frequency converter
Pressure measurement	8. Potentiometer pressure transducer plus v/f converter
Length measurement, extensometer etc.	9. Displacement transducer, linear potentiometer plus v/f converter
Temperature measurement	10. Thermocouples plus v/f converter
Vibration and acceleration measurement, shock wave detection	11. Piezo-electric or quartz accelerometer plus v/f converter
Weighing	12. Resistance strain gauge plus v/f converter
Measurement of linear acceleration	13. Potentiometric accelerometer plus v/f converter
(b) Counter	
Measurement of integrated liquid flow (fuel consumption etc.)	14. As 1
Item counting, batching etc. (proximity and position indication)	15. Capacitance transducer probes, photo cells etc.
Measurement and control of integrated weight (proportional mixing etc.)	16. As 5
(c) Timer	
Measurement of fuel consumption	17. Photocells
Velocity measurement	18. As 17
Viscosity measurement by time taken for an object to fall through the liquid	19. As 17
Control of valves, pumps etc.	20. Limit switches etc.

Fig. 4. Typical set-up for checking a turbine flow meter



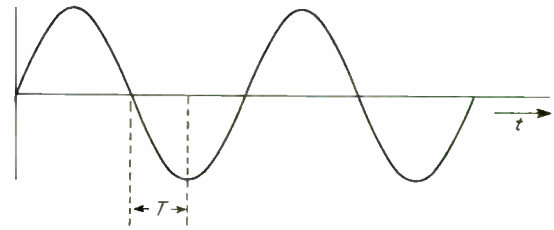


Fig. 5. Measurement of phase angle by time interval

driven. Thus, on the count of 8 when $TR_{7/8}$ is switched the gate is closed, the next positive-going output from $TR_{1/2}$, which occurs at a count of 10, being routed directly to the 'on' side of $TR_{7/8}$, thus resetting the decade to zero. This provides pure binary 1-2-4-8 working.

It is often desired to record the readings obtained and this may be done with a suitable printer actuated at the completion of each count. The printer is controlled by the condition of the binary circuits in the counting decades which is made available at a multi-way connector as a convenient d.c. signal.

Applications

Table 1 shows some typical applications and the types of transducers which may be employed. It will be seen that these fall into three categories.

(a) *Frequency Meter*

This covers those uses where the variable to be assessed may be expressed as a function of frequency, either by the generation of an alternating voltage, or by the variation of a signal frequency generated in the ancillary apparatus.

(b) *Counter*

These types cover the straight-forward totalization of events and, in some cases, such counters are equipped with pre-set facilities, so that at the end of the pre-determined number of events an output can be provided to perform some control function.

(c) *Timer*

In these applications elapsed time is measured. Here again we may either measure the time between two events which represents the variable to be monitored or the device may on occasion be pre-set so that an accurate time interval can be offered for process control. The device thus acts as a digital clock.

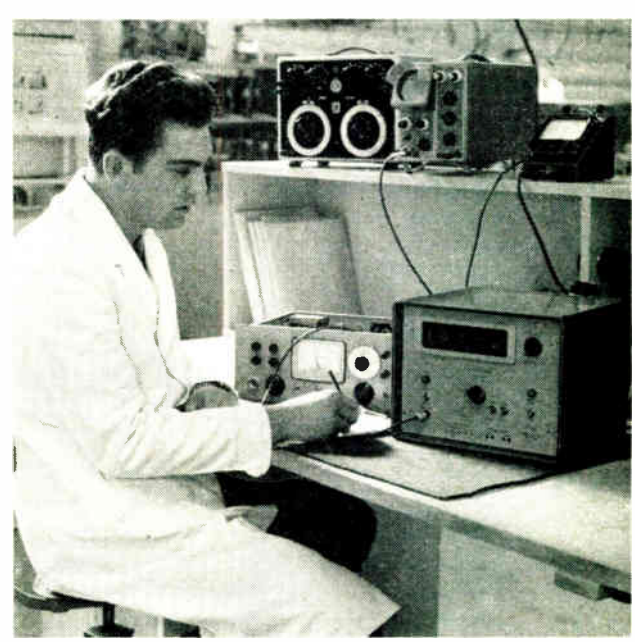
Those industries where processes are applied to large quantities of raw material with no individual items involved have been the first to adopt automation and it is in these fields that the electronic counter is now making its impact.

Examples are clearly chemical processing, steel making, textile and paper production. Allied techniques are to be seen in those industries where repetitive processes are carried out on large quantities of identical individual items; i.e., can and bottle manufacture and the filling of such receptacles and other boxes and packages.

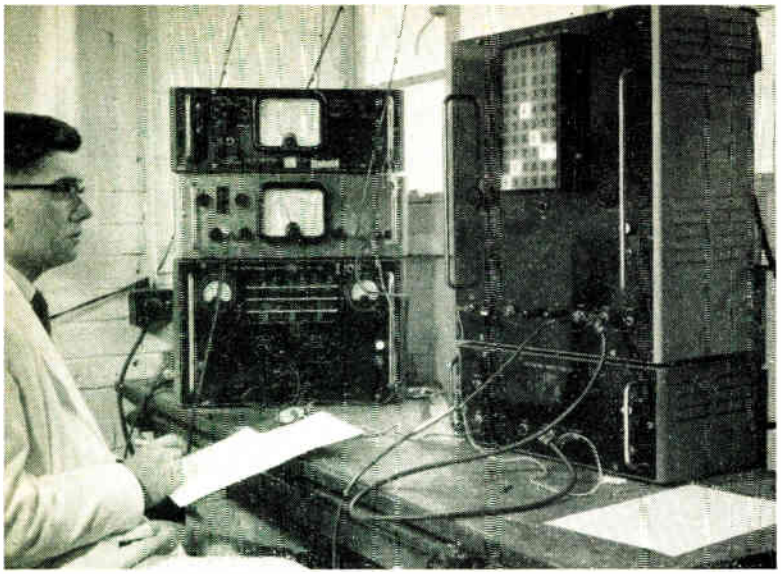
Steel Strip Length Measurement

The steel industry has applied electronic control and monitoring to several processes. Table 1 gives an example in the use of a counter to measure the thickness of steel strip from a rolling mill by computing the ratio of input and output velocities. Another interesting application is the measurement of length in conjunction with the closed-circuit television equipment which is now in use in many such installations. The t.v. unit is used to observe the steel strip and thus, since in the camera tube the peak-white image is scanned linearly, a signal can be derived which is a direct measure of length. This is conveniently done by placing an optical element in front of the camera tube arranged to superimpose a bar pattern on to the photo-cathode and so modulate the peak-white video signal into a train of pulses, the number of pulses being proportional to the length of the image and so of the steel strip. To accommodate additional length beyond the view of the camera larger increments may be pre-set and fed into the counter when the end of the steel strip arrives at one of a number of stations where a photo-cell is positioned. The count of the pulses is then added on to the pre-set quantity.

The pre-set facility may be obtained by arranging that the counter totals up the internal clock pulses until the condition of the counting binaries as evident at the print out connector agrees with that desired. Some highly developed



A Southern Instruments counter is being used here as an aid to accurate measurement of amplifier performance



An Airmec counter is being used for measuring the time difference between the zero points of two sine-wave signals

counters may be equipped with more sophisticated forms of pre-set facility and indeed a high and low value may be selected and the counter arranged so that if the function to be counted deviates beyond these values an alarm or control signal is produced. The device is thus used as a 'go–no go' gauge.

Flow Metering

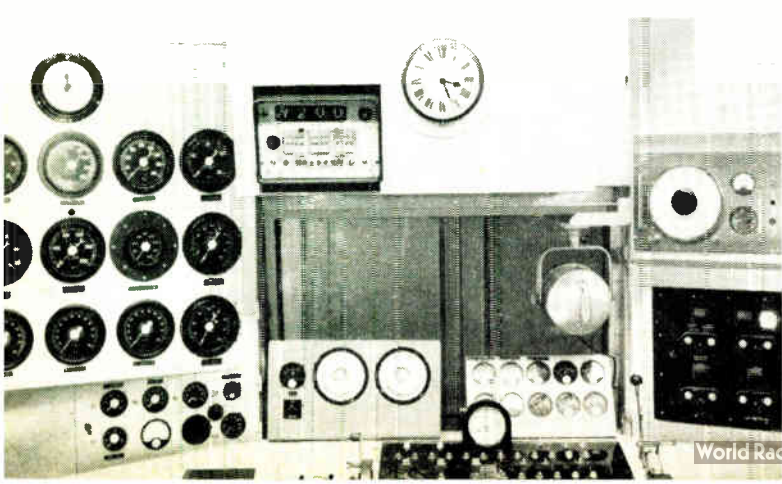
Table 1 gives an example of the type of transducer which may be used for general applications. One major use of flow measurement is to compute the fuel consumption of jet aero-engines, etc. Totalization of the number of revolutions of the turbine runner provides a measure of total fuel flow and thus the frequency of the output pulses may be equated to the rate of fuel flow. A very specialized form of electronic counter which may be used in conjunction with this kind of computation is the Time-Function Translator. This instrument may be used to convert one function of time into another function of time, for example fuel flow may be converted into pounds, gallons, pounds per hour, gallons per hour, etc. This operation can be performed by the provision of a time base variable in fine discrete incremental steps instead of the more usual decade steps. The correct factor may thus be applied as shown in the following example.

If the turbine gives 10 pulses per revolution then a gate time of 6 sec gives a readout directly in r.p.m. Thus if there are X revolutions per gallon, then a gate time of $6X$ sec gives a readout directly in gallon/min.

In some counters of this type a second set of decade counting units equipped with readout devices is arranged to indicate the selected gate time by counting the appropriate number of clock pulses.

The proving of turbine type flow meters may also be carried out as shown in Fig. 4. The total number of output pulses is recorded for a period of time determined by the displacement of the previously measured prover volume as evidenced by the movement of the spherical piston from the start detector to that at the stop position.

Racal SA501A digital computing counter controller installed in a test bay at Bristol Siddeley for checking the performance of a jet aircraft engine



Phase Measurements

There are numerous applications where it is desirable to measure the phase difference between two signals. For example, in the study of mechanical systems measurement of the phase angle between force and velocity permits the use of impedance techniques in the mathematical analysis.

Again, the measurement of phase angle enables comparison to be made of the damping characteristics of similar structures.

The out of phase signals are derived by separate transducers, e.g. a force transducer and a velocity or displacement transducer.

Such measurements may be conveniently carried out on a general-purpose counter by measuring the time interval between two identical points on the waveform as shown in Fig. 5. This may be done by applying the reference and out of phase signals to the stop and start gates. To render the read-out directly in degrees special timing units must be provided externally from a suitable oscillator at a frequency 360 times that of the signal frequency.

A more elegant method provided on specialized counters is that shown in Fig. 6. It will be seen that the two signals whose phase difference is to be measured are applied to the two input circuits. After shaping and level adjustment

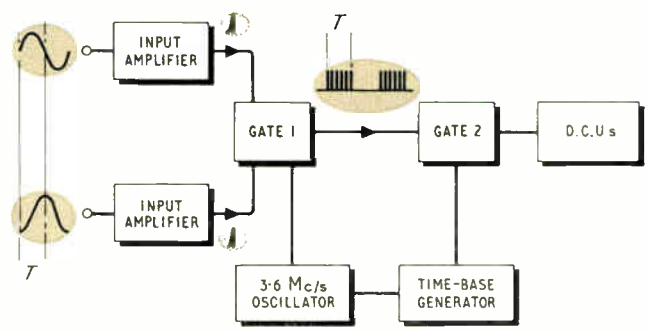


Fig. 6. Special counting arrangement for the measurement of phase angle

these two signals operate Gate 1, one signal opening the gate to permit a burst of pulses through to the counter, the second, determined by the lagging phase terminating the burst. The second gate ensures that the read out is directly in degrees irrespective of the frequency of the input signals. It also determines the discrimination to which the angle is read.

For example, if there are x pulses/cycle for a given phase angle at a certain frequency then raising the frequency n times will dictate that there will be x/n pulses/cycle but for the same gate time as before there will be n cycles; i.e., xn/n or x pulses again.

Conclusion

The preceding discussion touches briefly upon some of the more common industrial applications of electronic counters. In general the accuracy of any digital counter cannot be better than plus or minus one digit of the least significant figure with, of course, the additional error due to the tolerance of the internal crystal standard.

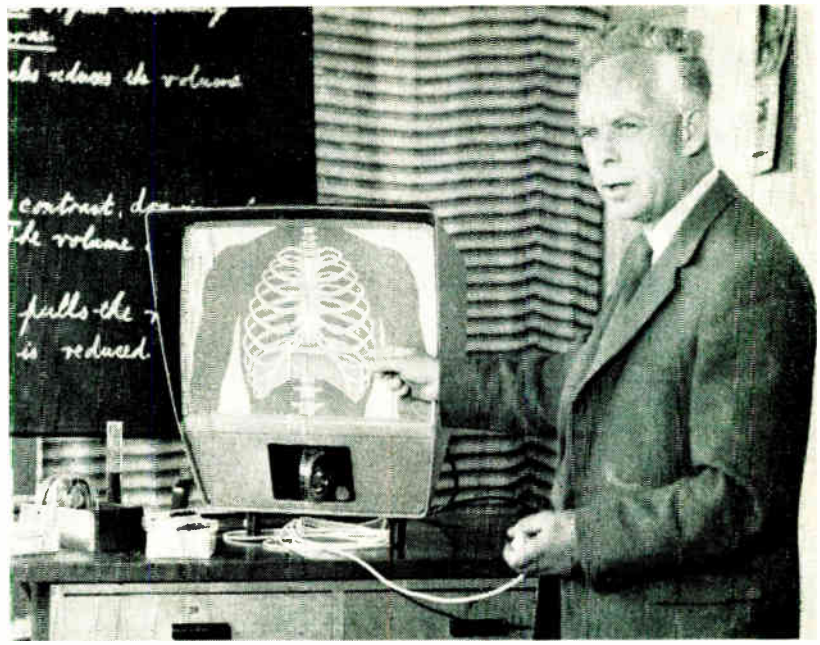
For frequency measurement, accuracy is proportional to f/T where f is the unknown frequency and T is the gate time.

For period measurement, accuracy is proportional to NV_s/V_n when N is the number of periods and V_s/V_n is the signal-to-noise ratio.

New Aids for Industrial Training

By R. C. WINTON, B.Sc., A.C.G.I., M.I.E.E.*

There has recently been considerable interest in new ways of training and there are now a number of different training aids ranging from special books to adaptive machines. In this article some of these aids are described and their special characteristics outlined.



Technicolor type 800E projector with an 8-mm concept film. The cassette can be seen below the screen

IF the Government proposals on industrial training, contained in the recent White Paper, live up to their promise, there is bound to be a very considerable increase in the volume of practical training, whether it is carried out in industry, in technical colleges, or in the training centres which the proposed training Boards will have power to set up.

This expansion will bring with it the problem of finding sufficient instructors, and the proposals themselves are bound to lead to a new outlook on almost every aspect of industrial training. For both these reasons I expect to see increasing use of a number of teaching aids which have become available during the past year.

The new aid which seems to hold the greatest promise for practical training in the immediate future is the silent 8-millimetre concept film. It is so-called because instead of running for 20 to 30 minutes and dealing with a complete subject, like an ordinary film, it runs for between half and six minutes and deals only with one idea or concept, such as the motion of a single particle in a medium transmitting a sound wave, or the relationship between a point describing a circle and sinusoidal motion.

Other outstanding features of the concept film are the simplicity and relatively low cost of the projector and of the films. Each film is in the form of an endless loop with a take-up coil, and is supplied in a cassette which is simply plugged into the front of the special projector in order to show the film. No threading is required and positioning is automatic.

The only projector marketed so far is the Technicolor type 800E at £55. The price of films varies from £1 to £1 10s. Both films and projectors are available from the Educational Foundation for Visual Aids **(38).**

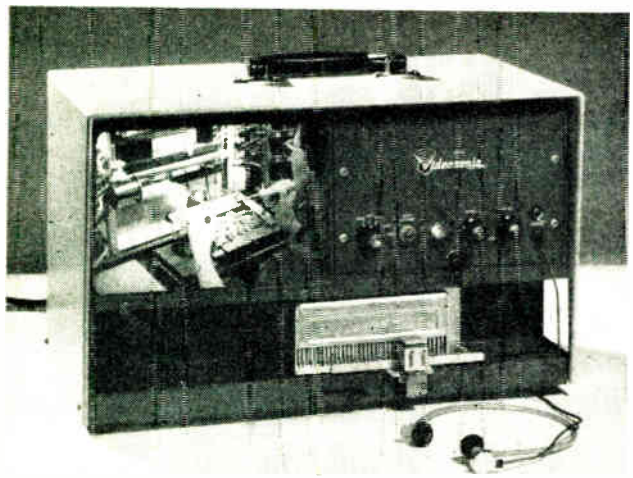
Concept films clearly provide an excellent means of helping the instructor to demonstrate the correct use of hand and machine tools, and of bringing various processes to life, the heat treatment of metals for instance, by showing them actually being used in industrial processes.

This is a recent development, so that although the library of films is being built up it is not yet extensive. However, among the subjects already covered are riveting, filing, use of the cold chisel, construction of a sliding bevel, cutting a thread, and tapping.

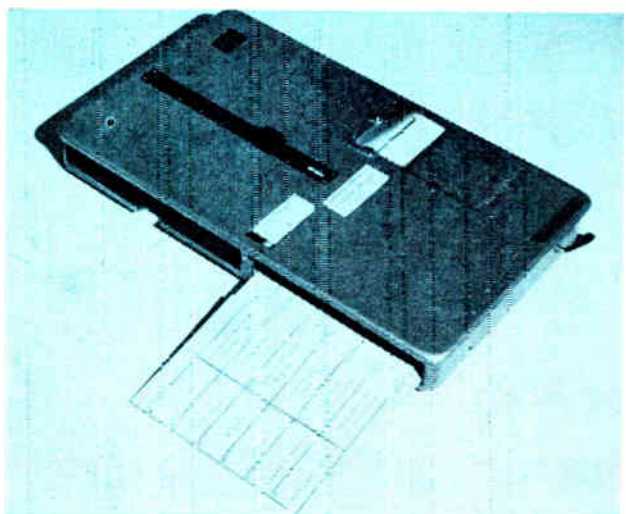
Advantages of concept films being silent are that the instructor can give his own commentary, suited to his particular teaching methods and to the level of his audience, and that there is no outside speaker, which many teachers feel tends to separate them from their class.

Another new device with possible applications in the training both of skilled and semi-skilled personnel is the Videosonic system of audio–visual

Mullard Ltd.



The Videosonic automatic slide projector with synchronized tape recorder



The Esatutor, a relatively inexpensive teaching machine using linear programmes

Close-up of keyboard and display panel of SAKI for training I.B.M. card-punch operators

presentation of information. This is a small portable unit incorporating a slide projector and a tape recorder. Slides are automatically rear projected in sequence on to a small screen built into the equipment, and synchronized with the tape recorder.

Thus, as each slide is seen, the appropriate commentary can be heard, either through headphones or over a loud-speaker.

The Videosonic equipment was originally developed by the Hughes Aircraft Company of California to present semi-skilled workers with the correct procedure for wiring-up electronic assemblies which were so complex that the normal written instructions, wiring diagrams and drawings failed to make the proper procedure clear.

The Videosonic programme can easily be changed simply by inserting a new set of slides and a new tape. Besides its application to assembly work it has obvious applications to industrial training of both semi-skilled operators and apprentices. The equipment is available from Audio Visual Methods Ltd. **(39).**

Another aid, or rather a whole field of aids, which has been little exploited for industrial training in spite of its great potential, is programmed instruction, which comprises teaching machines, including the adaptive types, and books. Before considering how this technique might be used, it is essential to understand how it operates.

The method presents the student with information in such a way as to ensure as far as possible that he understands it; the way in which the information is presented is called the programme. There are two main types of programme—the linear, developed by Professor B. F. Skinner, of Harvard University, and the non-linear, multiple choice, intrinsic, or branching programme developed by Mr. N. A. Crowder, of the Educational Science Division of U.S. Industries in America.

In the linear programme the student is presented with information in a logical sequence of small steps, and tested after each step.

As an example, take this extract from 'Earth in Orbit', a book with a linear programme by Patrick Thornhill, published by Methuen at 3s. 6d., which should be read by anyone interested in how this type of programme works.

'Another word for the turning or spinning movement of the Earth is its ROTATION. We can say that the Earth ro . . . . . es. (rotates)

'The Earth rotates from . . . . . st to . . . . . st (West to East)

'If you thread a bead you can make it rotate on the thread; the thread through its centre marks the AXIS on which the bead r . . . . . es. (rotates)'

After the student has filled in his answer he can check it against the correct answer (given in brackets above), and by examining his replies afterwards the teacher can assess his understanding.

The replies are intentionally made easy, and in a properly written programme they should all be correctly answered by 95 per cent of the students. This is necessary because if a student makes a mistake there is nothing in the programme to show him why he is wrong.

This is in contrast to the non-linear, multiple choice programme, in which the student is presented with information in somewhat longer steps, and then tested immediately by a question to which several possible answers are given. If the correct answer is selected the lesson proceeds with the next step, but if the answer is wrong the student is given what is termed 'remedial material' to explain his mistake, and then returned to the original step for another attempt to get the answer right.

In a teaching machine for a non-linear programme the information is projected from frames on a filmstrip on to

a screen, and the student presses a button corresponding to the answer he selects. This automatically projects another frame, which may be either remedial material or the next step in the lesson.

In a book the student is given the page number to turn to in accordance with the answer he selects—to make 'cheating' as difficult as possible these pages are placed in the book at random, and these books are therefore sometimes called scrambled books.

A series of such books, called Tutortexts, has been published by the English University Press at 25s. each. The following extract from page 16 of one of these, 'Introduction to Electronics', shows how the multiple choice programme works.

'Each proton in the nucleus has one positive charge. Each electron has one negative charge. Normally there are just as many electrons in orbit as there are protons in the nucleus. The positive and negative charges just balance. What would happen if one electron were missing from an atom?

The atom would be left with a negative charge page 4.
The atom would be left with a positive charge page 11.'

On page 4 the student reads:—

'Take an atom with six protons in the nucleus and six electrons in orbit. Now remove one electron. You're left with six positive charges—but only five negative charges. So the atom is left with one extra positive charge.

Please return to page 16 and select the correct answer.'

There is still little agreement on which of these two methods is the better, nor is there likely to be for some time, since one of the unexpected revelations of programmed instruction is that we really know nothing about the best ways of teaching or the actual processes by which we learn. Probably we shall find that one method is better for some kinds of instruction, and the other for different kinds.

On one point, however, there can be no doubt—a linear programme can be presented better in book form than a non-linear programme, and can be used with a far cheaper teaching machine than a non-linear programme. For instance, the Grundytutor, a teaching machine for non-linear programmes marketed by International Tutor Machines Ltd. **(40)**, costs £230, compared with £14 16s. for the Esatutor, a linear machine marketed by the Educational Supply Association Ltd. **(41)**.

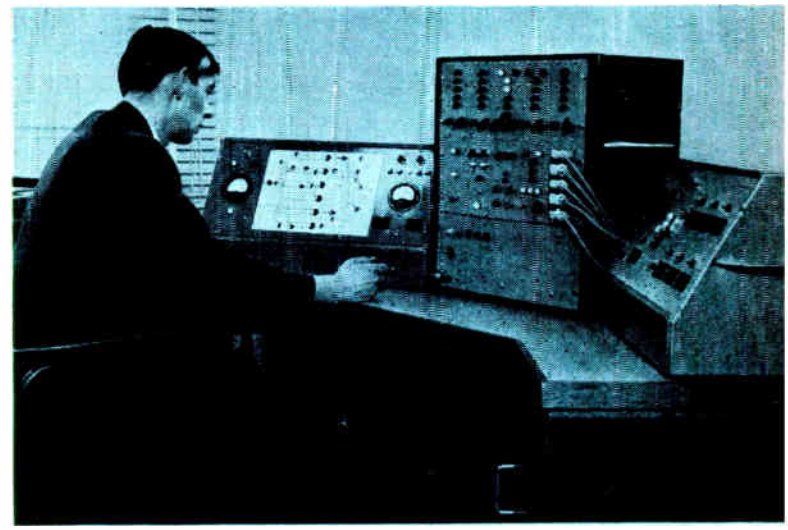
The Empirical Tutor marketed by Lampson Industries Technical Products Ltd. **(42)** can present information not only by projecting printed material on a screen, but also through the use of a tape recorder, slide projector, oscilloscope, or meter, and so helps the student's understanding and retention by enabling him to use more than one of his senses.

In understanding programmed instruction it is vital to appreciate that the teaching machine is only a means of presenting the programme to the student, and that its success depends entirely on the quality of the programme itself.

Hitherto I have been writing about non-adaptive machines with programmes which remain unaltered whatever the ability of the student; he can merely learn more or less quickly.

Adaptive machines on the other hand can change their programmes in accordance with what they learn of the student's ability, and thus approach more closely to the normal student-teacher relationship. As they are necessarily more complex than non-adaptive machines, however, they are more expensive.

The first adaptive machine marketed in this country was the Solartron Automatic Keyboard Instructor (SAKI), now handled by Cybernetic Developments Ltd. (C.D.L.)



An adaptive teaching machine developed by Cybernetic Developments Ltd., comprising a general purpose controller (centre) and the experimenter's display console (right) here shown controlling a small generalized fault-finding training display applicable to computer logics

(43). The machine continuously alters its programme so as to give more practice on those keys on which the operator makes mistakes, and as she gains experience she is required to operate the keys more quickly.

Among the adaptive machines which C.D.L. are now developing is an equipment to give instruction in quick reading and to test comprenension. It can not only measure the student's reading speed and adapt its programme accordingly, but it can also determine whether he is better at understanding factual or generalized information, and give more practice on the type of material on which his comprehension is less.

Another C.D.L. machine can teach electrical and electronic service engineers the methods, logical thinking and intuition necessary for fault finding in complex equipment. Control equipment, computer logic elements, and counters are simulated, and the serviceman taught to fault find by measuring a.c., d.c. and signal voltages at different points with the use of a circuit or block diagram.

The machine adapts itself to improvements in the

The AutoTutor being demonstrated by Mr. Norman Crowder, who developed the intrinsic programming technique used in this teaching machine

student's skill by presenting more complex faults, reducing the time allowed for finding the fault, and presenting less information for him to work from.

Among the first users of SAKI are B.E.A., for training I.B.M. punch-card trainee operators, and the Royal Assurance Company, for training the punch-card operators who will feed the De La Rue Bull computers which they are to install at their Acton and Liverpool offices.

B.E.A. were also among the first to use non-adaptive machines—they installed the AutoTutor, made by U.S. Industries **(44)**, last year to teach their staff how to complete aircraft load sheets. Another organization to use these machines are Richard Thomas and Baldwins, for their apprentice and operator training, and in this case they even trained their own staff to write the programmes for them.

I have heard an estimate that 1,000 training centres, each with 250 trainees, will be needed to implement the new Government proposals on industrial training contained in the White Paper. Even if this is considered fanciful, there is no doubt that a tremendous expansion in training facilities will be required, and in my opinion the only way we can raise the necessary instructional effort sufficiently quickly, or indeed at all, is by making use of the advances in teaching technology, some of which I have described. It is not so much a case of whether we make use of them, but of how and when we do so.

For further information on a specific item circle the numbers in brackets on the Service Card

ATLAS MASS FILTER

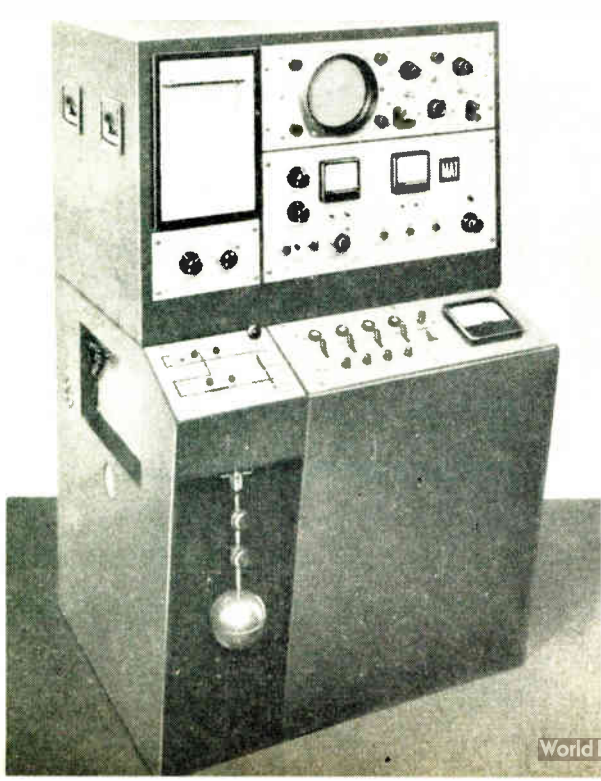
A SMALL and easy to operate ion filter of high sensitivity for qualitative and quantitative analyses of gases and vapours has been introduced into the U.K. by Europa Engineering. This instrument is suitable for quality control of production gases, control of chimney and flue gases, safety monitoring of gaseous area and like applications.

Known as mass filter AMP3 it is produced by Atlas MAT of Bremen and, by mass spectrometry, it provides for analyses in the mass range 2 to 100.

Principles of Operation

The gas to be analysed is introduced into the ion source at a pressure of between 5×10^{-4} and 10^{-12} mm Hg. Ionization is achieved by electron bombardment, and the ions are beamed by means of an ion-optical lens into a quadrupole electrical field. The field is generated between four cylindrical rods to each of which a d.c. voltage with a superimposed high frequency a.c. voltage is applied, adjacent poles carrying opposite charges.

A console version of the equipment with the vacuum pumping system and sample container fitted in the bottom half



The amplitude and frequency of the superimposed a.c. and the corresponding d.c. component define the mass of the ions which will pass along this field and impinge on the collector at the farther end. Ions of mass either greater or less than that defined will be excited to oscillate within the field and will finally pass out of the ion beam. By alteration of the h.f. voltage ions of any mass between mass numbers 2 and 100 may be brought on to the collector. The ion current at the collector, which is directly proportional to the partial pressure of the components of the gas under analysis, is amplified and recorded.

There are several advantages peculiar to this method of ion separation:

(1) No magnet is employed, and consequently the gauging tube can easily be connected anywhere in an existing pipework system.
(2) Within the mass range, 2 to 100, the transmission of the quadrupole field amounts to a maximum 100%.
(3) The partial pressure of a component and the total pressure can be measured.
(4) Indication is quantitative and the mass scale is linear.

Construction

In order to make the mass filter as versatile and adaptable as possible, the instrument is constructed on the unit principle, permitting extension of the range of application by means of additional units.

The basic instrument consists of: A gauging tube with ion source, analyser (quadrupole field) and collector. In addition the following units are housed in standard 19-in. rack mounts in a portable case: Ionization unit, which delivers the ion source operation power. The h.f. generator, which delivers both the h.f. and d.c. supplies for the quadrupole system. The d.c. amplifier with indicating instrument for the amplification and indication of the ion current.

To extend the range of application, a number of units may be built on to the basic equipment.

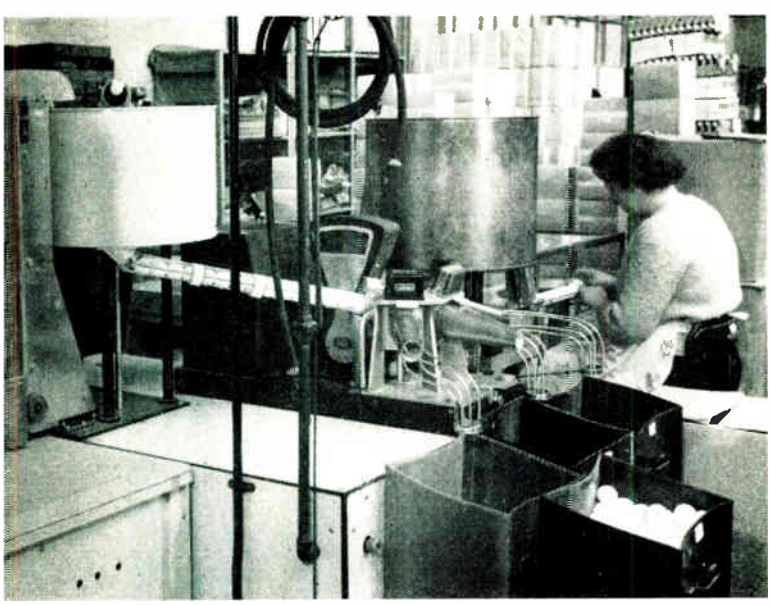
For further information circle 45 on Service Card

This article describes a simple automatic weighing machine developed for table-tennis balls. It also sorts the balls into three categories of weight.

WEIGHING TABLE-TENNIS BALLS BY ELECTRONICS

AT some time in life most people play table tennis, but unless one is a keen player very little thought is given either to the balls used or to the effort that has gone into making them. Throughout the manufacture of all table-tennis balls produced by Halex Ltd. processes are held to very close limits and extensive testing is carried out to ensure that each ball meets an accepted standard. Following a series of mechanical tests, which include those for flaws, bounce and bias, Halex Ltd. weigh each and every ball produced! Those falling within the range of 37 to 39 grains are classified as 3-star or top-grade balls, those within the range 39 to 41 grains are classified as 2-star balls, and those greater than 41 grains and less than 37 grains are general-purpose balls.

Considering that there are 437·5 grains to the ounce, it is quite difficult to devise quick and economical methods of classifying very large quantities of table-tennis balls. Until the early 1950s Halex employed operators, with scale balances, to weigh and classify each ball manually—a slow and laborious process. It was at this time that one of the production supervisors at Halex decided to think about a design for the automation of the weighing of balls and by 1954 Elcontrol had engineered and delivered two automatic weighing machines. By close co-operation between Halex and Elcontrol a simple but efficient system was produced at a modest cost using a standard scale balance, four photoelectric detectors and four amplifiers with relays in their output circuits to control counters and electromagnetic air valves.



General view of the apparatus. The balls are fed down a chute from the hopper on the left, pass through the weighing section, and out into one of three bins, according to weight

In operation, the balls are automatically fed from the bias-testing table into a hopper. A chute from the hopper terminates just above the weighing platform of the scale balance and the balls are retained in the chute by an electromagnetically-opened shutter. The weighing platform, or ring into which the ball is dropped, is at one end of a horizontal pivoted arm while at the other end there is a small metal flag which interrupts the light falling on to one of four photoelectric cells according to the weight of the ball.

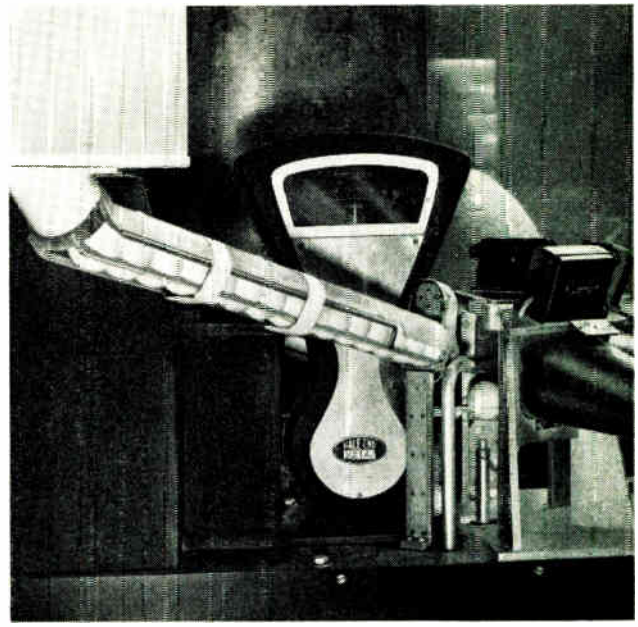
The sequence of operation is as follows: The shutter on the hopper chute opens and allows one ball to fall into the ring on the scale balance pivot arm, causing it to move. As the ring-end of the pivot arm moves downwards so the other end, on which there is a metal flag, moves in an upward direction. When the arm comes to rest, the flag interrupts the light, from an associated bulb, falling on to one of four vertically-mounted photoelectric cells and produces a change in the output signal from that cell.

Each cell is mounted in a position corresponding to a particular weight range. The lowest is operative for balls weighing less than 37 grains, while the highest operates when a ball weighing more than 41 grains is in the ring of the pivot arm. The two intermediate cells cover the weight ranges 37 to 39 grains and 39 to 41 grains. The change in output signal from the photoelectric cell is amplified by a double-triode amplifier associated with that cell and causes a relay in the output circuit of the second triode to operate. Contacts on the relay close and energize two electromagnetic

air valves which blow the ball out of the ring and down one of three chutes. At the same time the relay contacts provide a switching signal for the electromagnetic counter attached to the output chute.

With the ball removed from the scale balance the pivot arm returns to a zero position and in so doing causes the photoelectric cell, its amplifier and associated relay to return to their original condition. During this final sequence of events, contacts on the relay produce a signal which makes the shutter on the hopper chute open, releasing another ball, and close.

Two of these weighing machines will do the work of 5½ operators. Since 1954 two of these machines, combined into a single system, have been in operation for about 50 hr a week and to date have weighed and classified over 28 million table-tennis balls. No serious trouble has been experienced with the machines apart from the occasional replacement of one of the bulbs or valves and adjustment of the relay contacts.



A close-up of the weighing section. A ball can be seen in a ring which constitutes the weighing platform

MONITORING RADIATION

THE rapid expansion of nuclear engineering and the increasing use of isotopes as track elements, for non-destructive testing, and for various new techniques has spread the need for a simple yet reliable radiation detector from specialized laboratories to industry in general. This need is now met by the latest monitor made by Airmec Ltd., known as the Type 255. It is a fully transistorized battery-operated portable unit weighing only 16 lb.

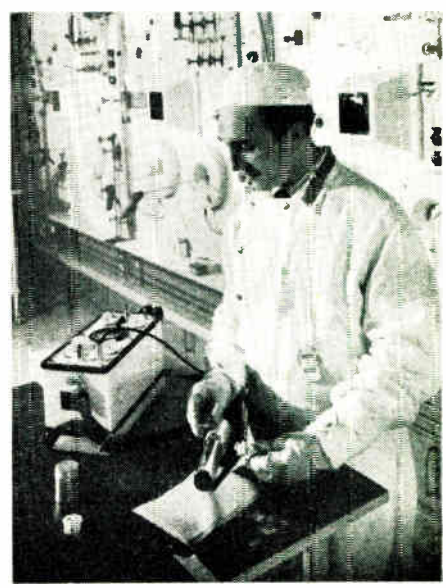
The rate meter unit has a range from 0 to 5,000 counts per second in four steps, with an accuracy of better than 3%. An additional electromechanical counter gives absolute accuracy up to 25 counts per second. Audible indication is provided by a small built-in loudspeaker. There is also an output for driving a scaling unit.

A Geiger tube is mounted in the base of the monitor to enable large areas to be surveyed with the instrument slung from the shoulder, leaving both hands free. For more selective work, four different special-purpose probes can be plugged in. For alpha particles there is a scintillation probe incorporating a photo-multiplier, which can detect particles with energies down to 4 MeV. A Geiger-type beta–gamma probe has a sliding shutter to cut off beta radiation, to which its sensitivity is 0·5 MeV.

For the most accurate work special sample holders of fixed geometry, for both solid and liquid samples, are available.

For further information circle 46 on Service Card

Left: The Mobile Radiography Unit of the Central Electricity Generating Board uses Type 255 Radiation Monitors in decontamination checks after leak tests in power station piping with radioactive sources



Right: Workers at the Wythenshawe research laboratory of A.E.I. (Manchester) Ltd., where the effect of irradiation on nuclear reactor materials is being studied, use Airmec Type 255 Radiation Monitors to check equipment for contamination

For an industrial computer control system to be of practical value, the output information must be presented in a suitable form. The main requirements and methods available for achieving them are discussed in this article.

OUTPUT DEVICES FOR INDUSTRIAL COMPUTER SYSTEMS

By J. F. ROTH, B.Sc., A.M.I.E.E.*

THE use of digital computers for the solution of industrial problems is now a generally accepted technique. From information describing the condition of the plant or process the computer programme will analyse its state and present selected data for further consideration or action. The conventional output media for a computer is punched paper tape which must be transcribed into a more readily comprehensible form to be of any practical use to a human operator. When dealing with real time, or on-line, applications the time scale involved nearly always demands that the output information is produced as rapidly as possible for either direct action or in a form which is immediately comprehensible to an operator. In addition, the output information will generally be required at many points spread over a large area, and at considerable distances from the computer itself.

The problems involved in selecting suitable output devices and organizing the presentation of the information for such on-line applications are well illustrated by considering these aspects of the Information and Data Handling System recently installed at the Spencer Works steel strip mill of Richard Thomas and Baldwins. The various devices which could be used fall into various categories which are illustrated diagrammatically in Fig. 1.

Advisory Information

Whenever direct control of the plant is impractical, the human operator must be retained, and provided with adequate information upon which to act. It is essential that this information be concise and readily understandable, for the operator must interpret it and decide on the action he is to take. Thus the quicker the operator is expected to act on the information the more carefully must its method of presentation be considered.

Aural

Of the five senses with which man is traditionally said to be blessed, only two of these—aural and visual—are of help in the present context. The former is usually retained for alarm indications where it is necessary to attract the attention of the operator rapidly. The effect is non-directional, inasmuch as the spatial relationship of the operator to the signal is immaterial—he may, for instance, be in the next room, but he will still be able to recognize the signal. However, the ability of the operator to discriminate on the direction of the source of the aural signal can be used to lead him to a selected device or location. Coding, to increase the discrimination and provide additional information, can be employed, but if this exceeds a few easily remembered sequences the operator's reaction time will be greatly increased, for he must first make sure that he has correctly understood the signal and then, possibly, refer to a table for interpretation.

Visual Display

The visual sense is of far more use as the eye can assimilate a large amount of varied information very rapidly, although minor differences may pass unnoticed. The combination of the brain and eye is subject to tricks of the imagination, and the operator may honestly believe that he is observing something which in fact differs from what is there in reality. This factor must be borne in mind in the design of visual information facilities and is of special importance where the operator is subject to fatigue.

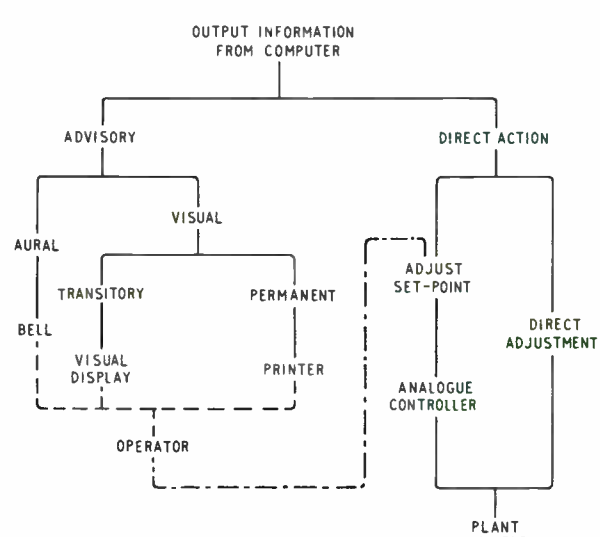
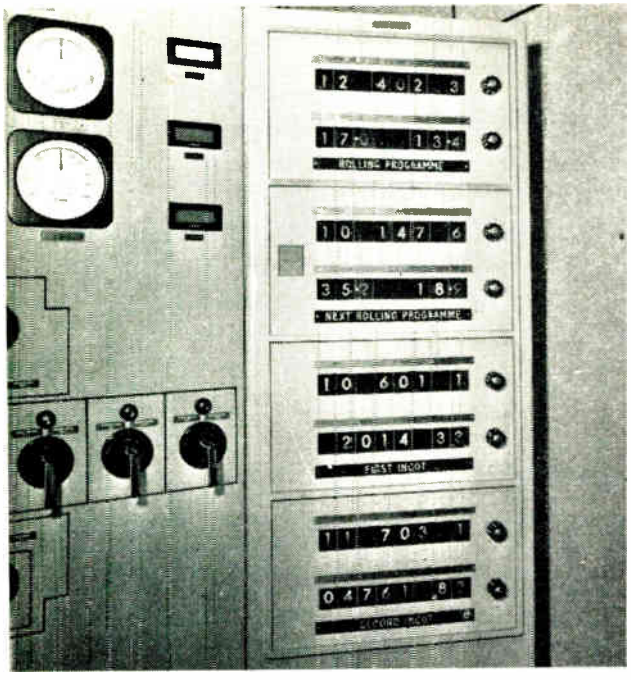
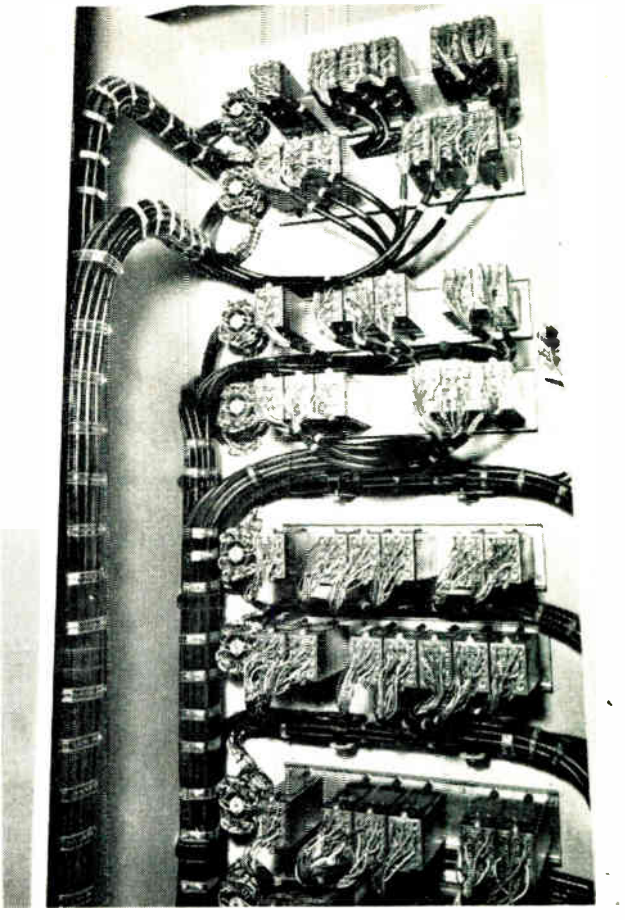


Fig. 1. Relationship between the various classes of output devices which can be used with an on-line computer control system

* Process Computing Division, Elliott Bros. (London) Ltd.



Above : Fig. 2. Multi-decade display panel to inform slabbing mill operators of current rolling operations



Right : Fig. 3. Rear view of display panel shown in Fig. 2 showing magnitude of the wiring associated with the display

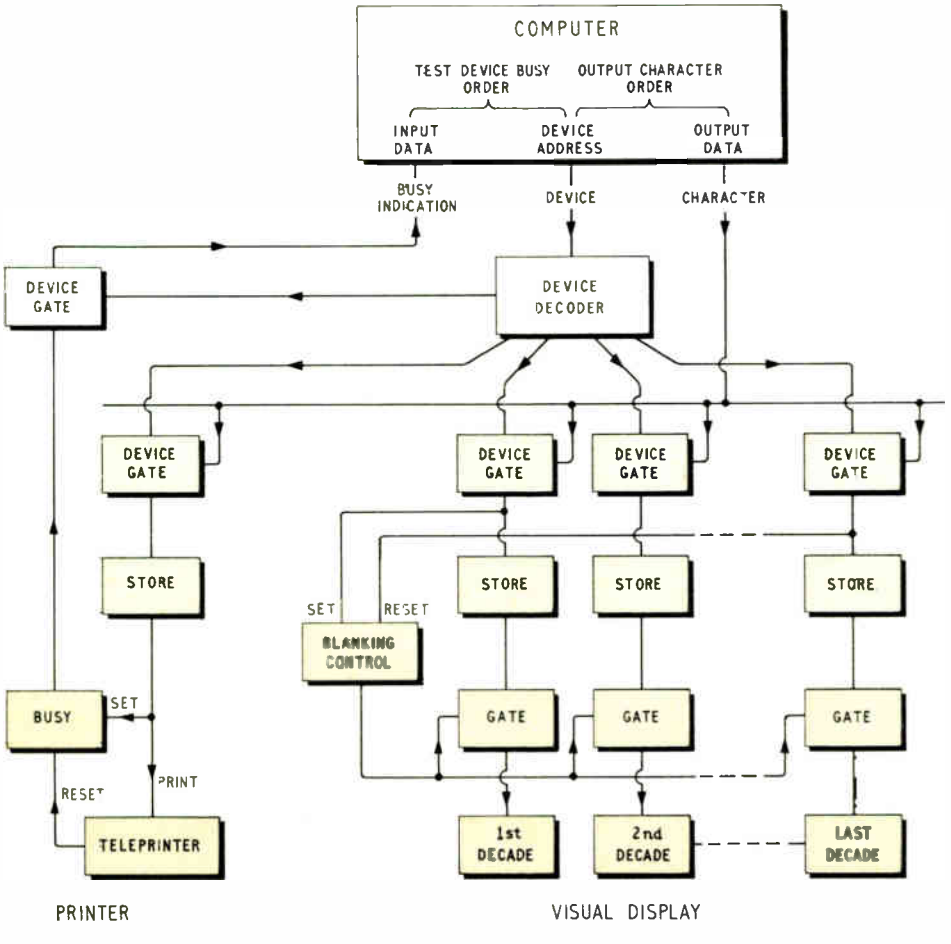


Fig. 4. Schematic representation of the organization for controlling a printer and a visual display from a computer

The method adopted for presenting information to the operator for him to detect visually will depend on the particular application. If the information is only required for a short period, after which it is of no further value, a display can be used. An example of the simplest type of display, that of a single lamp, can be readily appreciated by considering the soaking pit discharge organization at Spencer Works. The computer calculates when the ingots in the soaking pits have been adequately heated and are ready to be withdrawn and sent to the rolling mill. On deciding that a pit is ready, a lamp is illuminated adjacent to the pit indicating that it is the next to be discharged, and this also shows the crane operator the pit to which he has to move his crane.

A slightly more complex arrangement would be an alarm annunciator as, for example, is provided on the system supervisor's console to indicate error conditions. Here two interlinked displays are provided, one being illuminated under normal conditions and the other during an alarm state. Immediate differentiation between the two states is provided by having the normal display immediately above the alarm display, so that discrimination is on indicator position. Colour difference is also provided as a secondary aid, the normal indicator being in green and the alarm in red, but due to the distorting effects of the surrounding general lighting conditions and the varying degrees of colour blindness of so many people this cannot be relied upon. The success and universal understanding of colour traffic lights is due more to the position of the command indicators than to their colour.

Where it is necessary to provide the operator with data to enable him to process correctly each of the items he is dealing with, a more complex display will be required. Fig. 2 shows a multiple display provided for the slabbing mill operators. The top display identifies the ingots and gives the dimensions of the slab to which they are to be rolled. The second display provides similar information for the next group of ingots, and thus provides advanced information of the following rolling programme. The third display provides quality information for the ingot being rolled, and the bottom display gives similar information for the next ingot. This information could be prepared on a printed schedule which lists all the items to be dealt with, but the operator would have to check each one off as it was completed in order to keep his 'place'. With a display his 'place' is being maintained automatically by the control system.

In order to be able to display the required information, each decade of the visual display must be capable of showing ten numeric characters. As the time for which the display is to be illuminated is very much longer than that required by the computer for producing it, and as the computer is too valuable to be allowed to deal solely with the display while it is required, a buffer store is necessary to retain the display data. Each decade must have its own individual store, which is capable of being set to any one of ten states. The display itself has ten separate lamps, the selected one being illuminated to project the corresponding digit on the front screen. The complexity of such a display system is reflected in Fig. 3 which shows a portion of the wiring at the rear of the display shown in Fig. 2. To exclude erroneous indications while the display is being changed the first character of the new information, which the computer outputs serially, will extinguish all displays, and the last character will illuminate them. The functioning of a display system is illustrated in Fig. 4.

One of the main disadvantages of such output devices is that they are somewhat costly. However, a display can be easily seen by a number of people and can be automatically indexed so that it is always displaying current action information. Depending on the location and use, there is a wide variety of sizes and types of display devices from which to choose. Thus the most suitable style of devices can be selected for each application, whilst the control circuitry remains unchanged. An example of a different style of display can be seen from Fig. 5 which shows a display for indicating to the engine driver of the train carrying ingots to which of the stocking locations he is to go for unloading. One aspect of a visual display system which is evident from this example is its inflexibility. The display is normally designed for a particular use and if this changes or if a different information content is required the modifications could well be extensive.

Printers

Where the output information is to be recorded permanently a printer is necessary. The printed record may be required for a number of reasons. For instance, in the mould preparation bay office a list of moulds to be assembled on each train is printed out. These lists are taken by the operatives into the mould stock yard so that the correct moulds are chosen. To protect against loss of the copy, multi-ply paper is used, so that there is a record copy always available. Another example would be in the steel plant where a printout is produced each time a train of moulds is assembled and ready to leave the mould preparation bay, for this area cannot be seen from the steel plant. As the train is not required immediately, this permanent record allows at any time a check to be made of the trains which are waiting to be used.

When only one or two different types of information are to be printed at a given printer and each is represented by just a few digits, a strip printer may be satisfactory. As the number of types of information increases, coding symbols must be added so that each can be recognized but the limit of the device is soon reached. Complex coding can be used but this throws an unnecessary burden on to the operator.

With a longer typeline and the facilities for printing full alpha as well as numeric information, these limitations are overcome. Each item of information can be prefaced by a short description so that it can be readily recognized. The longer typeline allows an output format to be chosen so that the information can be laid out in the best manner.

Fig. 5. View from train driver's cab showing display indicating unloading location

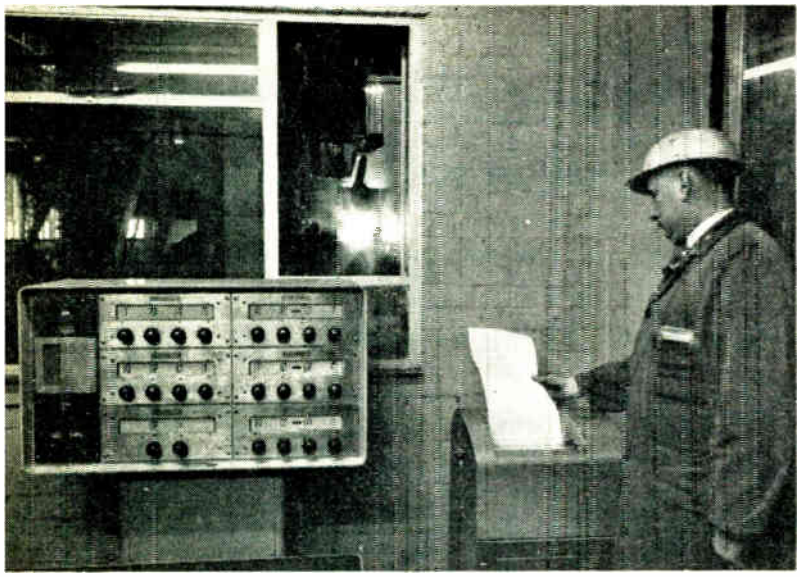


Fig. 6. Operator examining printout from teleprinter which is housed in a protective console

and the layout can be relatively easily modified. From practical considerations a moving-carriage printer is unsatisfactory. The carriage movement requires a large amount of space to be available, and as the printer must be enclosed to protect it, the enclosure would become unduly large. The paper feed and storage would also present problems, as the carriage would not be able to support the weight of the paper reservoir. This must be quite large to overcome the necessity for replenishing it too frequently, as the paper cannot be allowed to run out. The paper must be continuous to avoid constant feeding problems and a roll is therefore very suitable. This will normally be multi-ply so that a number of copies can be made at a time.

These requirements will be fulfilled by a teleprinter and as this device is also self-decoding the number of signal channels required to operate it is reduced from one per character—42 for full alpha numeric and standard symbols—to six, giving a considerable saving in cabling cost alone. Being an electro-mechanical device there are a large number of moving parts and regular maintenance is essential if reliable operation is to be obtained. To protect the printer, it is housed in a cabinet—as shown in Fig. 6—and a glass panel is provided at the top so that the typeline can be seen as it is being printed. When the printout is complete, the paper can be fed forward manually and the printed section torn off. The information presentation in this case is not as easy to comprehend as a visual display but where it is not required for immediate action this does not matter.

A printer is a relatively slow device, especially when compared with the speed of the computer. Therefore some means must be provided for indicating when the printing action is complete, so that the computer is not held up while the printer is operating. The arrangement for doing this is shown in Fig. 4 where the 'busy' indicator is set by the print instruction and this is reset by the printer as it completes the action.

Direct Action Information

The output units so far considered cover the main devices used for the presentation of advisory information. Where direct action is required a means must be provided for enabling the output data to adjust the process variable directly. This can be done directly although such a procedure has many drawbacks, especially when failure considerations are taken into account. The conventional method for the control of the process variable is by an analogue controller, where the operators set the 'desired' value manually and the controller maintains the variable at that setting. A unit can be added to a controller to allow the set-point to be adjusted remotely and this adjustment can then be done from the computer. In this way not only can the operation of the computer system be checked prior to closing the loop but in the event of a failure operation of the plant can revert to manual control.

Construction

To achieve the maximum value from an industrial computer-controlled data-handling system the way in which the output data is prepared and presented is of the utmost importance. From the point of view of the operators and others viewing the system, it is only the output (and also the input) devices with which they will normally come into contact. They will only be able to assess the usefulness and value of the complete control system from the performance of these peripheral devices and from these experiences their confidence in the system must be established. The peripheral devices, unlike the remainder of the system which can be housed in special buildings, must be placed in the plant itself and are therefore subject to very severe environmental conditions. Hence it is of extreme importance that these devices are adequately constructed so that they can stand up reliably to the type of use—and abuse—to which they will be subjected. Great care must be given to the mechanical design not only with regard to adequate robustness but also with due consideration to the problems of the man-machine interface.

Continuing the discussion of storage cathode-ray tubes, further applications are described. These range from acceleration impulse testing to slow-scan television.

Applications of STORAGE TUBES in Instrumentation

By F. J. HORLEY*

(Concluded from p. 462 June issue)

ANOTHER application of the direct-view storage tube is in the instrumentation associated with acceleration impulse testing equipment.

This type of investigation is a fairly new development in the field of environmental testing and is designed to assess the reliability of electrical and electronic components in assemblies under shock conditions. Fig. 7 shows a General Electric acceleration impulse machine,[7] which provides a controllable accelerating pulse, together with its associated instrumentation; in the photograph electronic equipment is fixed to the load platform for testing. The impulse itself is provided by compressed air at 450 p.s.i. acting on a piston which is in contact with the load-bearing platform. This platform is retained by a shear pin whose breaking stress determines the level of thrust and hence the acceleration required. These pins are available in a number of sizes to give a particular g required. The stroke of the piston determines the duration of the pulse.

The acceleration waveform is picked up on a barium titanate accelerometer attached to the load-bearing platform. The signal is fed via a cathode-follower and amplifier into the storage tube, which is again in the form of a Remscope. A typical waveform is shown in Fig. 8. The start of this trace represents the point at which the pin shears and the initial leading edge represents the release of energy on shearing. The platform then continues at constant acceleration for a short while before the platform leaves the piston; at this point the platform is retarded by the restraining straps on the instrument and the deceleration takes place. The accelerometer gives a signal of 56 mV/g and this particular waveform represents an acceleration of approximately 80 g on a time scale of 1 msec/cm.

It can be seen that there is a considerable amount of noise, etc., superimposed on the waveform, and one of the reasons for this is that the specimen under test is shock excited during the acceleration pulse at its own natural frequency and this frequency, together with its harmonics, appears on the fundamental waveform. The energy content of these natural frequencies is negligible and does not, therefore, have any effect on the fundamental acceleration wave-

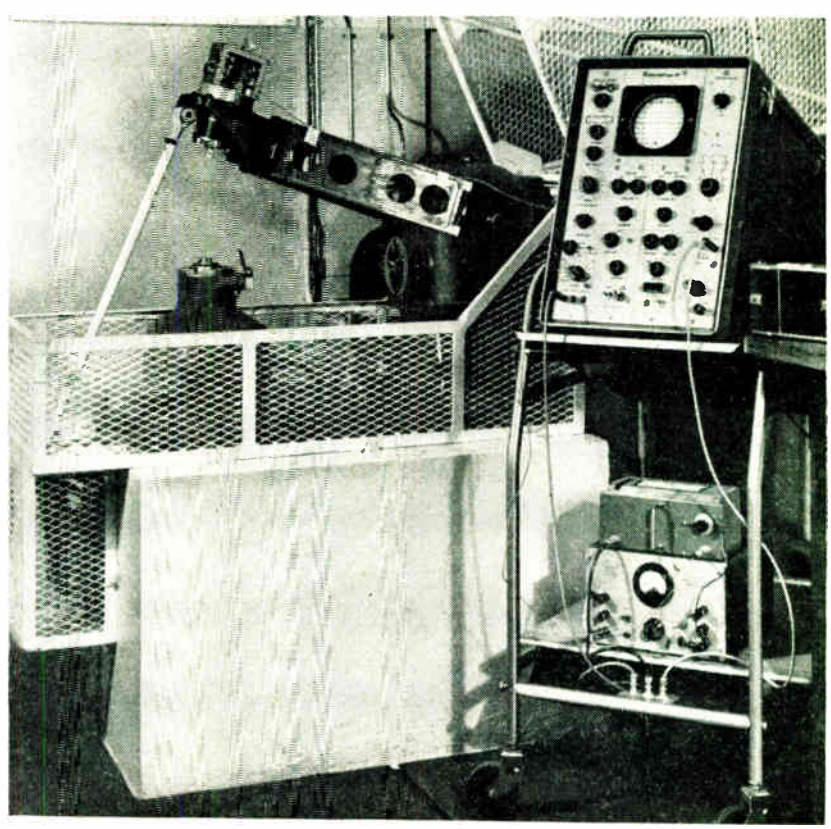


Fig. 7. Acceleration impulse machine with storage oscilloscope

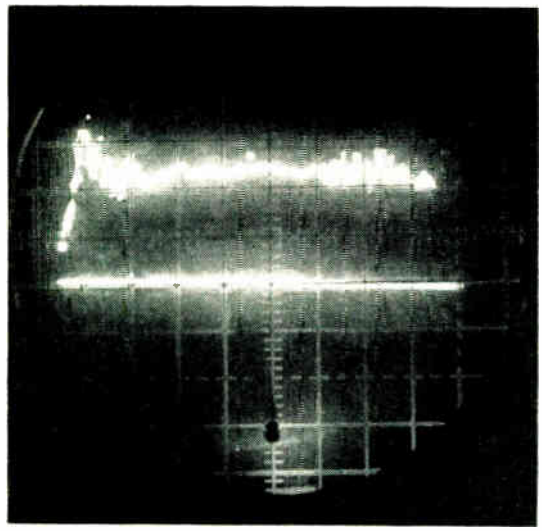


Fig. 8. Typical acceleration waveform

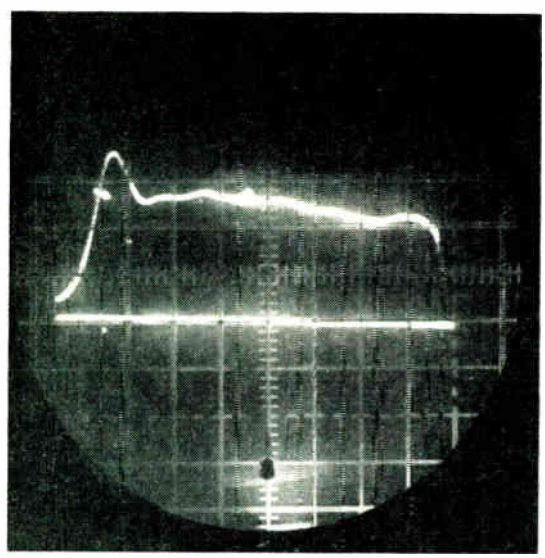
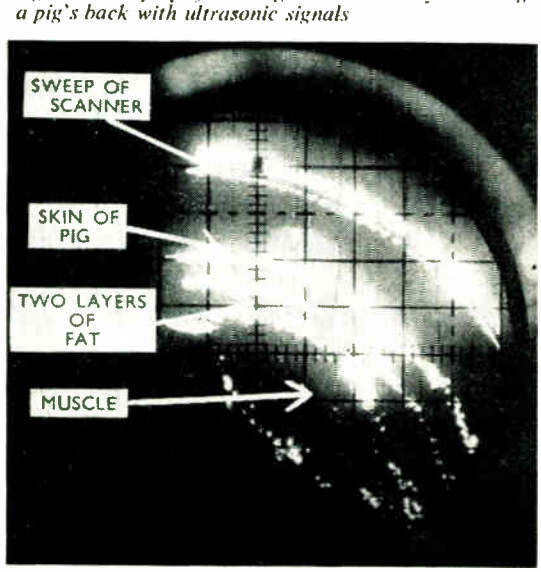


Fig. 9. Acceleration waveform with filter cutting off at 3 kc/s

Fig. 10. Display of echo signals obtained by scanning a pig's back with ultrasonic signals



form. In view of this, it is possible to filter out these signals to present a much cleaner trace for study. An example of a filtered waveform is shown in Fig. 9. The filter was set to attenuate all frequencies above 3 kc/s. It should be remembered, however, that the use of RC filters will introduce some phase shift and it should be pointed out that the use of a filter in these tests is a point of contention and there are two schools of thought as to whether any information is lost by the use of the filter.

The impulse machine and its associated equipment can simulate accelerations up to 150 *g* and the actual load platform is so arranged that connecting leads may be run to the equipment under test on the platform, and the equipment may then be evaluated under actual working conditions.

A number of other fields of environmental engineering are also using storage tubes in their instrumentation. The techniques involved are to obtain a signal from a transducer such as an accelerometer, which is attached to the test sample, and then to excite the sample on a bump test table or drop test apparatus. The design of air crew helmets to withstand certain supersonic *g* forces and also the study of microphony in valves are being done in this way.

A new and important field is in the packaging business. Packing cases, etc., are now being subjected to drop and bump tests, with a view to designing packing materials capable of sustaining a limited amount of impressed force before distortion or permanent damage occurs to the cargo. The days of the old wooden case crammed tight with wood wool are numbered; packing cases today are being scientifically designed to withstand specified *g* forces and conditions.

Research in Pig Breeding

A rather unusual application for a direct-view storage tube is in the plotting of ultrasonic echoes from a pig's back. This is known technically as 'tissue visualization'.

The problem is to determine what the rasher of bacon is like in the live pig, so that a superior strain of animal may be bred for its bacon quality.

This work is in its early stages and is being attempted by scanning across the back of a pig with a focused ultrasonic probe. Signals, similar to radar echoes, are reflected back from the layers of tissue which constitute the animal's back and these are intensity modulated to form a display on the storage tube.

Fig. 10 shows a typical display, the various echo signals clearly indicating the different fat layers, etc. It can be seen from this picture that there is a delay between the sweep of the scanner and the first echo received from the skin of the pig. This is due to a water column which is used as a couplant between the transducer and the skin of the pig. Scans of this type take up to two minutes and it is extremely useful to study the scan as it takes place, and also to have the complete picture in view. This can only be achieved by the use of a storage tube.

Integration Effect of Direct-View Tubes

An extremely useful effect with these tubes is their ability to integrate repetitive signals which have a large amount of random noise superimposed on the signal. By using a storage tube, it is possible to improve the signal-to-noise ratio considerably. This improvement is achieved by the fact that the noise signals, being of a random nature, strike the mesh in an irregular formation and only slightly increase the potential of the mesh. The signal, being repetitive, additively builds up the potential of the mesh, where it is continually writing, and hence the signal appears very bright and the random noise appears lost in the general background illumination.

It is also possible to achieve the same result with the electrical-in-electrical-out tubes.

Storage of Television Pictures

The half-tone direct-view storage tube can prove extremely useful because of its ability to store complete television pictures. Pictures can be stored for periods of up to a week and viewed for up to five or six minutes during this time.

These tubes have a number of television applications, one of which is on continuous production processes where the operational speed of the production line is such that conventional closed-circuit television would not present an image of the item to be inspected for a long enough period. By using two half-tone storage tubes and two inspectors, the inspection time for each item can be approximately doubled.

Fig. 11 shows a typical production process with a rotating table carrying items to be inspected and a television camera viewing each item as it momentarily stops in front of the camera. The storage tubes are housed in two Tele-Remscopes, which are commercially available instruments specially designed for this purpose. Although not necessary, in this particular application, a television monitor is used for initial setting-up and the sequence switch in the diagram is actuated so that alternate images of the object to be inspected are switched, via the control unit, to each Tele-Remscope in turn. The inspector reject units allow the inspector to reject an item by pressing a button; this would then be taken off the production line, via a memory pin, to stop all further operations on the object.

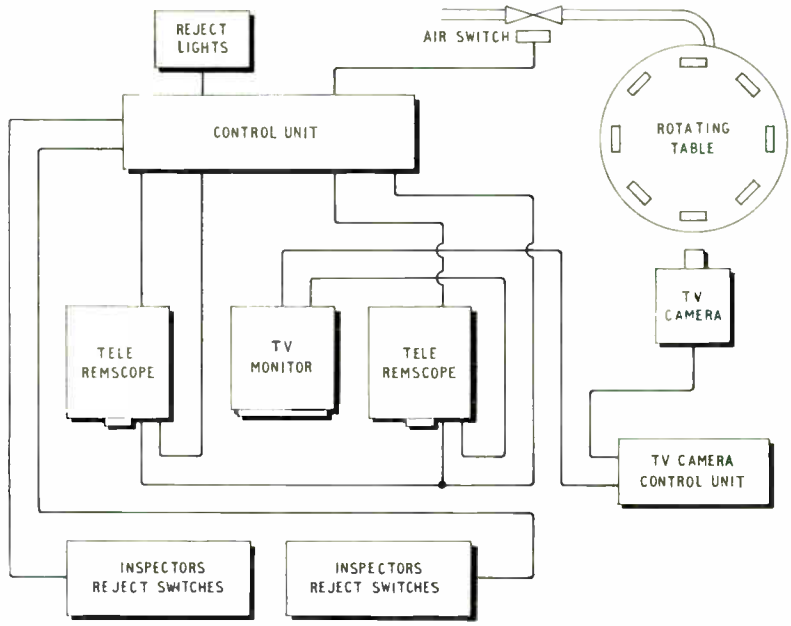


Fig. 11. Production process using closed-circuit television and a storage display tube

Fig. 12 shows a general view at the inspection point and Fig. 13 is a photograph, approximately four times actual size, of the items used for the purpose of this test. It is a small tag board with various components on it. Fig 14 shows a similar tag board viewed on a storage tube. By the use of such equipment it has been proved that where television equipment has to be used for inspection processes on production lines, the inspection efficiency is increased and that inspection by storage tube is less tiring and generally easier to view. The latter probably is because the image on the storage tube appears as a succession of 'stills', whereas on the conventional television monitor the inspector would see the object move on to the screen, stop, and then move off again.

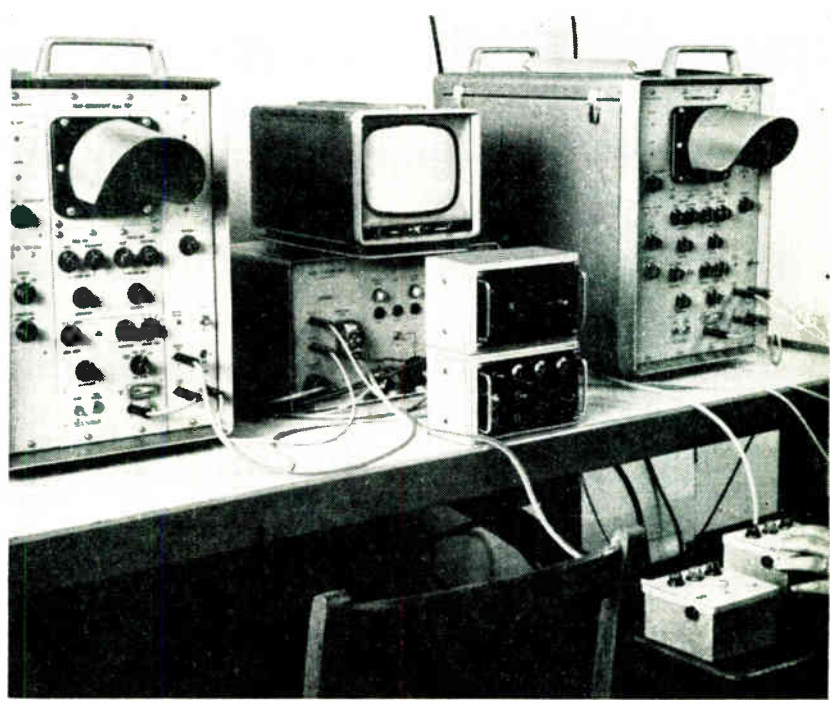
The ultimate resolution of the picture displayed on a direct-view tube is dependent on the resolution of the storage mesh and the density of the writing beam current. Under normal conditions this varies from 60 to 110 lines per inch. Fig. 15 shows the results of some tests. This photograph was taken from the face of an English Electric E702C tube and is a typical illustration of the resolution which can be achieved. The information consists of Stock Exchange prices, which are written in black on a white background and then viewed with a normal closed-circuit television system. A number of tests, using different coloured pencils and backgrounds, did not improve the resolution and black on white was found to be the best medium for such information

On the English Electric tube it is possible completely to resolve the standard British television Test Card 'C'. From the tube face it is possible to see the 3-Mc/s vertical bars and also the five tone gradations which go to make up this picture.

Half-tone storage tubes have numerous applications in the 'frozen action' television type of display and can be also used for the presentation of radar and weather map information. It is now possible to obtain these tubes with screen sizes of from 5 in. to 21 in., although the 21 in. size screen is very expensive.

As an alternative to using a large screen half-tone tube

Fig. 12. General view of an inspection point for a production line



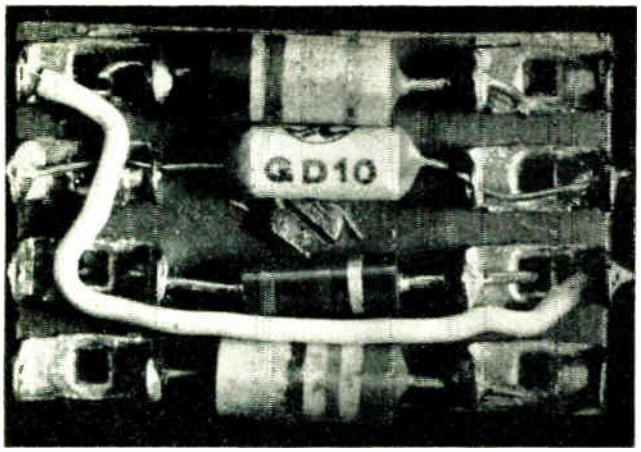


Fig. 13. Photo of item used as a production test

Fig. 14. Item of Fig. 13 as reproduced on the storage tube

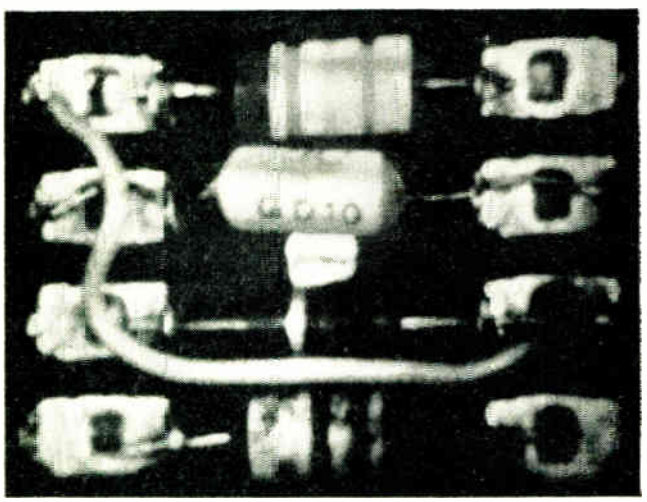
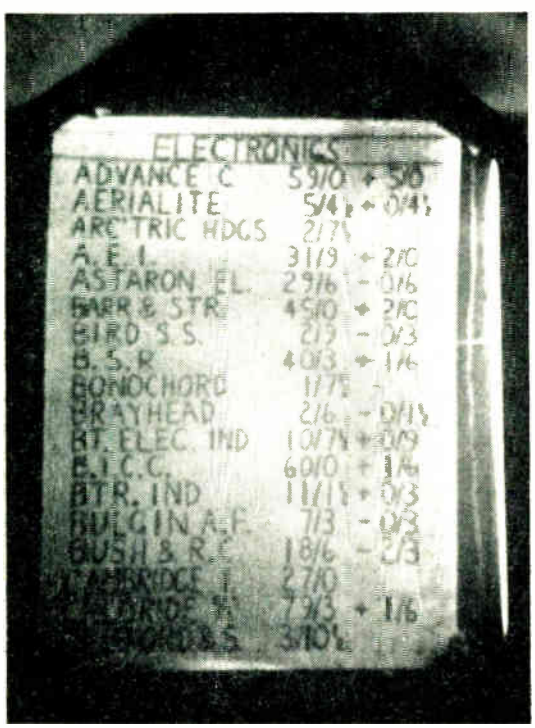


Fig. 15. Stock exchange prices as reproduced on a storage tube



to display stored information, it is possible to achieve the same effect by using an electrical-in-electrical-out type of storage tube. As previously described, these are available with non-destructive 'read outs' and a typical application would be to write one or a few frames of television information into the storage tube which is then scanned and the stored television picture retrieved from the storage mesh and displayed on a conventional large screen monitor. The advantage of using this system over a large screen direct-view tube is that a number of conventional television monitors can be connected to the one slave electrical-in-electrical-out storage tube and thus stored information can be made available at a number of monitoring points.

Using this arrangement, considerably better resolution can be achieved than is possible with the direct-view tube. A resolution of the order of 500 lines per inch is possible from electrical-in-electrical-out storage tubes.

Slow-Scan Television

Another application of storage tubes in television techniques is in the transmission of television pictures over telephone lines.[8] At present, the cost of transmitting television 'still' information via microwave links or coaxial lines, is extremely high. If, therefore, this information can be transmitted over a normal telephone line with a 3-kc/s bandwidth, considerable economies can be effected. The problem is to reduce the bandwidth of the television system to such a level that it can be transmitted over a telephone line. One way of achieving this is to use an electrical-in-electrical-out storage tube at both the transmitting and receiving end of the telephone line and Fig. 16 shows a simplified diagram of such a system.

The equipment utilizes a conventional high-speed closed-circuit television camera to produce an image. This image is then gated to allow a single picture to be read into the storage tube at normal frequencies. This television picture is then 'read out' at a slow scan speed and this signal modulates a carrier frequency which is transmitted over the telephone line. The storage tube acts as an electronics standards convertor where conversion to the slow scan standard takes place.

At the receiving end the reverse standards conversion takes place and the resulting signal, at normal television frequencies, can be viewed on a number of conventional monitors. The picture appears, of course, as a still of one frame of the original. With the non-destructive 'read out' qualities of this type of storage tube a maximum viewing time of from 6 to 10 minutes is possible for the transmitted information.

The electrical-in-electrical-out storage tube also has application in the large screen presentation of radar information. This type of system has been in use for a few years now and basically converts a radar type picture to a television picture to provide a bright display on a number of monitors. This is particularly useful at airports and harbours where one master radar control, incorporating an electrical-in-electrical-out storage tube, converts the radar picture to a television picture. This radar information can then be distributed in the form of a television picture to any ship in the area possessing a television monitor linked with the shore transmitter. Hence, this information is available to any ship having a television monitor suitable for the particular transmission frequency. The salient feature, of course, is that the bright display, featuring target trials, allows easy assessment for course and speed calculations. To stop the tube being written to full saturation by successive radar scans, the mesh is partially erased as the information is being read out. This eliminates the possibility of the mesh saturating and presenting a mass of very bright, blurred information.

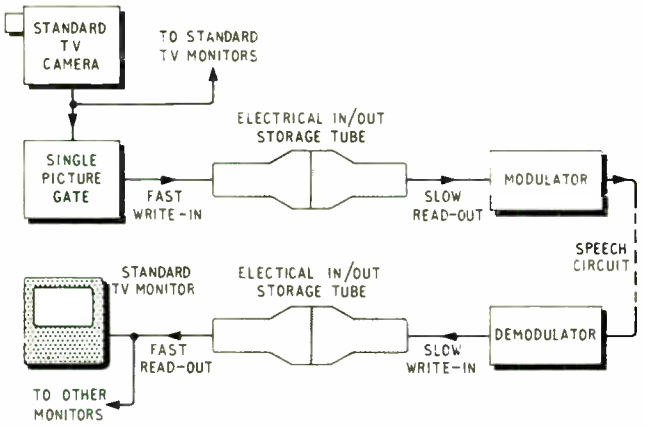


Fig. 16. Simplified diagram of slow-scan television system

The use of storage tubes in instrumentation is increasing. With new tubes which are available it is possible to write information in and selectively erase any part of the trace.[9] With these tubes it is also possible to view stored and non-stored information simultaneously.

These tubes are of the direct-view half-tone type and operate in a similar way to other direct-view tubes, with the exception that the mesh not only has secondary emissive properties but also has an induced conductivity effect. The tube contains three separate gun assemblies, a writing gun, a flood gun and a high energy erase gun. The electron beam from this erase gun is focused and used to erase selected areas of the mesh. It is also used to write non-stored information on to the storage mesh while other parts of the mesh are retaining stored information.

Acknowledgments

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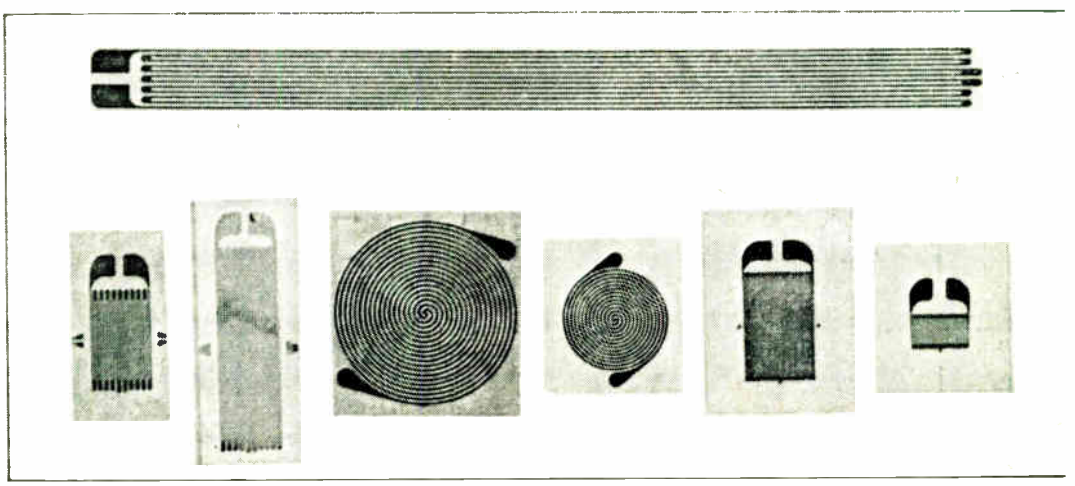
ETCHED-FOIL STRAIN GAUGES

An important advantage of the etched-foil strain gauge is its suitability for use in situations where it would be difficult to mount a conventional strain gauge owing to the small area or awkward shape of the surface. This type of gauge takes the form of a miniature grid etched in thin foil, with a flexible backing which allows it to be bonded easily and effectively to the surface under test. Strain is determined by the change in resistance of the element.

Technograph are manufacturing a range of these gauges, some of which are shown in the photograph. Two of their main features are: a low cross-sensitivity and a negligible temperature coefficient of sensitivity; i.e., the sensitivity factor, $\frac{\Delta R/R}{\Delta l/l}$, remains constant over a wide range of temperature.

The use of a homogeneous thin foil element reduces to a minimum the shear lag in strain transmission from surface to gauge. Due to the high ratio of contact surface area to conductor cross-sectional area, a high power input can be tolerated: in some circumstances the heat dissipation of the gauge may be limited only by the thermal capacity of the item under test.

For further information circle 48 on Service Card



A selection of Technograph etched-foil strain gauges

In cases where time is not important radioactive materials often form a useful and inexpensive alternative to X-ray generators for such things as the radiographic inspection of castings and welds. Both conventional photographic and electronic methods of detection can be employed.

USE OF RADIOACTIVE MATERIALS IN INDUSTRIAL RADIOGRAPHY

By **DENIS TAYLOR**, *M.Sc., Ph.D., M.I.E.E., F.Inst.P.**

THE ready availability of radioactive materials produced by neutron-induced reactions in a chain-reacting pile (or nuclear reactor) has led to the use of such materials in place of X-ray generators for industrial radiography. They are finding particular application for the radiography of castings, welds and other products of heavy engineering and are tending to replace X-ray sources since they are cheap, the running costs are negligible and they are very compact. The compactness of radioactive materials used as γ-ray sources makes possible the examination of products and parts of products previously regarded as inaccessible to radiography and this has extended very much the applications of this inspection technology.

X-ray sources can provide a continuous variation in energy and so the optimum penetrating power can be adjusted by variation of the applied voltage. This facility is not available with γ-ray sources, since the γ-rays produced by each radioactive isotope are of a fixed energy (or energies) characteristic of that nuclide. This means that different radioactive isotopes have to be employed for different purposes. Thus, the thicknesses of steel suitable for examination with Cobalt^{60} (which emits γ-rays of 1·12 and 1·33 MeV energies) are 2 to 6 in., for examination with Iridium^{192} (which emits 10 γ-rays over a range of 0·14 to 0·61 MeV energy) are 0·5 to 2·5 in., and for Thulium^{170} (which emits γ-rays of energies 0·2 to 0·36 MeV) are 0·1 to 0·5 in. Thulium^{170} is also useful for the examination of castings of light alloys. It is also necessary to consider the half-life† of the nuclide. For this application a relatively long-life is an advantage, so that replacement is not required too frequently. The half-lives of the nuclides mentioned above are given in Table 1.

TABLE 1

Nuclide	Half-Life
Cobalt^{60}	5·3 years
Iridium^{192}	72 days
Thulium^{170}	127 days

† See 'Nucleonics and Industry', *Industrial Electronics*, Vol. 1, pp. 18-21, October 1962.

Principles of Radiography

A radiograph is a photographic record produced by the passage of X-rays (or γ-rays) through the object under examination. This is illustrated in Fig. 1. As will be apparent the dark regions on the photographic film when developed show the regions of greatest penetration and therefore this allows the presence of flaws, voids, inclusions, etc., to be investigated.

It is usual to use intensifying screens in contact with each side of the film. Such a screen consists of a thin lead foil or a powdered fluorescent chemical, e.g. calcium tungstate. Under excitation of γ-rays the lead foil produces secondary electrons which are detected by the film with high sensitivity, whereas the calcium tungstate converts some of the radiation energy into visible light to which the film is highly sensitive.

Mention was made above that Cobalt^{60} was employed for the inspection of steel castings of from 2 to 6 in. thick and that other radioactive sources were employed for the inspection of thinner materials. The sources emitting less penetrating γ-rays are used for the smaller thicknesses and

* Plessey Nucleonics Ltd.

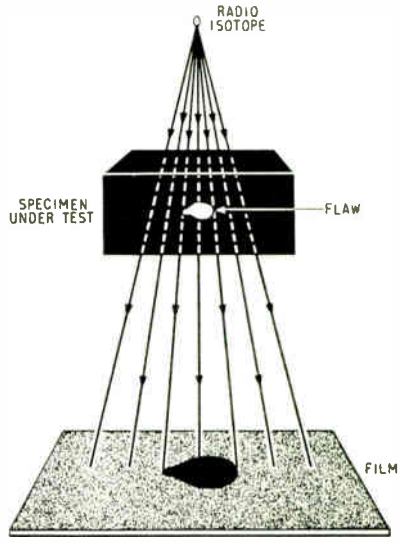
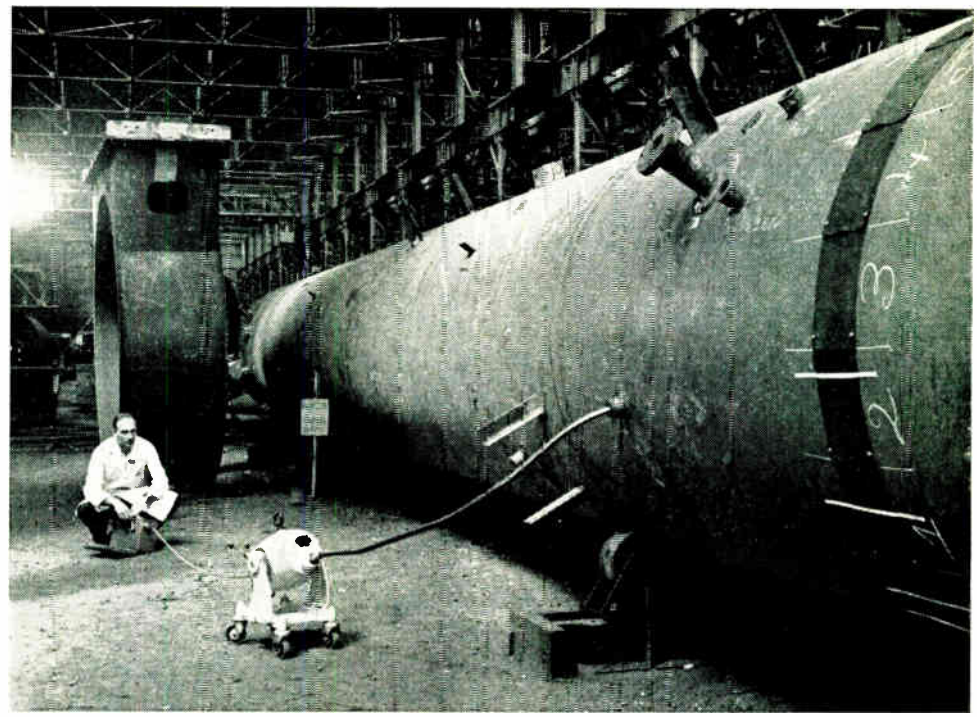


Fig. 1. Drawing illustrating fundamentals of radiographic exposure



Radiographic inspection of large diameter fabrications. (Pantatron Limited)

produce better contrast in the photographic film for these thinner materials.

The source strengths normally used are of the order of 1 or 2 curies of radioactivity. This means that such sources cannot compete with large X-ray machines in times of exposure. Thus, radiographs can be obtained with X-radiography in the order of a minute, which might take half an hour to several hours with a one-curie source of γ-rays. However, this is not always a disadvantage. In many cases it is possible to inspect all the day's production at once during the night. This means arranging all the castings, etc., so that they are suitable distances from a central source. Each specimen under test is backed by a photographic film in a light-tight cassette, the distances being worked out so that when the γ-ray source is placed in position, they each receive the right exposure to its radiations by the morning. The great advantage of this method is that no attention is required and the irradiation room can be kept locked overnight and the films collected for developing in the morning.

It will be appreciated that γ-radiography is not really a competitor to X-ray methods, it is a supplementary technique which extends its range of application and a cheap and efficient substitute when the time factor is not important. As already mentioned the greatest advantage in using small radioactive sources in place of X-ray machines lies in the portability and manœuvrability of the radioactive source. The γ-ray method of examination is particularly valuable when inspection 'in-situ' is required. Thus, γ-radiography is the recognized method of testing welds in cross-country pipelines.

A different application is shown in one of the photographs and in another are given some details of a typical method of moving the radioactive source out of the shielded container when taking photographs and returning it to the container.

Use of Non-Film Detection Techniques

It is possible to employ ionization chambers, Geiger counters or scintillation counters in place of the photographic film, and for certain applications this is an advantage. The technique has, for example, been employed for the detection of welding flaws, e.g. cracks and lack of

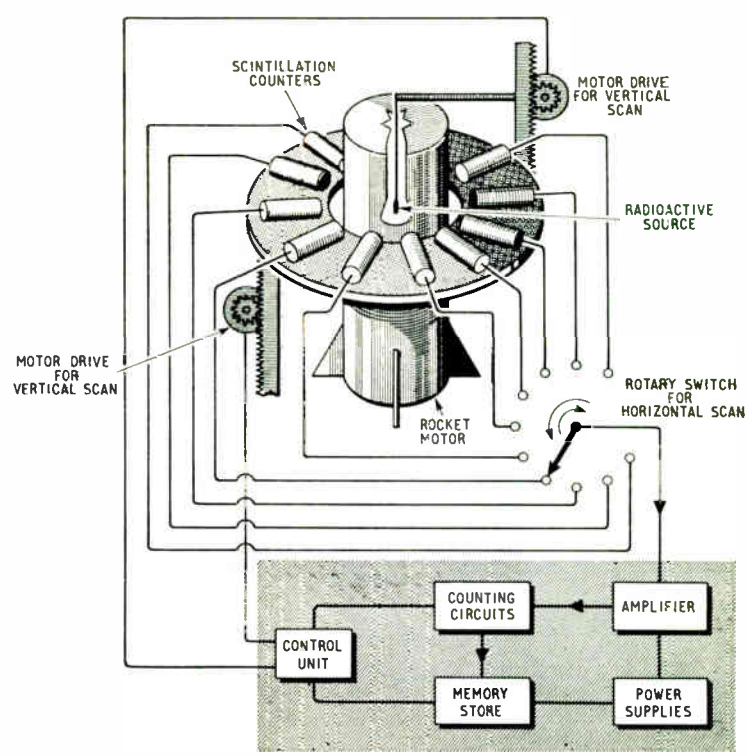
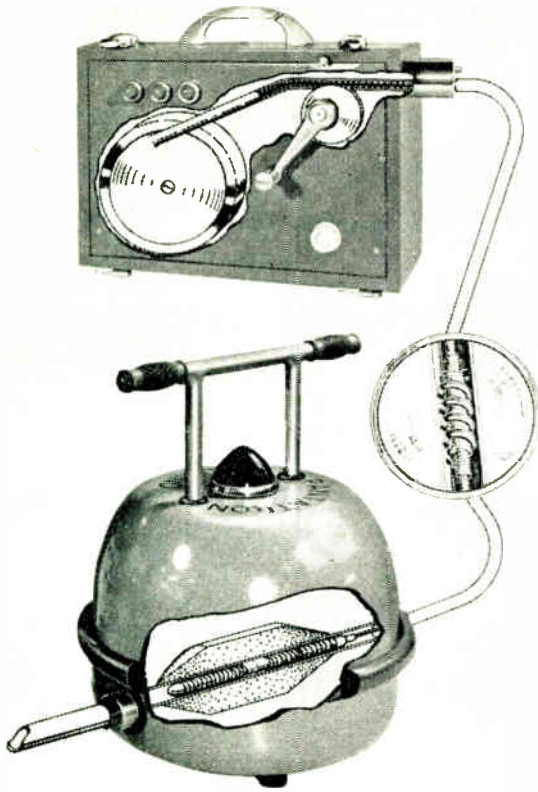


Fig. 2. Inspection of rocket motors using scintillation counters



Typical apparatus for controlling exposure using long distance cable controls. (Pantatron Limited)

penetration, in thin tubes. The method is to place the radioactive source inside the tube in a suitable U-shaped shielding positioned opposite the weld. The radiation detector is moved in synchronism with the rotation of the source (and the shielding), and the output of the detector, after suitable amplification, recorded on a pen recorder. From the inspection of the record, cracks, etc., are readily located.

Perhaps the most elaborate system of this type which has been reported‡ is that used for the inspection of solid propellant rocket motors. This is shown in Fig. 2. A Cobalt^{60} source is employed which can be raised and lowered and rotated through the body of the motor. A system of collimated scintillation counters is used around the upright motor and the output of these counters is analysed to provide information on the size and location of the defects.

The recent development of solid-state radiation detectors of very small size will allow such apparatus to be made to provide even greater precision for the location of faults and it seems fairly certain that automatic pattern recognition of this sort as a means of checking welds on products manufactured automatically will soon be with us.

Apart from the use of radiation detectors in this way, a combination of radiation detectors and photographic film techniques is sometimes an advantage. This is the case, for example, in the examination of long welded steel tubes. Here the radiation detector is employed to position the radioactive source inside the tube, and once the source is in position, a photographic film wrapped around the weld is used to obtain a radiograph. Fig. 3 illustrates the principles of the system. It will be noted that the detector is placed opposite the weld on the outside of the tube and the source is moved through the tube and positioned on the location giving the maximum response in the detector.

Radiation Safety

The methods of handling the radioactive sources require some comments. This is a specialist's subject§ and can only be treated very briefly here. Small gamma-ray sources of the order of a curie or less can be handled by attaching them to a suitable remote handling equipment to withdraw them from the shielded container. In many cases it is

TABLE 2
Dose Rate of a Number of Nuclides

Nuclide	Dose Rate per curie at 1 metre
Cobalt^{60}	1·35 rads/hr
Iridium^{192}	0·5 rads/hr
Thulium^{170}	$3{\cdot}5 \times 10^{-3}$ rads/hr

‡ See C. R. French, A. D. Trelan and P. E. Underhill, 'Gamma Scintillation Inspection of Solid Propellant Rocket Motor', Society of Non-Destructive Testing Conference at San Antarrio, Texas, 1960.

§ See D. E. Barnes and D. Taylor, 'Radiation Hazards and Protection', 2nd Edition, January 1963. Geo. Newnes Ltd., London.

Apparatus using solid-state detectors for positioning of radioactive sources. (Pantatron Limited)

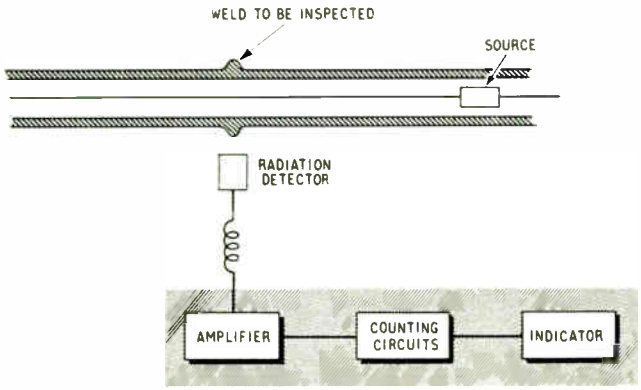


Fig. 3. Apparatus for positioning radioactive source inside a welded tube. After positioning a photograph is taken using a photographic film wound around the outside of the tube

satisfactory for the source to be stored when not in use in a hole in the ground. In all cases, however, the radiation dose received by the operator must be kept below the maximum permissible levels which are laid down in the legislation‖ introduced under the Factories Act.

In almost all the applications of radiography it is possible to use sealed sources, so that the radioactivity cannot be dispersed, and only the external radiation hazard need be considered. A knowledge of the type and size of the radiographic source allows the dose rate to be calculated. In this connection the figures given in Table 2 are of value.

The dose rate at different distances of one metre may be calculated from the inverse square law, e.g. the dose rate falls off according to the inverse square of the distance measured in metres. Graphs can, therefore, be produced showing the actual values of the dose rate (in rads/hr) at different distances from the unshielded source in use, and dose rates greater than the maximum permissible level of 100 millirads/week should be regarded as unsafe and the work planned so as to reduce the exposure of operators.

In all cases, however, it is an advantage to have a dose-rate meter so that actual tests can be made to check the safety of the set-up.

‖ The Ionising Radiations (Sealed Sources) Regulations 1961.

MULTI-LINGUAL TANNOY SYSTEM

The rapid growth of international conferences, symposia, etc., has brought an ever increasing need for combined simultaneous interpretation and public address facilities for delegates. Where the conference hall is a permanent one, it is possible to install a multi-way cable and output sockets to provide delegates with these facilities, but for temporary venues this is a costly proposition.

To overcome this problem Tannoy have developed a 6-channel public address radio system and the necessary equipment so that up to six languages can be broadcast simultaneously.

Each installation basically comprises a transmitter, a loop aerial around the conference hall, a 6-channel receiver and earphones for each delegate and sound-proof booths for the interpreters.

Transmitting Equipment

The channel frequencies are 14 kc/s apart and crystal controlled, covering a frequency band from 80 to 150 kc/s. Audio signals from the floor and interpreters' microphones are fed into combined high gain compression voltage amplifier/modulator/oscillator units. Audio signals above a certain level are controlled to lie within a 2-dB range, thus maintaining a relatively constant audio signal input to the modulator.

The r.f. outputs are combined and fed into a common linear power amplifier. Several power amplifiers may be fed from the r.f. signal line should it be necessary to feed more than one loop to cover an irregular-shaped hall adequately.

The Receiver

The delegate's receiver employs four semiconductors in a superheterodyne circuit. It comprises a ferrite-rod aerial, transistor oscillator/mixer, an a.g.c. controlled transistor i.f. stage, and a reflex l.f. stage, fed from the diode detector, driving the output stage. An output transformer feeds two separate headphone sockets. A third socket is fitted to enable the nickel-cadmium battery to be recharged. The receiver is slung about the neck by a strap; it measures $4\frac{3}{4} \times 3\frac{1}{4} \times 1\frac{5}{8}$ in. and weighs 12 oz. It has two flush thumb operated controls, the 6-channel click-stop selector and the combined volume and on/off switch.

Special cases have been designed to contain 60 receivers. Each case also incorporates a charger unit with a wide range of adjustment.

The system is flexible and can be extended to provide facilities for up to many thousands of delegates. It provides them with complete freedom of movement within the service area. Such systems can be purchased outright or may be hired for specific occasions.

For further information circle 49 on Service Card

An operator supervising recording and transmitting equipment and monitoring actual transmissions with a 'delegate' type receiver. (Inset): A 6-channel 'delegate' receiver. If desired two pairs of headphones may be operated from each receiver

EQUIPMENT review

1. Detachable Patch Panel

Electronic Associates have announced a detachable patch panel for their PACE TR-10 transistorized analogue computer. Of modular construction, so that any changes in the complement of equipment can be readily accommodated, it is an advance on conventional, fixed layout panels.

Ease of patching is attained through the use of colour coding and large clear lettering. Component positions are clearly numbered for convenience. Since the panel is matched to the existing display layout, the usefulness of the computer without it is in no way inpaired: the user has, in effect, two patch panels.

The cost of the patch panel for a second-order differential equation is £50. — *Electronic Associates Ltd., Burgess Hill, Sussex.*

For further information circle 1 on Service Card

2. Variable Frequency Power Supplies

A.C.M. Electronics are producing a range of variable frequency power supplies designed for the testing of servo-mechanisms and other electrical systems.

The standard range covers single, 2- or 3-phase instruments, 25 VA per phase, with a frequency range from 30 to 2,500 c/s in four steps with overlap, and with fine adjustment.

Frequency drift is better than 1% per hour and harmonic distortion not more than 3%. Maximum output voltage is to customers' requirements. Input: 200 to 250 V, 50 c/s.—*A.C.M. Electronics Ltd., 61 Osborne Road, Acton, London, W.3.*

For further information circle 2 on Service Card

3. D.C. Differential Amplifier

Benson-Lehner announce the introduction of a 'fast recovery', low level d.c. differential amplifier, Redcor model 371, for use in data acquisition systems.

The 371, which is completely solid state, provides the following features: Fast recovery from differential and common mode overload to 80 μsec, wideband common-mode rejection, bandwidth unaffected by gain change. The common-mode rejection ratio increases in direct proportion to the increase in amplifier gain. There are no transformers in forward or return paths. Line unbalance: 0 to 1,000 Ω in either line.

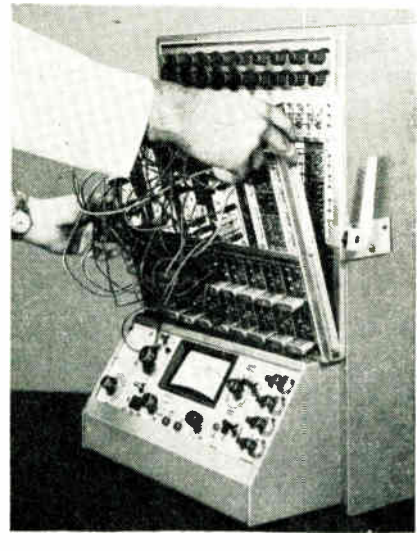
Other features include settling time of 20 μsec to 0·01%, gain accuracy and linearity of 0·01%, gaussian noise distribution and input impedance of 1,000 MΩ. Dimensions of the unit, which is either rack-mounted or available in a laboratory carrying case, are 8·5 by 1·66 by 19 in. and the weight is 5 lb.—*Benson-Lehner (G.B.) Ltd., West Quay Road, Southampton.*

For further information circle 3 on Service Card

4. Automatic Ultrasonic Drilling Machine

A Czechoslovakian ultrasonic drilling machine is being marketed in the United Kingdom by The Selson Machine Tool Co.

The VU-15 can not only drill and cut hard and brittle materials, but can also make holes and impressions. Manufactured by Strojimport, this machine uses a reciprocating, not a rotating tool bit, and can thus be used for making round and profiled holes, trepanning, cutting plates and rods, engraving and etching. The materials which it will machine include glass,



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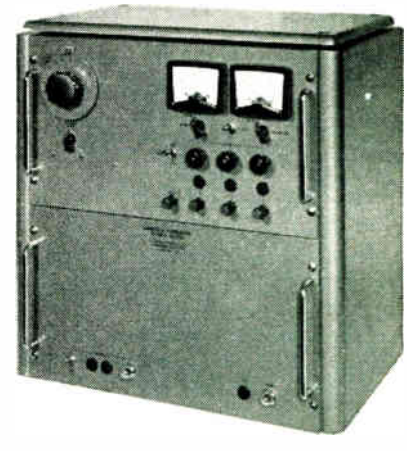

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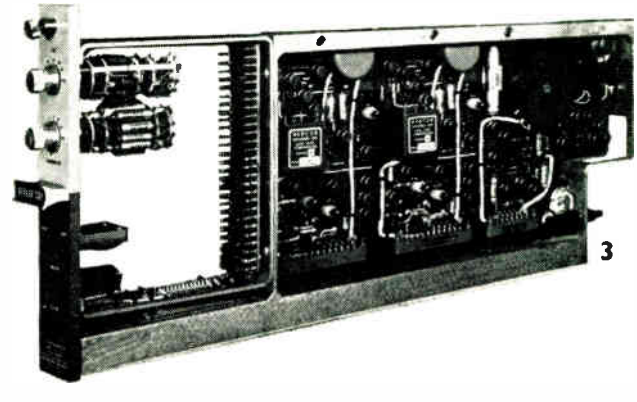

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ceramics, ferrites, silicon, germanium and sintered carbides.

The machine and the generator together weigh 318 lb. A pump and distributor, which are integral parts of the machine, supply the working fluid. —*The Selson Machine Tool Co. Ltd., Sunbeam Road, London, N.W.*10.

For further information circle 4 on Service Card

5. Industrial Proximity Switches

Mec-Test 'Proximitron' switches are solid-state inductive, ultrasonic or photoelectric devices designed to provide a high-speed, non-contacting, maintenance-free alternative to mechanical limit switches. The new designs are robust, self-contained units, and employ circuits which ensure long term temperature stability and a switching capability of 50 mA at 10 to 12 V d.c. with high repetition accuracy.

'Proximitron' switches, normally supplied with 10 ft of flexible armoured cable which may be extended to at least 250 yd, are particularly suitable for: (a) angular and linear position control on rotary tables, machine tools and material handling systems; (b) production control processes involving speed measurement, counting, batching, component flow, safety supervision, press clearance and tool breakage; (c) input to logic systems for the control of complex machine operations; (d) use in hazardous atmospheres.—*Mec-Test Ltd., 218 Dover Road, Folkestone, Kent.*

For further information circle 5 on Service Card

6. Thermocouple Compensators

Consolidated Ohmic Devices announces a series of self-powered, high performance thermocouple reference junction compensators. Each unit of this series can provide a reference temperature accuracy of $\pm\frac{1}{4}$ °F for any specified thermocouple material for up to five years. This complete reference package provides the user with instantaneous warm-up, total isolation, and requires no external power supply of any kind.

Thermocouple reference temperatures above or below the ambient operating environments may be specified, although reference junctions are stocked with a standard 32 °F reference temperature. Immediately available are chromel/alumel, copper/constantan, chromel/constantan and iron/constantan reference junctions compensating over the military environmental range of −40 to +212 °F. Noble metal thermocouple compensators are available but not stocked.

These epoxy encapsulated units have a diameter of $\frac{3}{4}$ in. and lengths from $1\frac{5}{8}$ to $3\frac{3}{4}$ in. Weights vary from 8 to 25 gm. Maximum input impedance is 220 Ω.—*Consolidated Ohmic Devices Inc., 900 Third Avenue, New Hyde Park, N.Y., U.S.A.*

For further information circle 6 on Service Card

7. Flameproof Solenoids

Decco Renco flameproof solenoids, suitable for use in areas where Group I (methane) and Group II inflammable gases and vapours are encountered, are now available from Expert Industrial Controls.

The flameproof housing, cast in 'Meehanite GD', complies with BSS 229/1957 and Ministry of Power Certificates FLP 4546 and 4547. Any model from the Decco Teen series of industrial solenoids may be fitted into the casing giving strokes up to $\frac{1}{2}$ in. with forces up to 10 lb at $\frac{1}{2}$ in. and 18 lb at quiet hold.

The new flameproof solenoids are supplied with a plug-in connector, and adaptor plates to fit any valve. They are also suitable for connection by PILC or VIR cables and for Pyrotenax glands or conduit.—*Expert Industrial Controls Ltd., Lount Works, Ashby-de-la-Zouch, Leics.*

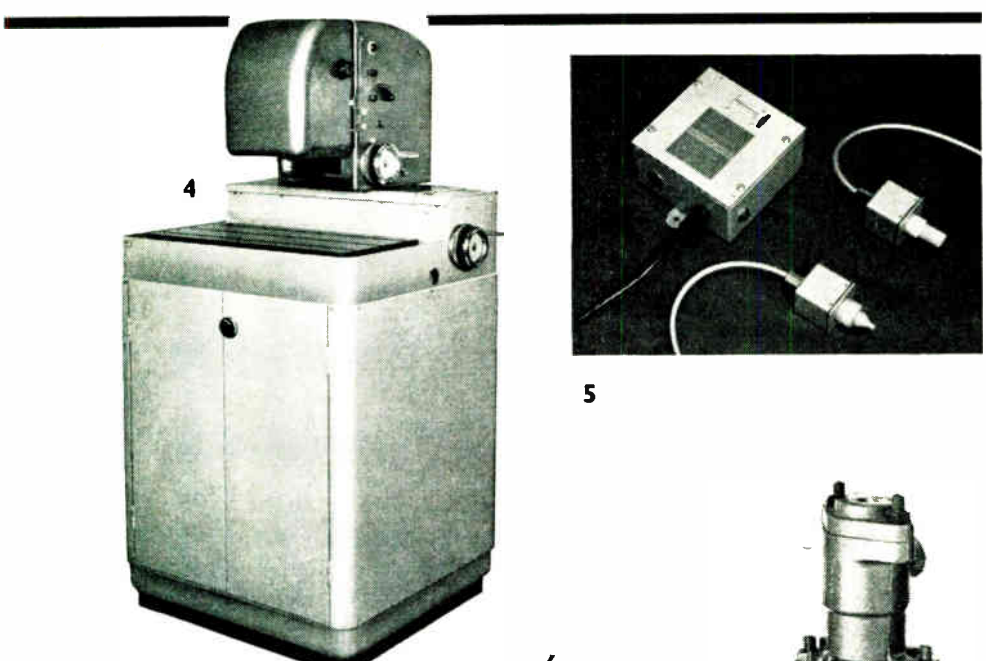
For further information circle 7 on Service Card

8. Brushless Motor Generator

The Kato Engineering Co. has developed a brushless rotating field type motor-generator set (Model 05XSS) to isolate equipment from power line voltage fluctuations. The unit consists of a motor, generator, magnetic amplifier type exciter, and control equipment.

A flywheel is employed on the motor end to limit generator speed-drop to below 180 r.p.m. for two seconds after complete loss of input power, thus allowing auxiliary equipment to begin functioning. Response time of the motor-generator set from no load to full load and vice versa, is within 200 msec. Maximum dip or overshoot is within 20%.

The generator illustrated is rated at



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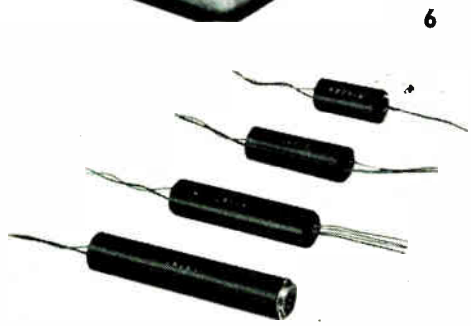

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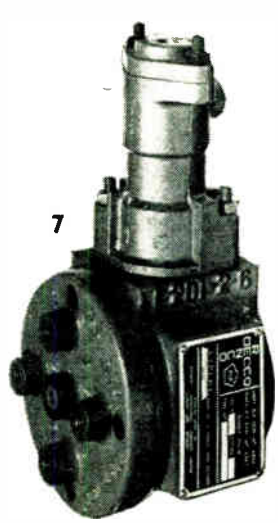

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EQUIPMENT

review

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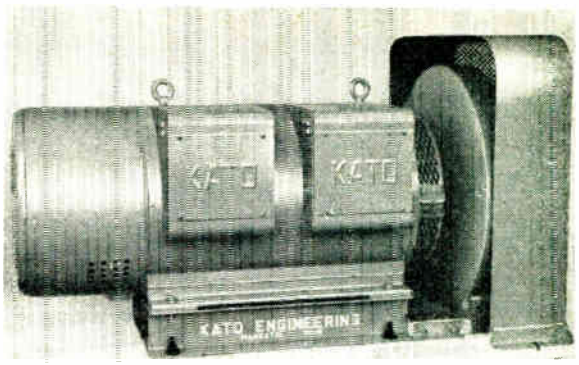

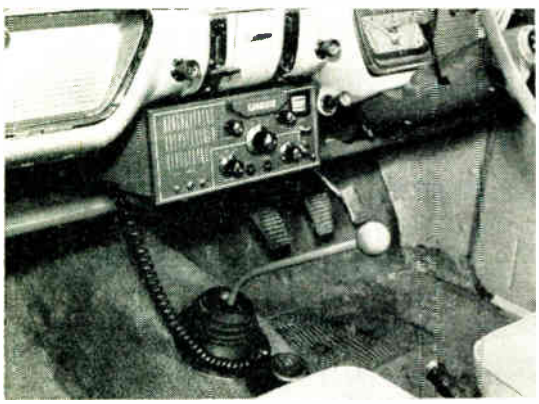

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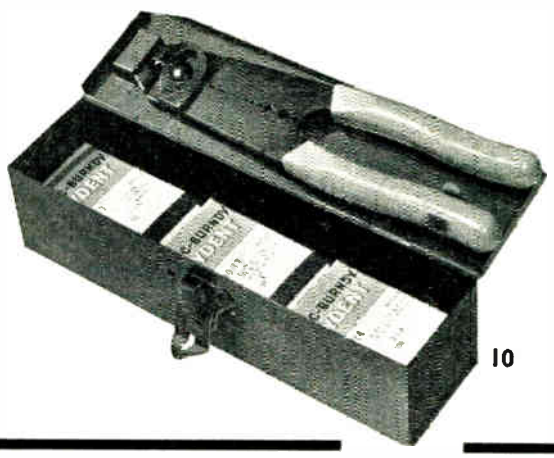

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10 kW, 12·5 kVA, at a 0·8 power factor. Output of the generator is 120/208 V, 60 c/s. A ½% slip induction type motor is used to drive the generator at 1,800 r.p.m. for full output continuously. A brushless magnetic amplifier voltage regulator maintains the output voltage within 1%. Phase balance is within 1% at the rated voltage and speed and harmonic content of the output is less than 6% total r.m.s. with a 3-phase balanced load.

The motor-generator set is available in several sizes other than those specified above.—*Kato Engineering Company, 1415 First Avenue, Mankato, Minnesota, U.S.A.*

For further information circle 8 on Service Card

9. SSB Communications System

To meet expanding demands for medium and long distance radio communications, Labgear are manufacturing a range of transistorized single-sideband equipment.

The first two models are the LS100 100-W fixed station and the LSM100 100-W mobile station (illustrated). Both use identical all-transistor plug-in receiver/exciter units providing selectable sideband operation on four channels located anywhere in the range 2 to 15 Mc/s.

In both fixed and mobile equipments attention has been paid to servicing: comprehensive front panel metering is provided, together with numerous internal test points, and all stage sub-assemblies have been designed for easy withdrawal.

Quick heating valves in the p.a. stage of the mobile equipment and the use of transistors in all other stages keep the 'receive' current drain to a minimum. The ruggedly constructed power amplifier/power supply unit is housed in a hermetically sealed cast alloy case, secured to a shock-mounted carrier assembly. Fins in the casting provide radiation cooling for the p.a. valves. The small physical size of the receiver/exciter unit enables it to be installed under the facia panel on most vehicles. — *Labgear Ltd., Cromwell Road, Cambridge.*

For further information circle 9 on Service Card

10. Compression Jointing Kit

BICC-Burndy are marketing the Hydent compression-jointing equipment complete in handy kit form. This comprises the Y10M Hytool incorporating wire cutters, wire strippers and bolt cutters and 200 Hylug connectors in three popular sizes. The latter are available with various stud-hole sizes and cover a range of conductors from 14/0·0076 to 7/0·035. (Tools and connectors are available for a range of conductors up to 1·5 sq in.).

The Hydent kit is sold in a compact metal container (10 in. long by 2½ in. square) and is priced at £4 19s. 6d. net. —*BICC-Burndy Ltd., Prescot, Lancs.*

For further information circle 10 on Service Card

11. Tape Recorder

A tape recorder in which the head block can be reversed by the user at will, to meet both the Anglo-American standard which uses tapes wound with the oxide surface on the inside and the European standard using tapes with the oxide surface on the outside, is announced by E.M.I. Electronics.

The type 311 professional tape recorder will accommodate 11¼ in. diameter European spools, in addition to all other types and sizes. The mechanical unit is available separately, so that it can be used with other electronic units. A three-way switch will select N.A.B., C.C.I.R. or E.I.C. equal-

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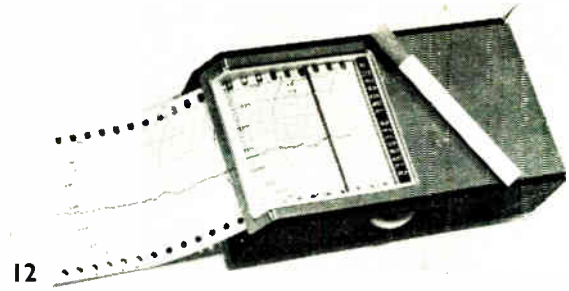

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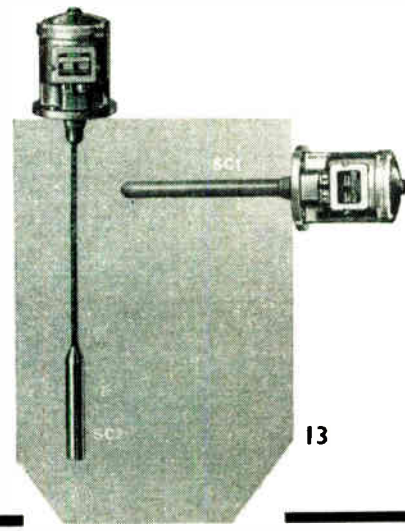

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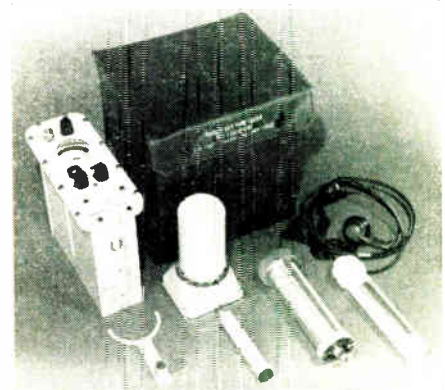

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izing characteristics.—*E.M.I. Electronics Ltd., Hayes, Middlesex.*

For further information circle 11 on Service Card

12. Miniature Recorder

Budgen Instruments are to provide a U.K. sales and servicing organization for the Amprobe miniature recorder.

This recorder is designed to indicate microamps or volts and is available in 12 models for specific purposes covering thermocouples, resistance bulb thermometers, snap-on split-core current transformers and pyrometer or oven outputs. In some instances transducers can be provided with the recorder.

The instrument is essentially for recording slowly varying a.c. or d.c. signals, being built with one fixed paper speed which can be chosen between 1 and 12 in./hr. Inscription is by means of a pressure stylus which marks the paper with a repetition rate of up to one mark every 5 sec. The chart length is 30 ft.

Under development is a panel mounted model complete with a paper re-roll unit for installation in the factory and a battery driven model for operation in the field The cost (without transducers) varies between £30 and £40 including import duty. Charts will be printed in the U.K. and cost less than 10s. each.—*Budgen Instruments Ltd., 25a Tangier Road, Guildford, Surrey.*

For further information circle 12 on Service Card

13. Compact Level Switches

Thorn announce the introduction of their Nivopilot S.C. series of level switches for use in liquids, powders, granular solids and bulky solids.

These capacitance switches are designed to meet the demand for a robust and reliable material measuring instrument at reasonable cost. They are completely transistorized and stabilized against mains variations. The control circuitry is mounted within a light alloy die casting, which forms a dust- and splash-proof mounting head for the electrode.

The Nivopilot can be used for upper or lower limit control; a red light in the instrument head provides a local indication that the desired level has been reached. A set of heavy duty changeover contacts is brought out for control purposes and the instrument is supplied with four different types of electrode, depending on the application.—*Thorn Electrical Industries Ltd. (Electronics Group), 105-109 Judd Street, London, W.C.1.*

For further information circle 13 on Service Card

14. Radiation Monitor

To meet a demand for a versatile radiation monitor, Bendix Ericsson U.K. have produced a modified version of the A.E.R.E. Harwell radiation monitor type 1320C. Marketed under the type number 1320X, this monitor is to the same electrical specification as the 1320C, with the addition of an X-ray range covering the 10 to 25 keV energy band. The instrument is self-contained, easily transportable, and is operated from six Mallory cells which provide approximately 50 hr continuous use.

The monitor unit is of the integrated-count ratemeter type, count-rate being displayed on an m.c. meter over three ranges having f.s.d. corresponding to 0 to 10, 0 to 100, or 0 to 1,000 counts per sec. Audible indication of count-rate is provided by plug-in headphones.

The complete equipment comprises the monitor unit, alpha probe unit, beta-gamma probe unit, X-ray probe

unit, headphones, connector and universal key, all contained in a strong, easily decontaminated waterproof haversack made from p.v.c. covered fabric.—*Bendix Erricsson U.K. Ltd., High Church Street, New Basford, Nottingham.*

For further information circle 14 on Service Card

15. Synchro/Resolver Bridges

A series of Theta panel-mounted synchro and resolver bridges has been designed for the rapid measurement of electrical error. The bridges, designated as series 11C, generate an output voltage which is linearly proportional to the electrical error of a synchro or resolver. A single detented control operates the bridge and some models contain a rotary solenoid to advance the bridge position automatically.

Accuracy: to 2 sec-of-arc. Interval: 5°. Line-to-line impedance: standard 10 kΩ. Size: 5½ by 5½ by 7 in. deep. —*Theta Instrument Corporation, 520 Victor Street, Saddle Brook, N.J., U.S.A.*

For further information circle 15 on Service Card

16. Mobile Ultrasonic Cleaning Unit

To facilitate on-the-spot ultrasonic cleaning Dawe have introduced the mobile Soniclean unit type 1173.

The type 1144 25 kc/s generator is pulsed at twice mains frequency and gives 300 W average (600 W peak) output. The cleaning tank with an integral 1-kW heater has a capacity of 4 gal. Internal dimensions: 14 by 9 by 12 in. deep.

Generator and tank are housed in a stainless steel cabinet mounted on castors, with overall dimensions of 42 by 25 by 38 in. high. Total power requirement: approx. 1·9 kW at 200-250 V, 50-60 c/s.—*Dawe Instruments Ltd., Western Avenue, Acton, London, W.3.*

For further information circle 16 on Service Card

17. Instrument Loads

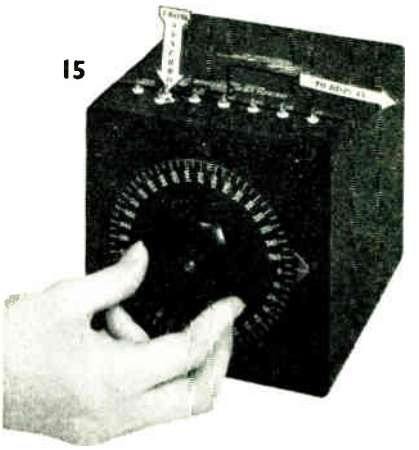
Telonic have announced a series of 50-Ω load mismatches operating over a frequency range of d.c. to 3 Gc/s with a tolerance of 5%.

Designed for general purpose coaxial termination and loading applications, these devices are available in 13 different values. The standard match, rated at 50 Ω with a v.s.w.r. of 1·0, plus 12 different mismatches from 1·1 to 2·0 v.s.w.r., make up the series.

Power rating of the Telonic TRM-1 mismatches is 0·5 W maximum. Standard versions have type N female connectors. Special models with other v.s.w.r. values and/or connectors may also be specified.—*Livingston Laboratories Ltd., 31 Camden Road, London, N.W.1.*

For further information circle 17 on Service Card

EQUIPMENT review



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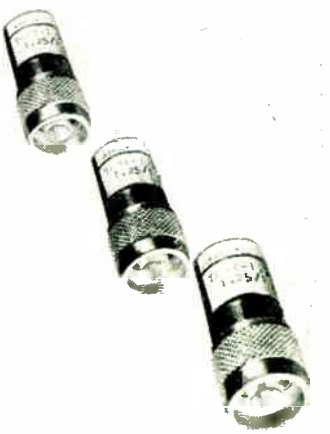

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18. 10 Mc/s Transistorized Timer Counter

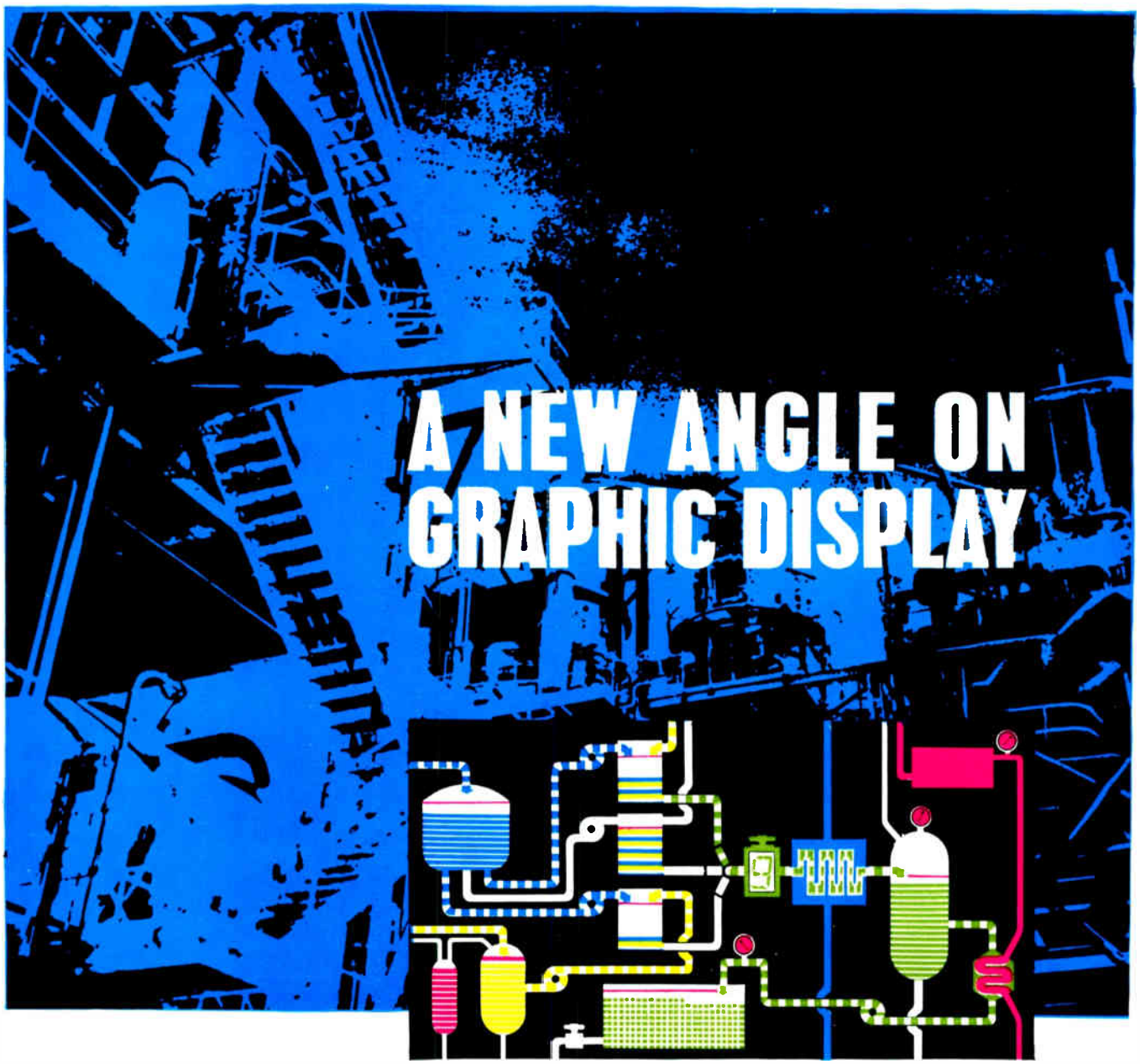
Advance Components announce the introduction of a new transistorized timer counter, the type TC10, designed for the measurement of frequency, period and time, and for the counting of regular or random electrical pulses at a maximum rate of 10 million per sec.

The display consists of a row of in-line indicators which provide a 7-figure number plus a decimal point and a unit caption to show the units of measurement in use. The display time on 'auto' is nominally 1 to 5 sec, or indefinitely when set to 'manual', and display accuracy is ±1 count ± accuracy of standard.

Any time not less than 0·5 μsec can be measured, but the maximum time that can be displayed is 10^8 sec. A 10 Mc/s temperature-controlled crystal oscillator provides the internal standard reference frequency to an accuracy of ±1 part in 10^7 at an ambient temperature of +25 °C and ±2 parts in 10^7 over the range of +10 to +40 °C. An alternative crystal standard is available with an accuracy of ±2 parts in 10^8. These standards also provide output timing pulses at 9 standard repetition frequencies by the use of frequency dividers. Self-checking facilities are built-in to test the operation of both counter chains. Frequency measurements can be carried out with a sensitivity ranging from 100 mV to at least 250 V r.m.s. When external control is required, 'start' and 'stop' may be carried out with positive going pulses between 2 V and 10 V peak and reference 'earth'.

Power requirements are 90 V to 130 V or 200 V to 240 V, 40 c/s to 100 c/s. Consumption is approximately 40 W. Dimensions are 18 in.

(Continued on page 529)



Graphic display panels have an important part to play in control, processing and supervisory systems but present techniques pose certain difficulties regarding layout and construction. Solid state electroluminescent lamps on the other hand offer many new features which make them ideal for this type of display. Construction is simple because they have little thickness and weight and can be made to display a choice of colours in any configuration, even in close proximity. This is particularly useful in desk type displays calling for detailed information in a restricted area. Simulated switching action, flow, level indication and other animation is readily achieved by suitable symbolism with good visibility under normal lighting conditions and at extremely wide viewing angles. Being solid state devices these lamp units will be of special interest to those concerned with vital industrial processes where catastrophic failure cannot be tolerated.

If you want a new angle on graphic display, then have a word with us now—it may be helpful.

Physics Division,
Technical Services Dept.,
Beeston, Notts. tel: 254831.

ERICSSON TELEPHONES LIMITED
ETELCO LIMITED

ERICSSON TELEPHONES LIMITED • ETELCO LIMITED • Head Office: 22 LINCOLN'S INN FIELDS • LONDON WC2 • Telephone: HOLborn 6936
ER55

wide by 13 in. high by 11 in. deep and the weight is about 35 lb.—*Advance Components Ltd., Roebuck Road, Hainault, Ilford, Essex.*

For further information circle 18 on Service Card

19. Miniature Thermocouple Connector

The range of miniature thermocouples and associated equipment available from Spembly has been extended by the development of a thermocouple connector.

This unit can be fitted to all the available miniature mineral-insulated thermocouple cables now being produced, down to 0·010 in. diameter. The connector itself is $2\frac{1}{8}$ in. long by $\frac{1}{8}$ in. diameter.

The two halves of the miniature connector are designed so that reversal of polarity is impossible: on being coupled, the two component parts lock together by means of a spring collet device which provides a positive load-absorbing junction between the thermocouple cable and its compensating or continuation leads. The conductor pins and sockets are manufactured from thermocouple material, thus minimizing stray e.m.f. effects.—*Spembly Ltd., New Road Avenue, Chatham, Kent.*

For further information circle 19 on Service Card

20. Printed-Circuit Connectors

A series of 11, 17 and 23-pin sub-miniature printed-circuit plugs, receptacles and adaptors for interconnecting wiring and p.c. boards has been introduced by Raytheon.

The new plugs and receptacles are polarized to prevent cross-matching, while knurled finger-grip areas on the plugs facilitate safe and easy removal of p.c. boards. Mating receptacles are available with hold-down clips for secure mounting despite shock and vibration.

Adaptor styles for joining dip or flow soldering p.c. sub-units directly to master boards are also offered with optional hold-down rivets. All devices in the series are spaced for standard 0·100 in. grids and feature low electrical resistance. — *Raytheon-ELSI, S.p.A., Piazza Cavour 1, Milano, Italy.*

For further information circle 20 on Service Card

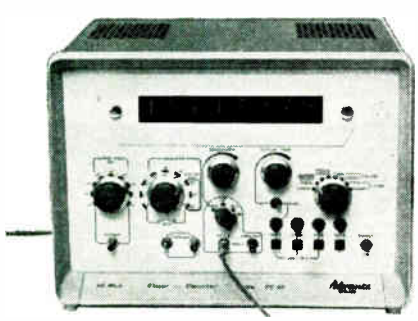
21. Valve Simplifies SSB Transmitters

A reduction in the number of driver stages required in s.s.b. transmitters is made possible by a 5-kW tetrode (type number YL1120) introduced by Mullard.

A new form of grid configuration is used to give a highly linear characteristic. As a result, 5 kW of peak envelope power can be obtained without grid current or r.f. feedback, with an intermodulation product level of 38 dB.

Under typical two-tone operating conditions at a frequency of 60 Mc/s the YL1120 requires an anode voltage of 5 kV, a screen-grid voltage of 800 V and a control-grid voltage of 175 V. Under these conditions the anode current is 1·3 A and the peak envelope power 5·8 kW. Forced air cooling is necessary.—*Mullard Ltd., Mullard House, Torrington Place, London, W.C.1.*

For further information circle 21 on Service Card



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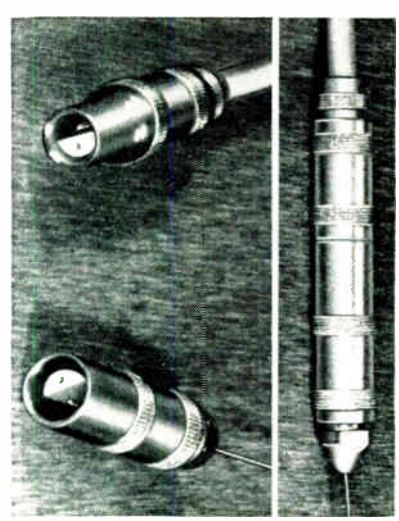

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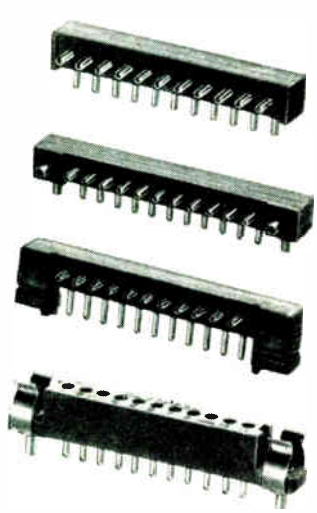

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22. A.C.-D.C. Converter

Alternating voltage measurement to an accuracy of 0·05% is achieved with the Digital Measurements a.c.-d.c. converter, DM2140. This instrument, although designed primarily for use with the DM2001 and DM2020 digital voltmeters, is completely self-contained and can be used with other d.c. voltmeters.

The DM2140 comprises an l.f. amplifier and a mean detector, together with an associated power supply. The complete equipment is supplied either in a cabinet for bench operation or as a 19 in. rack-mounting assembly. Four ranges are provided, covering 15 mV to 200 V, and an external attenuator can be supplied to extend the range to 1,500 V. The d.c. output corresponds to the rectified mean of the input voltage and is r.m.s.-calibrated for a sine wave.

The input impedance is 1 MΩ, in parallel with 50 pF (nominal) and is matched on all ranges; an additional switch position is provided for an input impedance of 10 MΩ on the most sensitive range. An accuracy of ±0·05% f.s.d. or ± 0·1% of reading (whichever is the greater) from 30 c/s to 1 kc/s and ±0·25% up to 10 kc/s is achieved, and usable accuracies obtain over a much wider range; the response is less than 3 dB down at 100 kc/s. Calibration is facilitated

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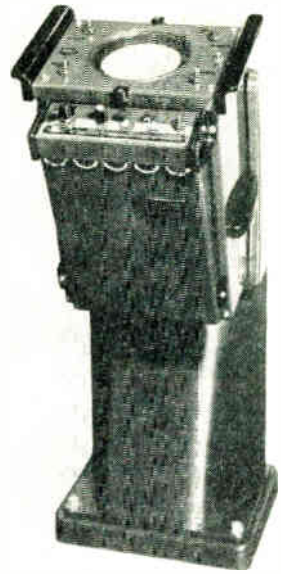

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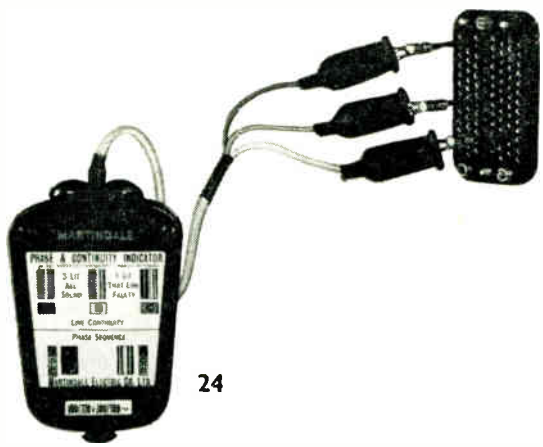

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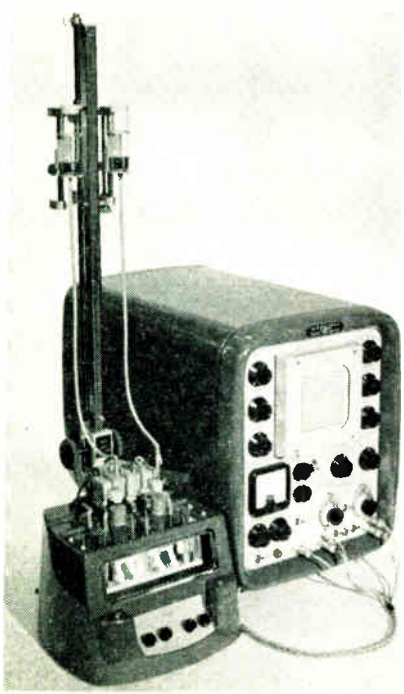

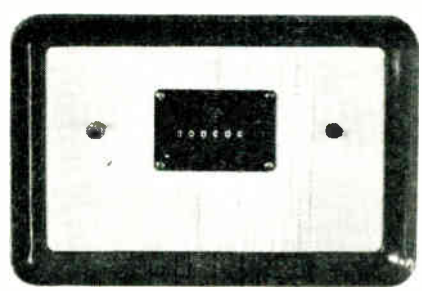

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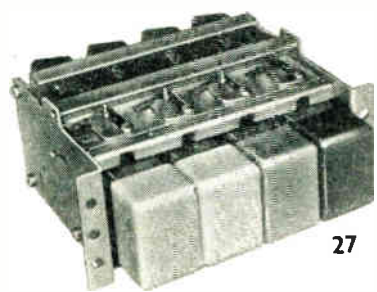

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by the incorporation of a built-in a.c. standard. Switched filtering enables the time constant to be reduced when voltages at the higher frequencies are being measured. — *Digital Measurements Ltd., 25 Salisbury Grove, Mytchett, Aldershot, Hants.*

For further information circle 22 on Service Card

23. Transistor Marine Radar

The D 202 transistor marine radar has been announced by Decca Radar. The makers claim that with its small size, low power consumption and low cost, it makes the fitting of modern radar a practical and economic proposition for every class of vessel.

This compact and lightweight equipment, with a 4-ft slotted-waveguide aerial, and weighing only 77 lb, provides a 7½ in. diameter display and incorporates six range scales from ½ to 24 n.m. Two pulse widths are automatically switched according to the range scale: a 0·1 μsec pulse for high picture quality in confined waters and a 0·5 μsec pulse for solid echoes at long ranges. The frequency band is 9,445 ± 35 Mc/s.

The gearbox and scanner unit may be mounted directly on the wheel-house roof, or on a pole mast: standard masts with integral wiring are available, either 2, 4 or 6 ft in height. The display is suitable for pedestal, bulkhead, shelf or deckhead mounting. All controls for the radar are located on the display unit and the five critical controls are arranged so that they cannot be accidentally misaligned. Power supplies are provided either by a motor alternator with an integral voltage control unit, or by means of a static inverter for 24 volt d.c. installations.— *Decca Radar Ltd., Decca House, Albert Embankment, London, S.E.1.*

For further information circle 23 on Service Card

24. Phase and Continuity Indicator

The Martindale 300/500 cycle phase and continuity indicator, developed for use in the aircraft and electronics industries, performs four functions: (a) determination of continuity of supply; (b) identification of faulty lines if continuity is not proved; (c) confirmation of correct connection of phases; (d) identification of the phase of an unmarked lead.

This instrument contains no moving parts and incorporates five neon tubes, arranged in two rows, three at the top and two at the bottom. The top row of tubes lights up to indicate continuity and the bottom row shows the order of phasing. All the electrical parts are contained in a robust, plastic case with a transparent front covering the neon tubes.

Leading from the instrument is a three-core flexible cable terminating in three leads: each lead incorporates a detachable prod which will fit into multi-pin socket connectors.

The Martindale 300/500 phase and continuity indicator is available ex stock and costs £5 5s. complete with a wallet holder.—*The Martindale Electric Co. Ltd., Movitex House, Empire Way, Wembley, Middlesex.*

For further information circle 24 on Service Card

25. Differential Polarograph

A new version of the Davis differential cathode-ray polarograph is in production at Southern Analytical. Improvements embodied in the type A1660 include: (1) an extra stage of amplification and increased feedback giving better long term stability and freedom from overload distortion ; (2) improved cooling to improve reliability under tropical conditions ; (3) new positive protection circuits for the meter and electrode systems giving increased safety in the event of an electrical failure ; (4) new correction circuits to allow for alignment errors in cathode-ray tube manufacture ; (5) new surface finishes for increased corrosion resistance.

Trace analysis at the 0·01 p.p.m. level is a routine procedure which includes complete cancellation of reagent blanks ; a precision of better than 0·1% can be achieved with many types of sample using the standard electrode system.

A complete installation costs less than £1,500 and is backed by a comprehensive maintenance scheme in England and Wales. — *Southern Analytical Ltd., Frimley Road, Camberley, Surrey.*

For further information circle 25 on Service Card

26. Flowmeter Integrating Unit

Meter-Flow have recently developed an integrating unit for use with their range of impeller meters. This instrument has the facility for matching any flowmeter (bore size $\frac{3}{16}$ to 16 in.) in units of gallons, litres, cu m, etc., with an overall accuracy of 0·1% or better.

The unit is completely transistorized and suitable for use on 230 or 110 V, 50/60 c/s supply. Other systems are at present under development for applications on road tankers, etc., suitable for use on 12 and 24 V batteries with extra print-out facilities. —*Meter-Flow Ltd., North Feltham Trading Estate, Feltham, Middlesex.*

For further information circle 26 on Service Card

27. Illuminated Pushbutton Units

Londex have announced the 'Variotast' series of illuminated pushbutton control units which can have up to 11 stages. Each button operates contacts of the enclosed snap action type, single- or double-pole and rated up to 10 A at 250 V a.c.

Pushbutton colours can be white, red, green or yellow, in any combination. Inside each pushbutton is a low voltage lamp wired to its own terminals so that it can be illuminated according to the circuit requirements for each position.

A variety of actions are available with individual or common interlock or a two-step operation.—*Londex Ltd., 207 Anerley Road, London, S.E.20.*

For further information circle 27 on Service Card

28. Ultrasonic Cleaning Unit

Kerry's have announced an 80-kc/s cleaning unit with a peak power output of 320 W. The generator, which is self-tuning, will drive either the 3-pint bath shown on the photograph, or two generators can be arranged to drive a 6-pint bath. Both the cleaning baths are of high quality stainless steel mounted in a stove-enamelled frame, and may be used for a wide range of solvent and water-based cleaning applications. This equipment should be eminently suitable for the small producer or for laboratories, etc., as it is robust, easy to service, and reasonably priced. — *Kerry's (Ultrasonics) Ltd., Warton Road, Stratford, London, E.15.*

For further information circle 28 on Service Card

29. Portable Television Tape Recorder

The Ampex VR-1500 Videotape television recorder is designed to extend the range and value of teaching staffs and instructional material. It can easily be integrated into closed-circuit television systems, enabling the recorded instruction to be viewed simultaneously in many rooms or buildings.

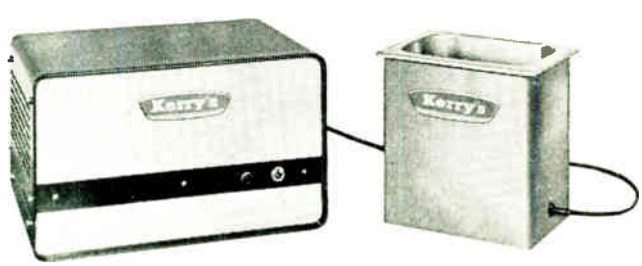
Costing under £5,000 and weighing approximately 130 lb, the VR-1500 features a single control switch for all operating modes including record, reproduce, fast forward and rewind. A single head and helical scan recording technique instead of the transverse scan technique, provides for increased head and tape life.

This compact fully transistorized recorder has a tape speed of 5 in./sec and records 64 min of programming on a single 8-in. reel of standard 2 in. wide video tape. — *Ampex Great Britain Ltd., 72 Berkeley Avenue, Reading, Berks.*

For further information circle 29 on Service Card

30. Alarm Units

Thomas Industrial Automation are in full production of their standard alarm units intended for use in conjunction



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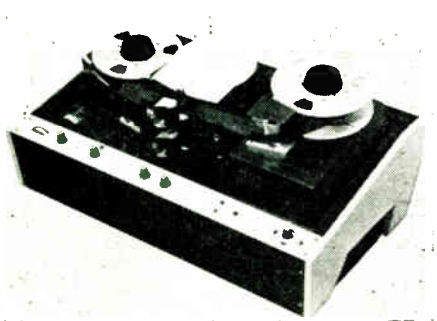

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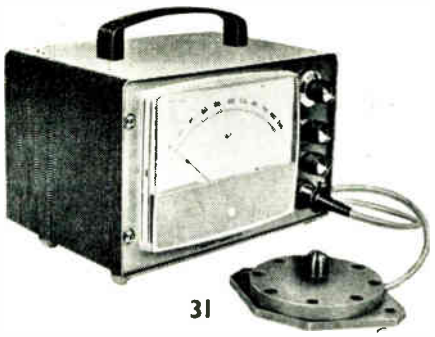

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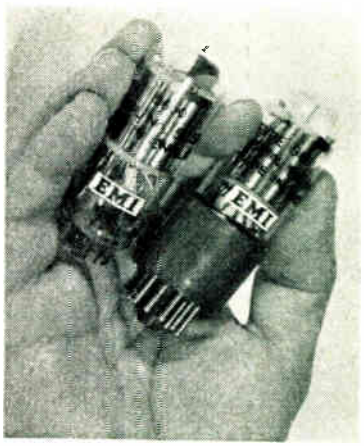

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with all types of industrial instrumentation to provide visual and audible alarm when danger conditions arise.

Units can be supplied to cover any number of alarm channels to meet customers' requirements, and each alarm channel is fitted with its own 'alarm' and 'cancel' relays. Irrespective of the number of channels covered, only one cancel alarm pushbutton is required, and the audible alarm can be cancelled from either local or remote stations.

The alarm units are in sheet steel or cast iron cases, and are wall-mounted. Standard power supplies are 110 or 240 V, 50 c/s. The size of a typical 2-point alarm unit is: width, $5\frac{7}{8}$ in.; height, $7\frac{1}{8}$ in.; depth, 5 in. — *Thomas Industrial Automation Ltd., Station Buildings, Altrincham, Cheshire.*

For further information circle 30 on Service Card

31. Semiconductor Load Cell

J. Langham Thompson announce the development of the new semiconductor load cell type BCL2 and indicator unit. With load ranges from 0 to 50, 100, 200 and 500 lb this battery-powered portable equipment exploits the high sensitivity of silicon piezo-resistive strain gauges, which provide adequate power to drive a 1-mA moving-coil indicator. Overall accuracy is better than 1%, and the operating temperature range is −20 to +60 °C.

The compression load cell is a bonded strain gauge type with a diaphragm stress member which is centrally loaded via an internally threaded boss. P-type silicon piezo-resistive gauges bonded to the diaphragm are connected as a 4-arm fully-active bridge to sense the strain induced by loading. This form of construction results in a cell of minimum overall height, making it suitable for many applications where there is restricted headroom. A pair of integral lugs is provided for mounting, and mechanical coupling is by means of a $\frac{3}{8}$ in. u.n.f. internal thread.

The indicator unit is housed in a compact robust case which incorporates meter, battery supply, zero control and span control. There is provision for checking the calibration of the system in the event of aging of the 9-V battery supply. Battery life is 120 to 160 hr.

Applications of this equipment include weighing, monitoring the bearing-pressures in calender machines, and measuring the force applied to a die during a drawing process. The photograph shows a unit developed for the Ford Motor Co. for measuring the operating forces on motor car control pedals. The basic price is £112.—*J. Langham Thompson Ltd., Park Avenue, Bushey, Herts.*

For further information circle 31 on Service Card

32. Photomultiplier Tube

A recent addition to the E.M.I. range of photomultiplier tubes, the type 9660, is a 9-stage 'squirrel cage' design having an opaque caesium-antimony photo-cathode with an S5 spectral response.

In contrast to other types of E.M.I. photomultiplier tube, the 9660 is sensitive to radiation through its side wall, which is made of u.v. transmitting glass. This gives a spectral coverage from approximately 2,000 to 6,700 Å with a peak at approximately 3,500 Å.

The high gain and low dark current which characterize this tube make it particularly suitable for low level u.v. and visible radiation spectrometers. It has a B14B pressed glass base, for which a p.t.f.e. socket can be supplied.

A quartz envelope version, type 9662, can be supplied to extend the short wavelength coverage to approximately 1,700 Å. The type 9661, an overcapped version of the type 9660, has a small shell sub-magnal 11-pin base and will operate as a direct

equivalent of the RCA 1P28.—*E.M.I. Electronics Ltd., Hayes, Middlesex.*

For further information circle 32 on Service Card

33. Valve Volt-Ohm Meter

The Philips GM6001 is a universal instrument which offers features such as small zero drift, high stability and floating input, for the price of £90.

Direct voltage measurements can be made in eight ranges from 300 mV to 1,000 V f.s.d. (30 kV with optional E.H.T. probe) with an input resistance from 10 to 1,000 MΩ. Alternating voltage ranges cover 1 to 300 V f.s.d. in six ranges, and the frequency response is within 1·5 dB from 20 c/s to 1,000 Mc/s. Resistance measurement ranges are from 1 Ω to 1,000 MΩ. The stability is such that fluctuations of up to 10% in the mains supply produce no observable change in the meter reading.

The input may be floating, the maximum permissible potential between the 'low' side of the signal input and earth being 300 V. For measurements on discriminators, bridges and similar circuits, a special switch position is provided for changing the meter to 'centre zero'. There is also a calibration socket from which a stabilized 0·3 V may be taken for a rapid check on the overall functioning of the instrument.—*Research and Control Instruments Ltd., Instrument House, 207 King's Cross Road, London, W.C.1.*

For further information circle 33 on Service Card

34. Circuit Modules

Packard Bell has added five new modules to its 3 MC module line: They include a DG109 diode gate, NA100 NAND circuit, ST100 Schmitt trigger, and TI100 and TI101 inverters.

In addition to the new units, the line includes flip-flops, input gates, emitter followers, amplifier gates, clock drivers, clock generators, shift registers, and amplifier inverters.

The modules are of high-density 35-pin design and incorporate derated micro-alloy-diffused transistors and gold-bonded germanium diodes with single-sided etched circuitry on fibreglass epoxy boards. — *Packard Bell Computer, 1905 Armacost Avenue, Los Angeles 25, California, U.S.A.*

For further information circle 34 on Service Card

35. Electro-Hydraulic Crimping Unit

Hellermann have introduced a new portable electro-hydraulic crimping machine to enable the maximum saving of production time for their 0·03 to 1 sq in. range of heavy duty terminals. This unit, which is wheel mounted, measures only 44 by 24 by 22 in. and is available with 12 and 30 ton heads with interchangeable dies. Compression is automatically controlled and a complete compression is performed regardless of the operator's skill. Operation is by a foot microswitch or at the crimping head, thus enabling terminals to be crimped up to 20 ft from the main unit. Each switch allows the fine control of 'inching'.

Built-in safety devices include an emergency stop button, which stops the crimping operation and releases pressure on the dies, and indicator lights to show when the pump is on and when the dies are open. The top of the unit forms a convenient work top, and storage space is provided for dies not in use.

The Auto Crimp is robustly constructed and operates at 230/250 V.—*Hellermann Terminals Ltd., Gatwick Road, Crawley, Sussex.*

For further information circle 35 on Service Card

36. Acrylic Spray Coating

A clear acrylic spray coating in aerosol dispensers is now available in the U.K. through Wentworth & Co. This is manufactured by Krylon, Inc., U.S.A., and is known as 'Krylon Crystal-Clear'. It is intended as an easy-to-apply protective coating for almost anything. Krylon is particularly suitable for electronic components and equipment since its dielectric constant is 3·2 to 3·7 (at 1 kc/s) and the specific resistance is 10^{10} Ω/cm³.—*F. & G. Wentworth & Co., 11 Bruton Street, London, W.1.*

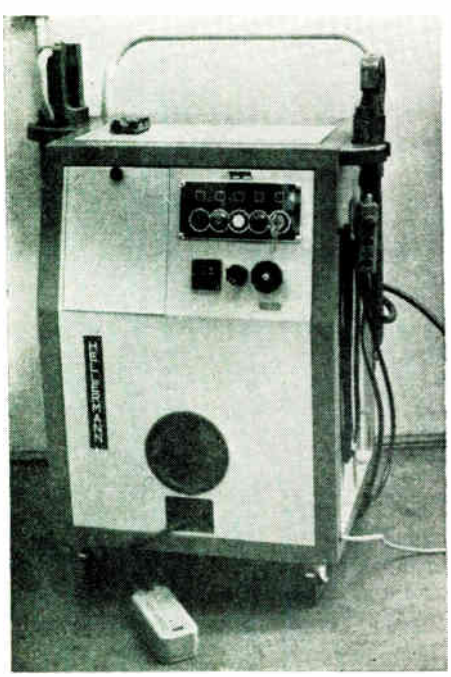
For further information circle 36 on Service Card

37. Universal Counter

A crystal controlled universal counter by Research Electronics, model 5543A, combines the functions of (1) a scaler or counter for counting regular or random pulses or events, (2) a chronometer for the measurement of elapsed time from 100 μsec to 1,000 sec and the period of waveforms over 1, 10 or 100 cycles, and (3) a frequency meter for the measurement of events per unit time up to 10 kc/s and for precision tachometry. One-sec timing contacts, standard frequency outputs, an automatic reset timer for continuous monitoring, and a timing ruler for oscilloscope photography calibration are also included.

Separate controls are provided for 'start' and 'stop' permitting any combination to be selected. A 'lock' gate with an overriding switch permits either 'single-shot' or cumulative timing, as required, even from continuously repeating input waveforms. A separate gating system is provided for operation solely from contacts: this gives further facilities for short-circuit and open-circuit start and stop from one or two pairs of contacts.—*Research Electronics Ltd., Bradford Road, Cleckheaton, Yorks.*

For further information circle 37 on Service Card



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A constant-voltage transformer is described which, in conjunction with filters and an electronic harmonic-extractor, provides an exceptionally pure output waveform. An output stable within 0·2% for input variations of 15% is obtained with a harmonic content of 1%.

LOW-DISTORTION CONSTANT-VOLTAGE TRANSFORMER

By J. K. CHOUDHURY, M.Sc., M.Sc.(Tech.), A.M.I.E.E.*
and S. N. BHATTACHARYYA, M.Sc., M.E.E. †

CONSTANT-VOLTAGE transformers[1-5] are robust and inexpensive alternating voltage stabilizers of simple design. They are popularly used in small laboratories and industrial and educational institutions for mains voltage stabilization, and are commercially available in several sizes up to about 10 kVA. The stabilization obtained by previous investigators of this type of equipment is of the order of ±1% for ±15% input fluctuations. This order of performance may be suitable for many applications but is inadequate for precision electrical measurements. A serious defect of constant-voltage transformers from the measurement point of view is the large distortion of the output waveform. This is due to the use of saturable reactors in the circuit, and distortions as high as 25% are quite common. Filters and other types of circuit are often used for reducing the distortion and commercially available equipment has been found with the distortion reduced to about 5%.

The objective of the present work was to design a constant-voltage transformer having an appreciably higher order of stabilization and lower distortion. A 220-V, 250-VA stabilizer was designed which gave stabilization better than ±0·2% for ±15% input fluctuation at full load, the total harmonic content in the output wave being about 1% only. A special harmonic elimination principle[6,7] was utilized for the reduction of harmonic content to this order. It is considered that the equipment will serve as an inexpensive high grade voltage stabilizer for use in a precision electrical-measurements laboratory.

The present stabilizer consists of the following basic components (i) the main stabilizing unit, (ii) the series-resonant harmonic filters and (iii) the electronic harmonic extraction unit. The circuit arrangement is shown in Fig. 1.

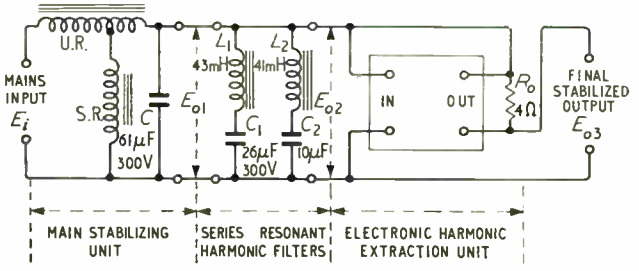
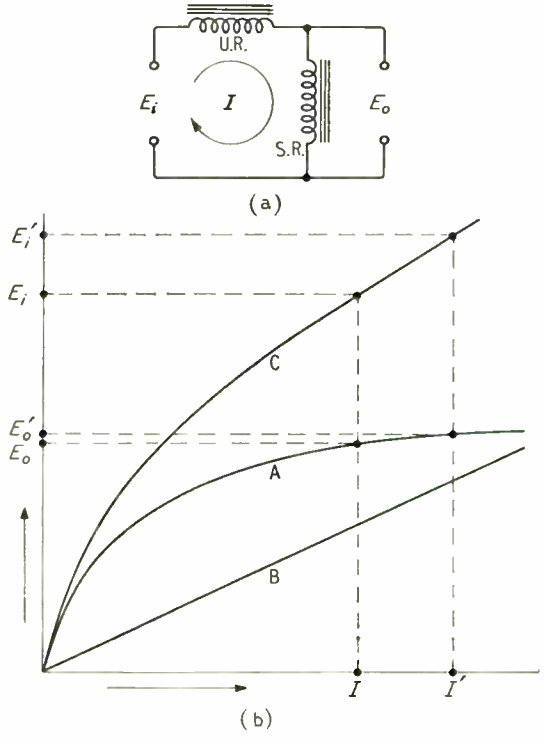


Fig. 1. Complete stabilizer circuit. Details of the harmonic extraction unit are given in Fig. 5

Fig. 2. Basic form of stabilizer with saturated (S.R.) and unsaturated (U.R.) reactors (a) and the current-voltage relations (b)



Main Stabilizing Unit

Constant-voltage transformers are usually based on the simple non-linear potential divider circuit shown in Fig. 2(a), comprising a saturable (S.R.) and an unsaturated (U.R.) iron-cored reactor. The stabilizing action of this arrangement is indicated in Fig. 2(b). Curves A and B represent, respectively, the volt-ampere characteristics of S.R. and U.R., whereas C represents that of the composite circuit from the input end. It is readily understood that for an input voltage change from E_i to E_i', the output voltage changes from

* Professor of Electrical Engineering, Jadavpur University, Calcutta.
† Reader in Electrical Engineering, Jadavpur University, Calcutta.

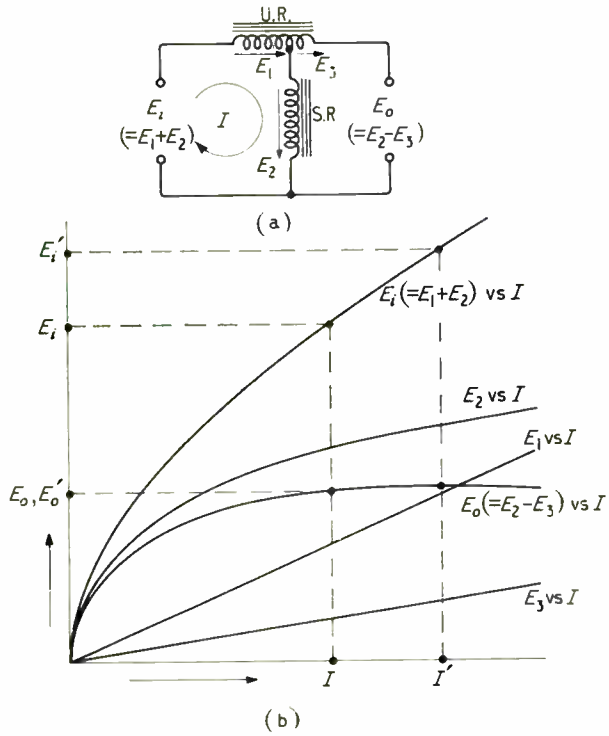


Fig. 3. Improved stabilizer (a) with a tapped unsaturated reactor; (b) shows the current-voltage relations

E_o to E' and assuming S.R. to be sufficiently saturated in the operating region,

$$\frac{E_o' - E_o}{E_o} < \frac{E_i' - E_i}{E_i},$$

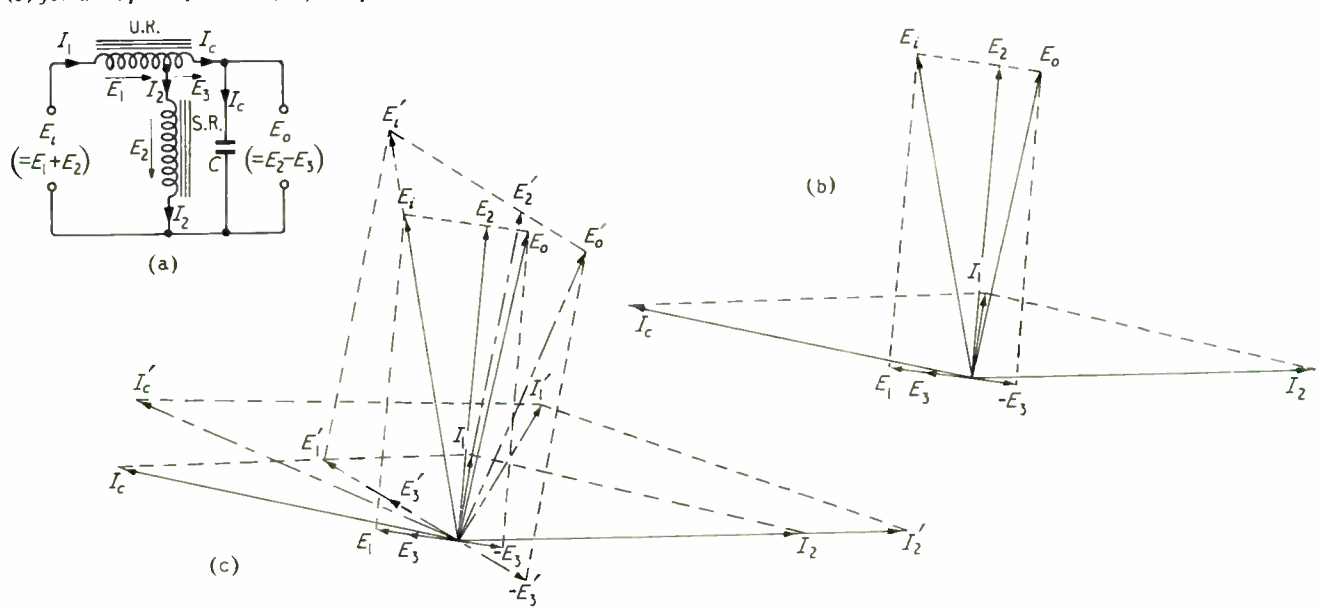
which indicates stabilization, though partial.

The stabilization is considerably improved in the slightly modified circuit of Fig. 3(a) wherein the unsaturated reactor is suitably tapped instead of being entirely in series with S.R. The action may be followed from the volt-ampere curves of Fig. 3(b), which is self-explanatory. It is evident that the output voltage, E_o, which is the difference between E_2 and E_3, hardly suffers any change when the input voltage changes from E_i to E_i'. It must be pointed out that actually E_o is the vector difference (the figure shows arithmetic difference) between E_2 and E_3 which are, in general, out of phase. This, however, does not vitiate the main point, since any phase difference may be allowed for in the design of the components, the objective being to get a flat-topped output characteristic in the operating region.

It has already been indicated that stabilization is improved by increasing the saturation of S.R. which, however, means an undesirable increase in the no-load current of the stabilizer. It becomes possible to operate S.R. at high saturation and yet draw only a relatively small no-load current from the supply source, by the use of a capacitor of suitable value across the output terminals, as shown in Fig. 4(a). The capacitor current I_c and the current I_2 through S.R. are roughly in antiphase (E_3 being small compared to E_2) and hence if C is chosen so as to make I_c nearly equal to I_2 in magnitude, the no-load input current I_1 becomes quite small. This is shown in the vector diagram of Fig. 4(b), which also shows the typical dispositions of the various current and voltage vectors at no-load. Now E_1, being proportional to I_1 (U.R. is unsaturated), is consequently much reduced and so, almost the entire input voltage is impressed across S.R. which may therefore be designed for the desired high saturation at the nominal mains input voltage. E_3 is also correspondingly reduced, but owing to the higher saturation now occurring in S.R. the reduced E_3 may still suffice to give the required flat-topped output characteristic of Fig. 3(b). The advantage of using the capacitor is thus to make the output voltage almost equal to the input voltage, whereas without it the ratio E_o/E_i is rather small—a factor which adversely affects the efficiency.

Fig. 4(c) shows how the output voltage adapts itself to changes of input voltage at no-load. The input voltage E_i is the sum of E_1 and E_2. The output voltage E_o is obtained by vector subtraction of E_3 from E_2. The current I_1 is almost 90° lagging behind E_1 since U.R. is unsaturated. When E_i increases to E_i', the saturation current I_2 considerably increases to I_2', which is accompanied with an increase and phase shift of I_1 to maintain the relation $I_1' = I_2' + I_c'$.

Fig. 4. The addition of capacitor C as shown in (a) reduces the no-load current. The no-load vector relations are indicated at (b) for an input E_i and at (c) for inputs E_i and E_i'



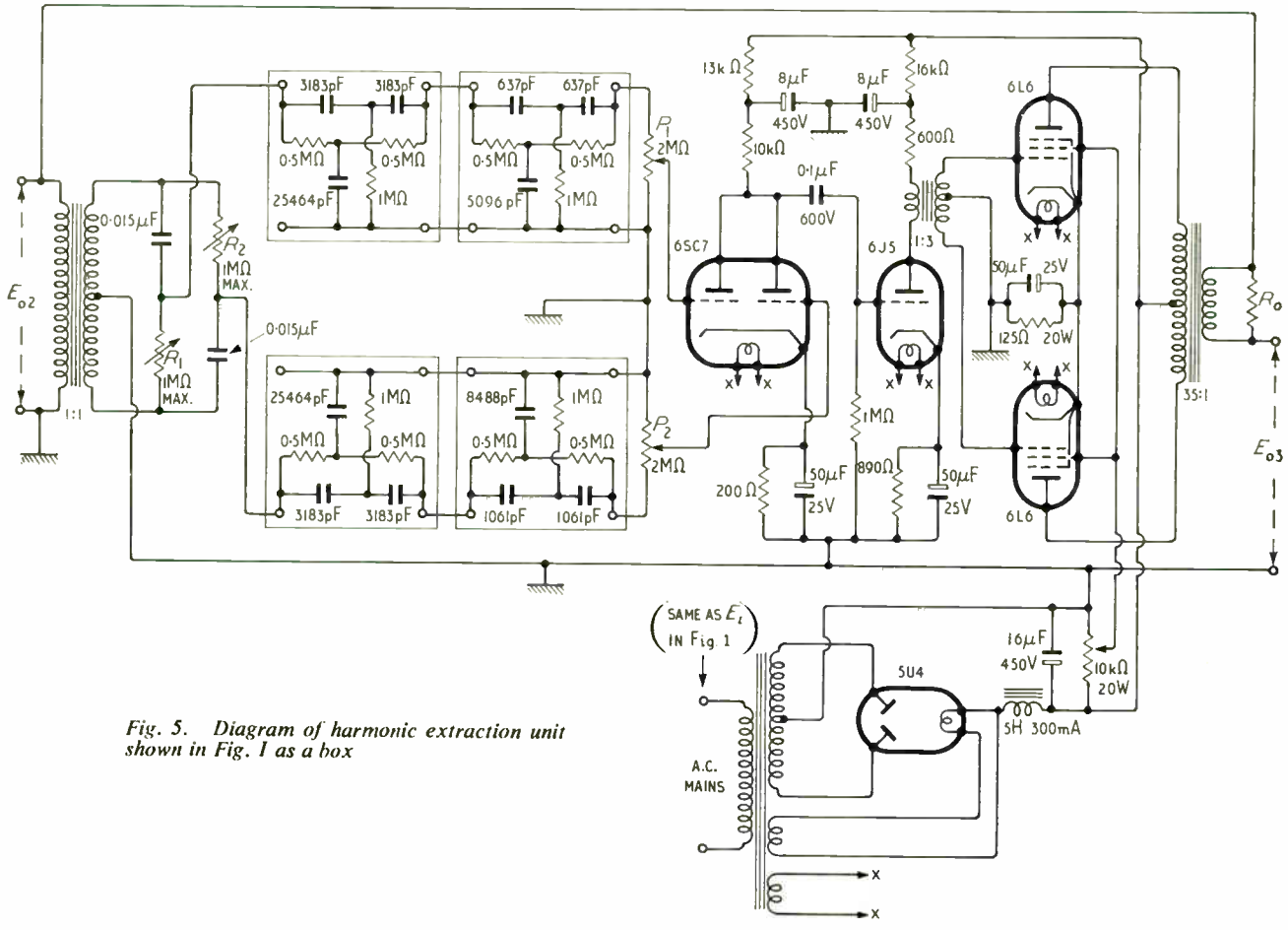


Fig. 5. Diagram of harmonic extraction unit shown in Fig. 1 as a box

This increase and phase shift of I_1 is, again, accompanied with a proportionate increase and equal phase shift of E_1 to E_1'. E_1' substantially accommodates the increase in E_i so that E_2' is only slightly larger than E_2. (It may be noted that even a small increase in E_2 causes a relatively large increase in I_2 due to saturation of S.R.) E_3 undergoes similar changes as E_1 and so the resulting output voltage E_0' is seen to be almost equal to E_0 in magnitude, though the phase is shifted. It is to be noted that I_c and I_c' are 90° leading on E_0 and E_0' respectively.

Changes of load have somewhat similar effects on phases and magnitudes but in this case the output voltage stabilization is worse than at no-load. It should be observed that the resistances and the leakage reactances of the windings have been neglected in the discussion. These are to be allowed for by minor trial adjustments in the design.

Both the reactors, U.R. and S.R., are assembled from E and I transformer sheet-steel stampings forming three-limbed cores, with no intentional air-gap in the magnetic circuit of S.R. but with a liberal air-gap in that of U.R. to make it suitable for a linear choke. The central limbs of the cores are wound with super-enamelled copper wire of liberal gauge. The copper section for S.R. is specially large since it must carry a large current due to its high saturation with almost the nominal input voltage impressed on it. The winding of U.R. is provided with a number of taps out of which the most suitable tapping is selected by judicious trial. The value of the capacitor C is decided from the consideration that at normal input voltage, the currents through C and S.R. should be nearly equal in magnitude. The value of C is, however, influenced by the values of the capacitors used in the next unit, viz., the harmonic filters, since at the fundamental frequency, the circuits L_1, C_1 and L_2, C_2 (Fig. 1) are almost entirely capacitive and so the sum of C, C_1 and C_2 must be considered as the shunt capacitance across the output of the main unit.

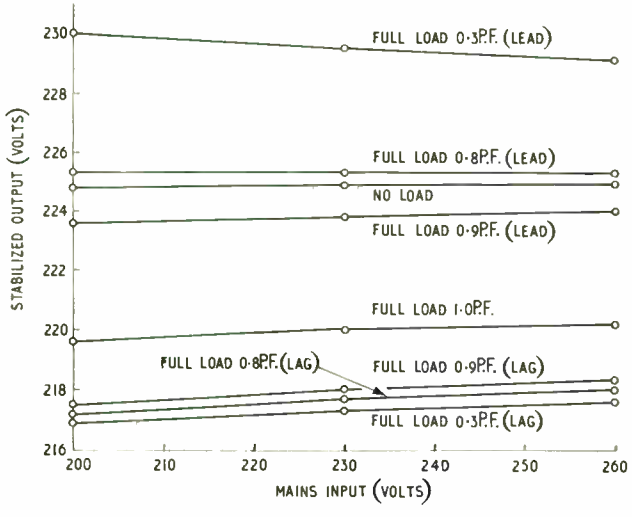


Fig. 6. Stabilized output voltage versus mains voltage at various loads and power factors. Nominal frequency 50 c/s

Harmonic Filters

Series resonant filters form the first stage of the harmonic reduction circuits. The output from the main unit (E_{01} of Fig. 1) contains about 30% total distortion which is

mostly the third and the fifth harmonics. To reduce these, series choke-capacitance filters, L_1, C_1 and L_2, C_2 of Fig. 1, are incorporated and tuned respectively to the third and fifth harmonic frequencies, viz., 150 c/s and 250 c/s. These filters provide nearly short-circuit paths to their respective resonant harmonic components which are thus substantially suppressed in the output, E_{O2}, of this unit, bringing the total harmonic content to about 5%. L_1 and L_2 are linear reactors, of about 50 mH each, similar in design to that of U.R. of the main unit. C_1 and C_2 are capacitors which resonate with L_1 and L_2 at 150 c/s and 250 c/s respectively. The voltage ratings of the capacitors are about 300 V in the present equipment, sufficient to withstand the resonant rise of voltage across them.

Electronic Harmonic Extraction Unit

This is based on a device developed by Choudhury and Das Gupta[6,7]. The output E_{O2} of Fig. 1 after the LC filters is applied as input to this extraction unit, the details of which are shown in Fig. 5. The input passes through a phase-shifting arrangement (variation of R_1 and R_2 can provide phase shifts without affecting magnitude) after which it is simultaneously impressed on two network systems each consisting of a tandem pair of high-impedance twin-T blocking networks. The left-hand networks block the fundamental (50 c/s), while the right-hand block the third harmonic (15 0c/s) and the fifth harmonic (250 c/s). Thus, assuming harmonics higher than the fifth as negligible, the output from the upper pair is entirely third harmonic and that from the lower is entirely fifth harmonic although each harmonic suffers attenuation and phase shift due to its passage through the various networks.

These outputs are then applied on the grids of a twin-triode (6SC7) mixer amplifier, the output of which is further voltage and power amplified by a triode (6J5) and a push-pull pair of beam tetrodes (6L6) respectively. The final output of this unit is available across the load resistance R_O. This output is constituted by only the third and the fifth harmonic components of the input, viz., E_{O2}. By properly adjusting R_1, R_2, P_1 and P_2, the magnitudes of these components in this output are made exactly equal to their counterparts in the input whereas the phases are made just opposite. Consequently, when E_{O2} and R_O are connected in series as shown in Fig. 1, the harmonics are just cancelled out leaving the final output, E_{O3}, of the stabilizer practically free from harmonics.

The amplifier must provide ample power to counteract successfully the harmonic power content of the output E_{O2}. Further, it must not itself be the source of any appreciable distortion. In the present design the output is about 15 W with class A_1 operation. The output load resistance R_O must also be as low as possible since it impairs the regulation of the stabilizer as a whole. In the present design it is 4 ohms.

Stabilizer Performance

The stabilization performance of the present equipment, designed for 220 V, 250 VA (unity p.f.) when operated from 50-c/s 230 V mains, is shown graphically in Fig. 6. An electrodynamometer type sub-standard voltmeter with knife-edge pointer was used to measure the output voltage, viz., E_{O3} of Fig. 1. It will be seen that at full load (250 VA), the stabilization at constant frequency is better than $\pm 0{\cdot}2\%$ for $\pm 15\%$ input fluctuations at all power-factors between unity and 0·3 lagging or leading. At no-load the stabilization (at constant frequency) is better than $\pm 0{\cdot}03\%$ for $\pm 15\%$ fluctuation at the input. The regulation on load is somewhat poor, being about 2% at full-load unity power-factor. The main cause of this is evidently the output resistance R_O of the harmonic extraction unit. The poor regulation is, however, not a serious handicap since stabilizers are usually required to supply fixed loads. As can be seen from the graphs, the stabilization of the present equipment is exceptionally good at fixed loads.

The total harmonic content of the final stage of the stabilizer, as measured by a distortion meter, was slightly more than 1%. It is felt that by a more efficient design of the electronic unit, this figure can be still bettered. If some more distortion may be tolerated (4·8%) then the stabilized output from the second stage (viz., E_{O2}) may be used. The stability performance even at this stage is essentially the same as that of the final stage but the regulation on load is better, being about 0·8% at full-load unity power-factor.

The present stabilizer, like many constant-voltage transformers, is self-protective against overloads. This is exhibited by the curves of Fig. 7, which are the complete load characteristics of the stabilizer for three different input voltages, viz., 200 V, 230 V, 260 V.

It is to be noted that when the output terminals are short-circuited, the current from the mains is chiefly limited by the reactance of almost the entire unsaturated reactor, U.R. Therefore, the short-circuit current is sensibly proportional to the input voltage. This is substantiated by the nearly equal intercepts on the current axis made by the curves at equal voltage intervals of 30 V.

The output of the stabilizer is rather frequency sensitive as is usual for constant-voltage transformers. The frequency characteristics are shown in Fig. 8 for the three output stages, viz., E_{O1}, E_{O2} and E_{O3} of the present equipment at no-load and normal input voltage. E_{O1} is least affected by frequency changes. This is to be expected, since stages E_{O2} and E_{O3} involve additional frequency sensitive circuits (LC filters and the harmonic extraction unit). It is expected that a stabilizer of this kind will be used on fixed frequency mains or in conjunction with a frequency stabilizer. In some commercial designs, frequency compensating devices are

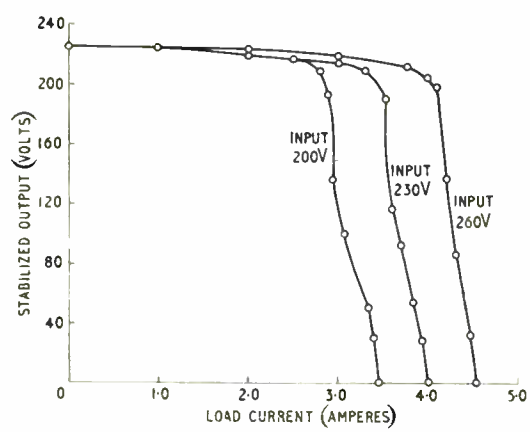


Fig. 7. Overload characteristics at various input voltages

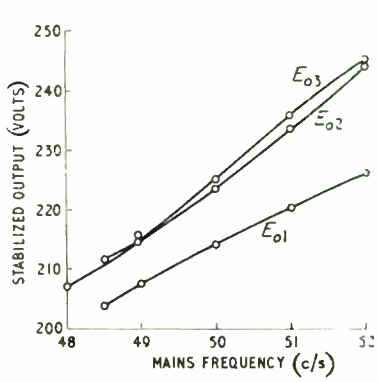


Fig. 8. Output voltage versus mains frequency at 230 V input

incorporated, but usually they are effective at particular loads only. (This remark does not apply to stabilizers employing feedback methods for stabilization.)

Conclusion

It is claimed that a constant-voltage transformer of very high stability and almost pure waveform of exceptionally good performance has been designed. The equipment which is self-protective against overloads suffers from the disadvantage of a rather poor frequency characteristic, however. This is basically inherent in the principle of operation of this type of voltage stabilizer.

Acknowledgments

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SYNTHESIZING THE RADIATION PATTERN OF A RING AERIAL

This article describes a method for determining the currents and voltages with which the radiating elements of a ring aerial must be driven in order to produce a specified radiation pattern, a process often referred to as radiation pattern synthesis. The application of the method to the practical case of a ring of dipoles mounted on a cylinder is illustrated with an example.

*By P. KNIGHT, B.A., A.M.I.E.E.**

WHEN designing aerials for very-high-frequency (v.h.f.) broadcasting, care must be taken to ensure that the powers radiated in certain directions do not exceed certain specified values; this is necessary to ensure that interference with other stations broadcasting in the same channel does not occur. At the same time, the aerial must give adequate coverage in its own service area. The maximum permissible and minimum desirable field strengths can be conveniently displayed in polar form as a templet comprising two closed figures. The horizontal radiation pattern (h.r.p.) of a v.h.f. broadcasting aerial must often satisfy somewhat stringent requirements and, although satisfactory radiation patterns can usually be obtained on a trial and error basis by calculating the performance of aerial arrangements which appear to be suitable, this can be a time-consuming process even when an analogue computer is available.[1] The investigation described in this article was undertaken in an attempt to determine the aerial design by direct calculation from the radiation pattern requirements.

The radiation pattern of any aerial, however complex, may be determined if its radiating currents are known, but the converse problem (generally known as synthesis) of finding the current distribution which will produce a given radiation pattern is much more difficult. To simplify the problem, certain assumptions are usually made about the phase variation of the radiation pattern, for example a particular relationship between the feeds to the aerial elements may be postulated. This is undesirable and may lead to an uneconomic aerial design, because the phase variation of a radiation pattern is generally of no practical interest; it is the amplitude variation which is significant.

In the method described in this article no restriction is placed on the phase of the radiation pattern, but the problem is simplified by limiting to five the number of real coefficients which specify the current or voltage distribution. This limitation restricts us to the synthesis of simple radiation patterns; these exist, however, in sufficient variety to enable many practical requirements to be satisfied. More complicated patterns could naturally be obtained by using more than five feed coefficients but the synthesis problem would then be much more difficult to solve.

The method may be applied to rings comprising any type of element whose radiation pattern is symmetrical both in amplitude and phase about a line joining the element with the ring centre. Suitable elements include rings of dipoles placed around a conducting cylinder; the individual dipoles may be either parallel to the cylinder axis or tangential to the circumference of the ring. It is equally applicable to rings of axial or circumferential slots in conducting cylinders.

In applying the method, the magnitude of the required field strength is specified in five directions. Although an infinite number of radiation patterns satisfying the specified values exist, the technique described in this article leads to a single pattern whose shape depends on the relationship between these values. Should the shape of this pattern not be entirely satisfactory for the requirements of the templet in directions other than those with specified field strengths, it

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may often be improved by making a fresh choice of the five specified values.

When an acceptable pattern has been obtained the current or voltage distribution of the ring aerial is determined. The aerial is initially assumed to contain an infinite number of elements and the required current or voltage distribution derived is therefore a continuous function of the angular position around the ring; it is analogous to the aperture distribution of a linear aerial. In general, four such distributions, all of which result in the same radiation pattern, can be obtained. The continuous distribution is then simulated (in the sense of a 'best approximation') by a finite number of elements with appropriate feeds and the extent to which the pattern deviates from the one originally specified is determined; the amount of deviation which can be tolerated determines the number of elements which are required. It is in this replacement of a continuous distribution of radiating elements by a finite number of elements that the weakness of the method lies. Although it is possible to satisfy a wide variety of templets, the number of radiating elements required is usually greater than the number which are found to give a satisfactory result by the trial and error method.

Description of the Method

Consider a radiating element P on a ring, as shown in Fig. 1. If the radiation pattern of the element in the plane

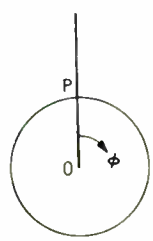


Fig. 1. Co-ordinate system

containing the ring is symmetrical in amplitude and phase about OP, the pattern may be referred to the centre of the ring and written in the form

$$K_0 + K_1 \cos\phi + K_2 \cos 2\phi + \ldots + K_m \cos m\phi + \ldots \qquad (1)$$

where K_0, K_1, K_2 etc. are complex coefficients, ϕ is the angle measured from the direction OP and m is any integer. $|K_m|$ decreases as m increases.

Suppose now that we have a ring of n equally spaced and co-phased radiating elements. Let the complex feed coefficient of each element be u_0/n; this can conveniently correspond to the loop current in the case of a dipole and the loop voltage in the case of a slot. Then the K_0-terms in expression (1) will add together for the n elements and give a total of u_0K_0, but the K_1-terms will mutually cancel, because of the symmetry, and so will the K_2-terms and the K_m-terms unless m is a multiple of n, in which case they will reinforce each other as the K_0-terms did, to give a total contribution of $u_0K_m \cos m\phi$. The first term for which this reinforcement occurs is $u_0K_n \cos n\phi$, and if n is sufficiently large this is negligible; the next 'reinforced' term $u_0K_{2n} \cos 2n\phi$ is smaller still. The radiated field is therefore effectively constant and equal to u_0K_0 in all directions.

Consider now a similar ring in which the elements are driven with equal amplitudes but with a phase which advances progressively round the ring by an amount equal to ϕ. If the feed to the element at $\phi = 0$ is u_1/n, the feed to the other elements is $u_1e^{j\phi}/n$ and the radiation pattern is then equal to $\frac{1}{2}u_1K_1e^{j\phi}$, provided sufficient elements are used.*

Similarly we may consider a third ring with an anti-clockwise phase rotation. If the feed to its elements is $u_{-1}e^{-j\phi}/n$ the radiation pattern will be $\frac{1}{2}u_{-1}K_1e^{-j\phi}$.

If the three rings are now superimposed the feed to the elements is given by

$$u/n = [u_0 + u_1e^{j\phi} + u_{-1}e^{-j\phi}]/n \qquad (2)$$

and the radiation pattern will be equal to

$$E = u_0K_0 + \tfrac{1}{2}[u_1e^{j\phi} + u_{-1}e^{-j\phi}]K_1 \qquad (3)$$

Since the absolute phase of the radiation pattern is arbitrary we may specify u_0K_0 as a positive real quantity and write the pattern in the form

$$E = A_0 + Qe^{j\phi} + Re^{-j\phi} \qquad (4)$$

where A_0 is real and positive and Q and R are complex. Thus

$$A_0 = u_0K_0, \qquad Q = \tfrac{1}{2}u_1K_1, \qquad R = \tfrac{1}{2}u_{-1}K_1 \qquad (5)$$

The radiation pattern may also be written in the form

$$E = A_0 + A_1 \cos\phi + B_1 \sin\phi + j[C_1 \cos\phi + D_1 \sin\phi] \qquad (6)$$

where A_0, A_1, B_1, C_1 and D_1 are all real. From equations (5) and (6) it may be shown that

$$\begin{aligned} Q &= \tfrac{1}{2}[A_1 + D_1 - j(B_1 - C_1)] \\ R &= \tfrac{1}{2}[A_1 - D_1 + j(B_1 + C_1)] \end{aligned} \qquad (7)$$

Since the relative phase of the radiation pattern is of no interest we need consider only the modulus of E or some function of it. The most convenient function is the square of the modulus, which is given by

$$|E|^2 = [A_0 + A_1 \cos\phi + B_1 \sin\phi]^2 + [C_1 \cos\phi + D_1 \sin\phi]^2 \qquad (8)$$

We may write this expression in the form

$$|E|^2 = a_0 + a_1 \cos\phi + a_2 \cos 2\phi + b_1 \sin\phi + b_2 \sin 2\phi \qquad (9)$$

where

$$a_0 = A_0^2 + \tfrac{1}{2}(A_1^2 + B_1^2 + C_1^2 + D_1^2) \qquad (10)$$

$$a_1 = 2A_0A_1 \qquad (11)$$

$$a_2 = \tfrac{1}{2}(A_1^2 - B_1^2 + C_1^2 - D_1^2) \qquad (12)$$

$$b_1 = 2A_0B_1 \qquad (13)$$

$$b_2 = A_1B_1 + C_1D_1 \qquad (14)$$

Equations (8) and (9) are therefore alternative forms of the power radiation pattern, and since they contain five coefficients, the relative field strength (or the relative power density) may be specified in five different directions. The absolute field strengths do not need to be specified. All that are required are the ratios between the field strengths in five different directions. Now the coefficients in equation (9) can be readily obtained from the specified values by solving five linear simultaneous equations and the radiation pattern may then be calculated for all other values of ϕ from this equation.

It is important to note that any set of coefficients which results in a negative value of $|E|^2$ for any value of ϕ must be rejected, since it does not correspond to a realizable aerial. This is likely to happen if very small field-strength values are specified or if rapid variations of field strength with direction are demanded.† If this occurs, the specified values must be modified until $|E|^2$ is positive for all values of ϕ; the coefficients of equation (9) then satisfy certain conditions which are discussed in the Appendix.

To find the feed coefficients of the elements it is now neces-

* Although ϕ denotes the azimuthal angle it is also used here to denote the phase of the ring element, because the phase of the element feed is directly related to its angular position.

† Although a ring aerial which will satisfy such requirements may be possible, the feed distribution in its elements will not necessarily be of the type described here.

sary to determine the coefficients of equation (8) from those of equation (9).

Algebraic manipulation of equations (10)–(14) gives

$$\left[b_2 - \frac{a_1 b_1}{4A_0^2}\right]^2 = C_1^2 D_1^2 \qquad (15)$$

where

$$C_1^2 = a_0 + a_2 - A_0^2 - a_1^2/4A_0^2 \qquad (16)$$

$$D_1^2 = a_0 - a_2 - A_0^2 - b_1^2/4A_0^2 \qquad (17)$$

The term $[a_1 b_1/4A_0^2]^2$ is common to both sides of (15) and cancels to leave a cubic in A_0. It can be shown that a practical solution is possible only if this equation has three real roots, in which case they are all positive, but only the two smaller correspond to physically realizable solutions of the problem. The equation therefore yields two values for A_0, which by definition is real and positive.

The remaining coefficients may now be determined from equations (11), (13), (16) and (17). For each value of A_0 there are two values (positive and negative) of C_1 and D_1 but as the signs of C_1 and D_1 are related to each other by equation (14), there are only two solutions for each value of A_0, or four in all. Thus the radiation pattern of equation (9) can be achieved by four different feed distributions; their calculation is straightforward, Q and R being determined from equations (7) and the feed coefficients from equations (5).

Application to Dipoles Mounted on a Cylinder

An application which is of particular interest is the synthesis of the h.r.p. of a v.h.f. broadcasting aerial. These aerials often consist of rings of dipoles placed round a mast; in many practical cases the latter may be assumed to be equivalent to an infinitely long conducting cylinder.

A templet typical of those prescribed for Band I television transmitting aerials is shown in Fig. 2; the radiation pattern of the aerial is required to lie between the two closed curves.

Investigation showed that by a suitable choice of the five specified field-strength values it was possible to obtain a pattern which satisfied the templet in all directions; the values which were chosen are given in Table 1.

By substituting these values in equation (9) and solving the

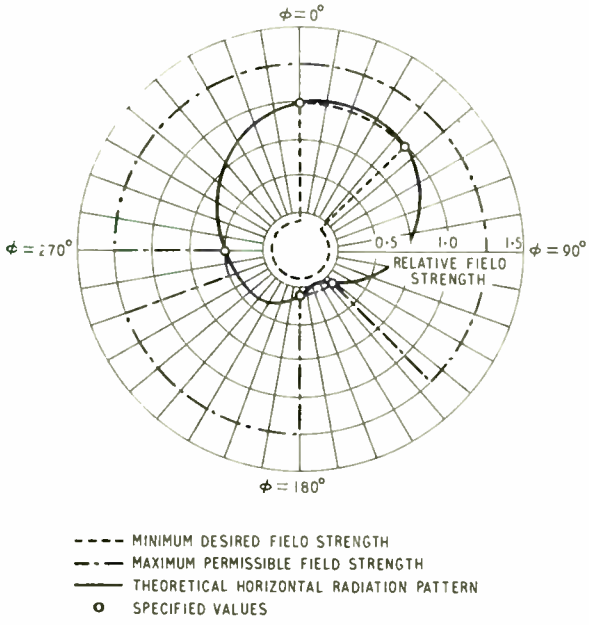


Fig. 2. Radiation pattern satisfying prescribed templet

TABLE 1

Specified Values

ϕ	0	45°	135	180°	270°
$\|E\|$	1·00	1·00	0·30	0·30	0·50
$\|E\|^2$	1·00	1·00	0·09	0·09	0·25

TABLE 2

Radiation Pattern Coefficients

	Solution Number			
	1(a)	1(b)	2(a)	2(b)
A_0	0·3513		0·5228	
A_1	0·6476		0·4352	
B_1	0·1736		0·1167	
C_1	0·0467	−0·0467	0·2870	−0·2870
D_1	0·4663	−0·4663	0·2899	−0·2899

resulting five simultaneous equations, the following values for the coefficients were obtained:

$$a_0 = 0{\cdot}458$$

$$a_1 = 0{\cdot}455 \qquad b_1 = 0{\cdot}122$$

$$a_2 = 0{\cdot}087 \qquad b_2 = 0{\cdot}134$$

These coefficients satisfy the conditions for which a solution can be found (as stated in the Appendix) and give the radiation pattern shown in Fig. 2.

Substitution of these values in equation (15) gives a cubic in A_0^2 with three real roots. In the Appendix it is shown that the two smaller roots lead to a physically realizable solution of the problem; their values are 0·1234 and 0·2733 and the corresponding values of A_0 are 0·3513 and 0·5228.

Each value of A_0 leads to a pair of solutions; the four solutions are designated 1(a), 1(b), 2(a) and 2(b) and the corresponding coefficients are given in Table 2.

It is of interest at this stage to calculate the radiation patterns, in complex form, from equation (6). When plotted on the complex plane they appear as ellipses, as shown in Fig. 3. It will be seen that the amplitudes of all four radiation patterns are identical and correspond to Fig. 2. The two patterns corresponding to a particular value of A_0 differ only in that their imaginary values are of opposite sign, but the two values of A_0 give quite different ellipses; it will be noted that the origin is inside the ellipse in one case and outside it in the other.

The coefficients of Q and R of equation (4) are now calculated from equations (7); their values are given in Table 3.

The coefficients given in Tables 2 and 3 define, in alternative ways, a radiation pattern passing through the five prescribed points.

Up to this point no mention has been made of the type of radiating element, since the aperture distribution can be obtained from any type of radiating element whose radiation

TABLE 3

Solution No.	Q	R
1(a)	0·5570 − j0·0635	0·0906 + j0·1101
1(b)	0·0906 − j0·1101	0·5570 + j0·0635
2(a)	0·3626 + j0·0852	0·0726 + j0·2018
2(b)	0·0726 + j0·2018	0·3626 − j0·0852

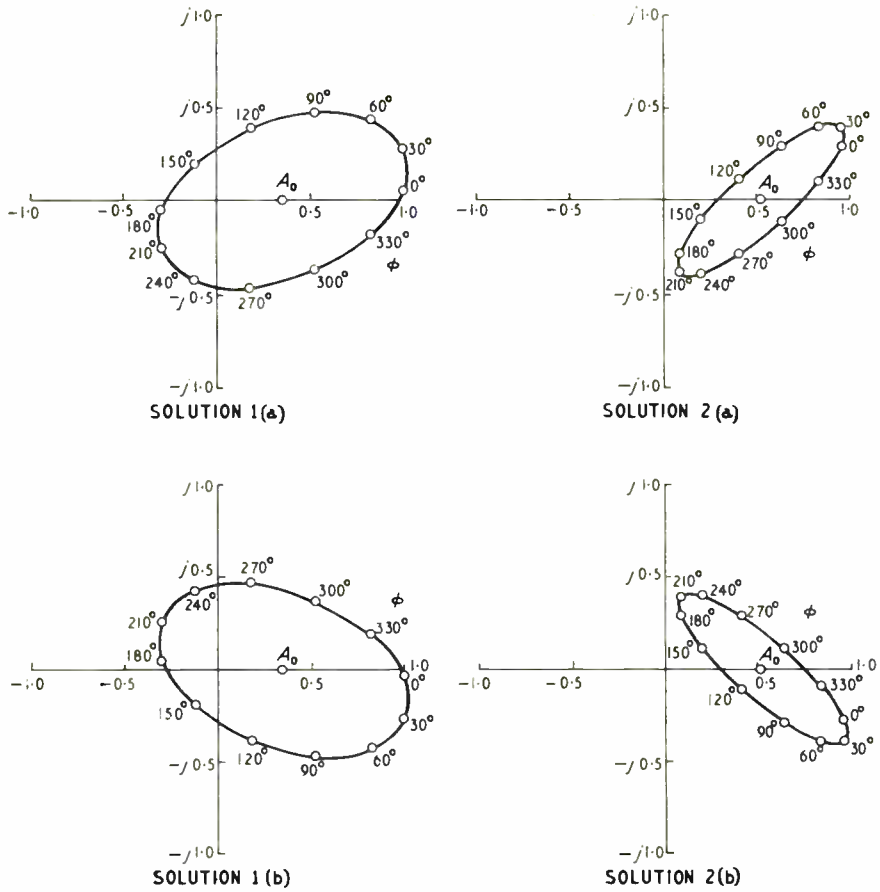


Fig. 3. Horizontal radiation patterns in complex form

pattern satisfies the requirements of symmetry. The element pattern must now be taken into consideration to enable the feed distribution to be determined.

Let us suppose that the aerial consists of a ring of vertical dipoles mounted on a mast, the latter being assumed to be equivalent to a conducting cylinder. The radiation pattern of a single element has been shown[2] to be

$$V_0 + 2\sum_{n=1}^{\infty} j^n V_n \cos n\phi$$

$$V_n = \mathrm{J}_n(\beta b) - \mathrm{J}_n(\beta a)\frac{\mathrm{H}_n^{(2)}(\beta b)}{\mathrm{H}_n^{(2)}(\beta a)}$$

$\mathrm{H}_n^{(2)}$ denotes the Hankel function of the second kind of order n, b is the distance of the dipole from the cylinder axis, a is the radius of the cylinder and β is the propagation constant of free-space. Comparing this expression with equation (1) it is seen that the complex coefficients of the element radiation pattern are given by

$$K_0 = V_0 \qquad K_1 = j2V_1$$

If $\beta a = 0{\cdot}5$ and $\beta b = 2{\cdot}0$ radians (typical values for a Band I aerial), K_0 and K_1 have the following values:

$$K_0 = 0{\cdot}2385 + j0{\cdot}0535 \qquad K_1 = -0{\cdot}1792 + j1{\cdot}0886$$

The feed coefficients for the three superimposed ring aerials may now be calculated from equations (5); they have the values given in Table 4.

These four sets of coefficients enable the four feed distributions to be calculated using equation (2). Each distribution is the sum of the currents or voltages with which the three basic ring aerials must be driven in order to give the radiation pattern shown in Fig. 2; they may therefore be regarded as cylindrical aperture distributions. Thus a ring aerial consisting of an infinite number of elements driven according to one of these distributions will have a radiation pattern which is identical with that shown in Fig. 2.

The four aperture distributions are shown in complex form in Fig. 4 and it will be seen that these again take the form of two pairs of ellipses. Since a finite number of elements must be used in practice, curves of the type shown in Fig. 4 enable the most convenient arrangement of elements to be chosen. For example, Fig. 4 shows that in solution 2(a) the current required in an element at $\phi = 180°$ is almost zero and in a practical aerial this element could be omitted altogether. This solution therefore offers a definite advantage over the other three solutions.

The current in each element may be either the average value for the sector of the aperture which contains the element, or it may be the value for the actual position of the element;

TABLE 4
Feed Coefficients for Vertically Polarized Aerial

Solution No.	u_0	u_1	u_{-1}
1(a)	0·270 − *j*0·570	−0·278 − *j*0·978	0·170 − *j*0·195
1(b)	0·270 − *j*0·570	−0·223 − *j*0·129	−0·050 − *j*1·015
2(a)	0·402 − *j*0·848	0·046 − *j*0·674	0·339 − *j*0·189
2(b)	0·402 − *j*0·848	−0·382 − *j*0·070	−0·259 − *j*0·624

the latter value is the more convenient since it may be immediately determined from Fig. 4.

The use of a finite number of elements means that the resulting pattern will deviate from that shown in Fig. 2. To illustrate the accuracy with which the idealized pattern may be reproduced, a number of patterns for different numbers of elements fed with currents corresponding to their actual positions (rather than values averaged over a sector) were calculated on an analogue computer;[1] the results are shown in Fig. 5. It will be seen that the agreement obtained with the use of eight elements is good, with six it is reasonable but with four it is rather poor. The number of elements which must be used to obtain good agreement depends on the ring radius and with a larger ring more elements will be required.

The necessity for using an almost continuous ring of elements to obtain a close approximation to the required radiation pattern can possibly be overcome by using an alternative approach. In this method a finite number of elements would be postulated and their feed currents or voltages denoted by complex coefficients. The expression for the resulting radiation pattern (with higher-order terms neglected) would then be compared with each of the four solutions of equation (6) in turn, thereby yielding four sets of feed coefficients. Whether this method is feasible and, if so, whether the approximations involved cause the resulting pattern to differ appreciably from the specified pattern, has yet to be investigated.

Conclusions

The design of television transmitting aerials is usually carried out on a trial and error basis; h.r.p. calculations are repeated, for different radiating element arrangements, until a satisfactory result is obtained.

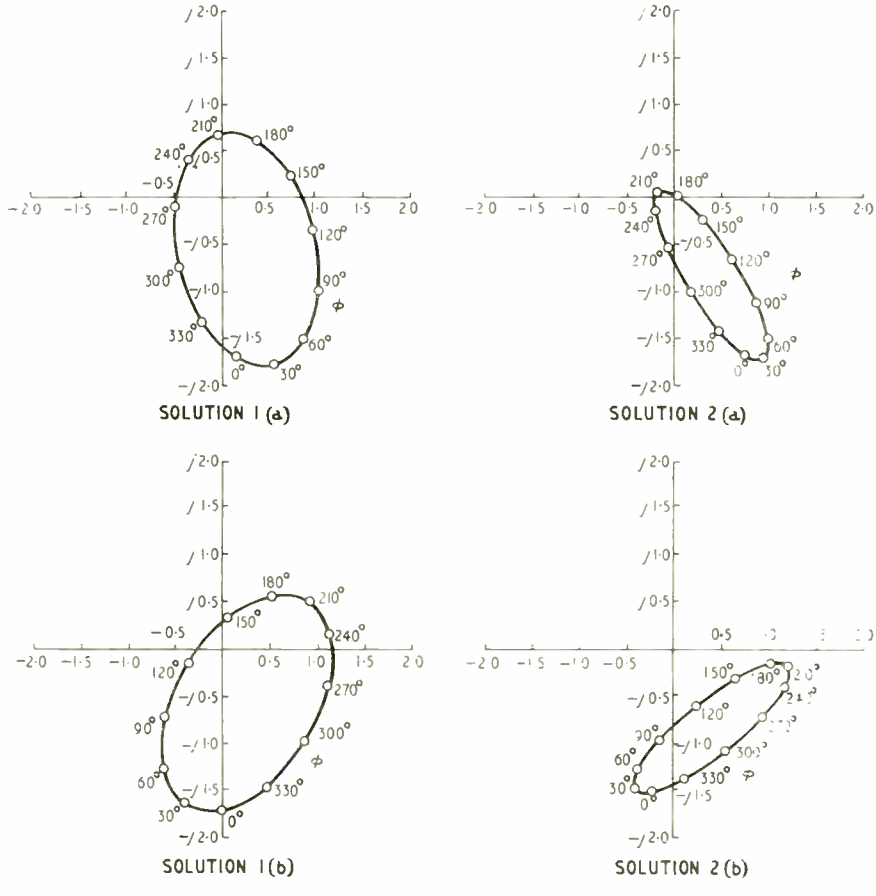
The alternative synthesis method described in this article enables the feed parameters for ring aerials to be determined when the field strength is specified in five arbitrarily chosen directions. The method may be used for v.h.f. broadcasting aerials consisting of rings of dipoles or slots, when directional h.r.ps are required. A single radiation pattern results from the method but this may be obtained with any of four different sets of feed parameters; the most convenient of these feed arrangements may thus be chosen.

The fact that the synthesis method leads to several solutions for the feed parameters suggests that a number of solutions can also be found by the trial and error method. Only one solution is usually found in this way, however, and it may not be the most convenient one to achieve in practice; the choice of solutions offered by the synthesis method is therefore an advantage. The fact that the method leads to a continuous aperture distribution is a disadvantage, since it requires that each ring should contain a sufficient number of elements to approximate to a continuous ring. Moreover it does not reveal the fact that the desired radiation pattern can sometimes be achieved by a much simpler aerial system. For this reason its usefulness, when applied to the design of Band I and II aerials (i.e., those comprising rings of less than one wavelength diameter), is somewhat limited, and the trial and error method is preferable. In the u.h.f. band, however, where larger rings may be required, the method may have a useful application.

Acknowledgment

The author wishes to thank the Director of Engineering of the British Broadcasting Corporation for permission to publish this paper.

Fig. 4. Aperture distributions



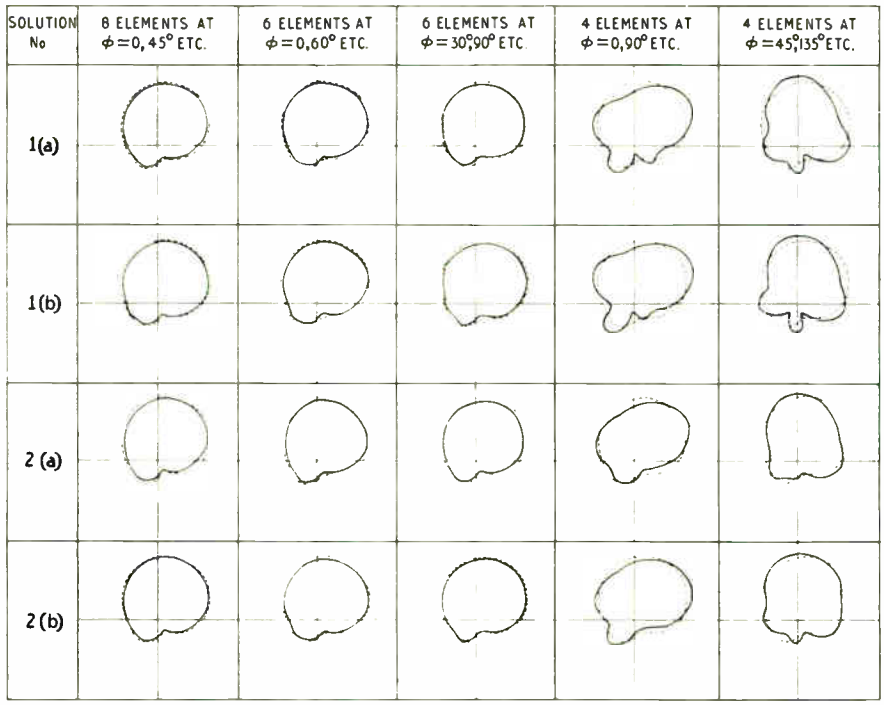


Fig. 5. Horizontal radiation patterns obtained with finite numbers of elements. The broken lines show the radiation patterns which would be obtained with an infinite number of elements

References

[1] H. Page, G. J. Phillips and J. A. S. Fox, 'An Analogue Computer for Aerial Radiation Patterns', *E.B.U. Review*, Part A, No. 62, p. 146, August 1960.

[2] P. S. Carter, 'Antenna Arrays around Cylinders', *Proc. I.R.E.*, Vol. 31, No. 12, p. 671, December 1943.

APPENDIX

Conditions for a Realizable Solution

Equation (9) gives a formula for $|E|^2$ in terms of the given quantities a_0, a_1, a_2, b_1 and b_2. The essential condition for a useful solution to be obtainable is that $|E|^2$ be positive for all values of ϕ. If we write

$$|E|^2 = a_0 + k_1 \cos(\phi + \alpha_1) + k_2 \cos(2\phi + \alpha_2) \quad (18)$$

where

$$k_1 = (a_1^2 + b_1^2)^{\frac{1}{2}}; \qquad k_2 = (a_2^2 + b_2^2)^{\frac{1}{2}};$$
$$\tan\alpha_1 = b_1/a_1; \qquad \tan\alpha_2 = b_2/a_2 \quad (19)$$

then $|E|^2$ must be always positive if $a_0 > k_1 + k_2$ and cannot be always positive if $a_0 < |k_1 - k_2|$. It is, however, less obvious what happens if a_0 is between $|k_1 - k_2|$ and $k_1 + k_2$.

Equation (15) reduces to a cubic in A_0^2, namely

$$A_0^6 + \lambda A_0^4 + \mu A_0^2 + \nu = 0 \quad (20)$$

where

$$\left.\begin{aligned} \lambda &= -2a_0 \\ \mu &= a_0^2 - a_2^2 - b_2^2 + \tfrac{1}{4}(a_1^2 + b_1^2) \\ \nu &= -\tfrac{1}{4}[a_1^2(a_0 - a_2) + b_1^2(a_0 + a_2) - 2a_1b_1b_2] \end{aligned}\right\} (21)$$

This cubic may have one real root or three, but it can be shown that no useful solution is obtained from the largest value of A_0^2 when there are three real roots, or from the real root when there is only one. The reason for this is that the corresponding values of C_1^2 and D_1^2 in equations (16) and (17) turn out to be negative. It can, however, be shown that even if equation (20) has three real positive roots in A_0^2 there is not necessarily a useful solution, but that the following conditions are sufficient to ensure that a pair of useful solutions can be obtained:

$$a_1^2 < (a_0 + a_2)^2 \quad (22)$$

$$b_1^2 < (a_0 - a_2)^2 \quad (23)$$

$$4a_2^2 < [\{(a_0 + a_2)^2 - a_1^2\}^{\frac{1}{2}} + \{(a_0 - a_2)^2 - b_1^2\}^{\frac{1}{2}}]^2 \quad (24)$$

$$\frac{1}{4}\left(\frac{2\lambda^3}{27} - \frac{\lambda\mu}{3} + \nu\right)^2 + \frac{1}{27}\left(\mu - \frac{\lambda^2}{3}\right)^3 < 0 \quad (25)$$

Although these conditions are always satisfied if $a_0 > k_1 + k_2$, this is not necessarily true if a_0 lies between $|k_1 - k_2|$ and $k_1 + k_2$; in this case useful solutions will only be obtained if the four conditions stated above are satisfied.

Personal and Company News

Sir William Garratt, a director of **Metal Industries Ltd.**, is joining the board of International Rectifier Europe S.A., Brussels.

Thorn-A.E.I. Radio Valves & Tubes Ltd. have acquired the industrial cathode-ray tube business of Associated Electrical Industries (Woolwich) Ltd. Enquiries should be directed to D. H. Yates at Enfield 5353.

The nucleonic and telecommunication sections of Burndept Ltd. have been transferred to **Burndept Electronics Ltd.**, Riverside Building, Erith, Kent. Both companies are subsidiaries of Royston Industries Ltd.

Sir Tufton Victor Hamilton Beamish, M.C., M.P., has joined the board of **A. C. Cossor Ltd.** A subsidiary of this company, the Cossor Valve Co., has moved from Highbury to The Pinnacles, Harlow, Essex (Telephone: Harlow 26862). The Cossor Instruments Service Department has moved to Edinburgh Place, Temple Fields, Harlow (Telephone: Harlow 26862).

James R. Stacey has been appointed chief of the engineering department of **Allen West & Co. Ltd.** following the retirement of Eric Heathcote, M.B.E., Frederick W. White, A.M.I.E.E., becomes deputy and Sidney Alfred Seear, A.M.I.E.E., assistant chief of the engineering department.

The Industrial Electronics Division of **International General Electric Co.**, of New York, is moving to new premises at Boulton Road, Reading, Berks.

E. M. Butterworth, chief engineer of B. & R. Relays Ltd., has been elected this year's chairman of the R.E.C.M.F. Panel W.

R. V. Powditch, O.B.E., T.D., A.M.I.E.E., Assoc.I.Mech.E., has resigned his position as a director of E.M.I. Sound Products Ltd. and general manager of that company's sound division. He has joined **Hirst Electronic Ltd.** as marketing director.

Elliott-Automation have formed a new subsidiary company, **Elliott Marine Automation Ltd.**

The Plessey Co Ltd. have acquired the 25% interest in Telephone & Electrical Industries Pty. Ltd. of New South Wales which was previously owned by The General Electric Co. Ltd. Through its subsidiaries, Automatic Telephone & Electric Co. Ltd. and Ericsson Telephones Ltd., Plessey previously owned a 50% interest in this company.

Derritron Research and Development Ltd. is taking on all the research and development work previously carried out by BEME Telecommunications Ltd.

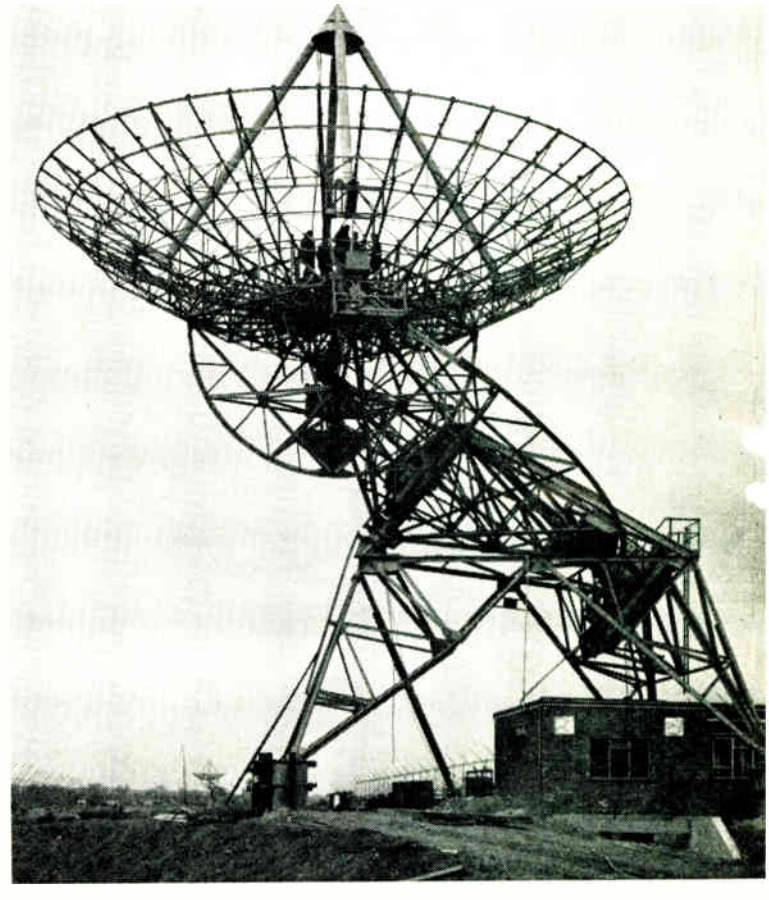
Walmore Electronics Ltd. have been appointed representatives in the U.K. for the products of the Electronic Components Division of Burroughs Corp.

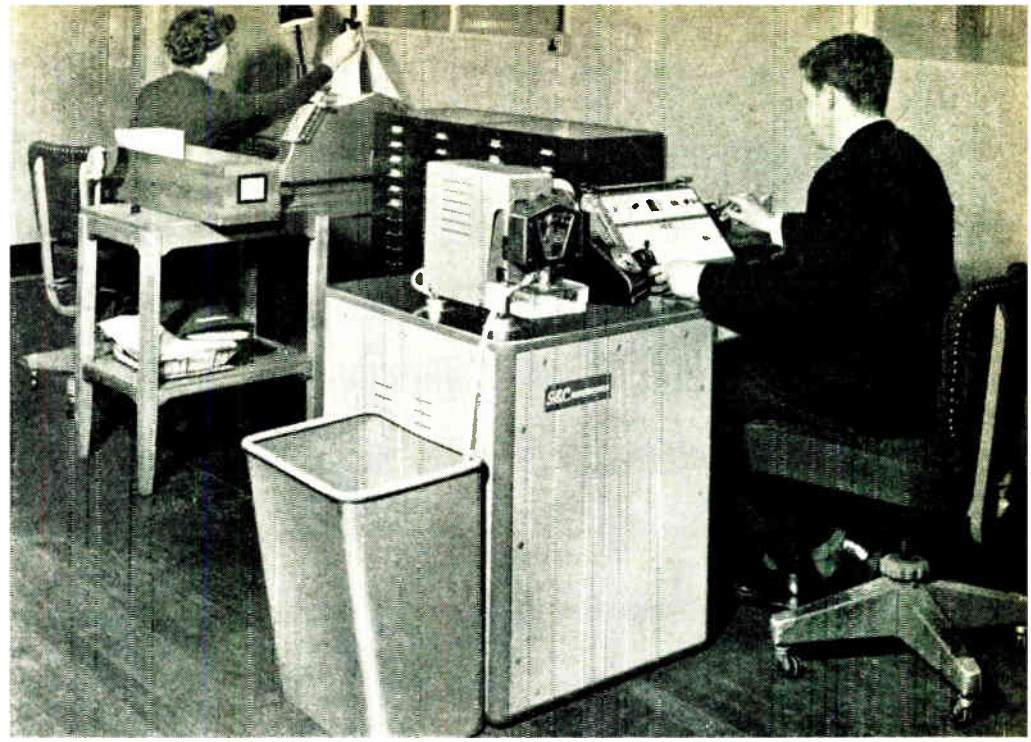
British Insulated Callender's Cables Ltd. have appointed Sir Harold Bishop consultant to the B.I.C.C. group and are electing him a director and deputy chairman of the company.

G. & E. Bradley Ltd. have appointed Harper Robertson Electronics Ltd., 372 Argyle Street, Glasgow, C.2, as industrial distributor for Scotland of Lucas silicon power rectifiers and transistors.

Rank Cintel are marketing some of the products of the Systron Division of the Systron Donner Corp. in the U.K., British Commonwealth and Western Europe. The products include counter-timers.

One of the 60-ft paraboloid dishes under construction at the Mullard Radio Astronomy Observatory near Cambridge. The tolerance on the curvature of the surface is only $\frac{3}{16}$ inch. Further details are given in Comment





At the Erith factory of G.E.C. (Engineering) Ltd. a DT10 digital data link is receiving data for a digital computer from the Witton factory 130 miles away. The system operates over G.P.O. telephone lines at the rate of 100 characters a second

The publicity department and press office of **Associated Electrical Industries Ltd.** has moved from Crown House to 33 Grosvenor Place, London, S.W.1. (Telephone: Belgravia 1234).

Standard Telephones & Cables Ltd. have appointed Dr. J. F. Watkinson as manager of the Magnetic Materials Division. The Division's first manager, R. M. Barnard, is joining Standard Telecommunication Laboratories Ltd.

The Glasgow branch and Scotland regional headquarters of **British Insulated Callender's Cables Ltd.** has moved to 460 Helen Street, Glasgow, S.W.1. (Telephone: Govan 2434).

J. N. Toothill, C.B.E., general manager of the Scottish group of Ferranti factories and a director of **Ferranti Ltd.,** is joining the board of A. I. Welders Ltd.

JFD Electronics Corporation of U.S.A. is now represented in the U.K. and other countries of the E.F.T.A. (outer eight) by Standard Telephones & Cables Ltd., of Footscray, Sidcup, Kent, and Paignton, Devon; and by LCC Steafix, Montreuil-sous-Bois, Seine, France, in the six European Common Market nations. JFD is similarly represented in Australia and New Zealand by Ducon Condenser Pty. Ltd., of Christina Road, Villawood, N.S.W., Australia.

Sellotape Products Ltd. is moving to Sellotape House, 54-58 High Street, Edgware, Middlesex (Telephone: Edgware 2345).

Jack Bushnell has been appointed managing director of **Crypton Equipment** in succession to Rear-Admiral Robert F. Storrs, C.B., who remains on the board.

R. G. Dancy has been appointed senior applications engineer of **International Rectifier Co. (Great Britain) Ltd.**

Roberts Electronics Ltd. are the exclusive U.K. agents of Melabs Inc., of California, manufacturers of ferrite u.h.f. devices.

Birthday Honours

C.B.

Major-General A. M. W. Whistler, C.B.E. (late Royal Corps of Signals and Chairman of the British Joint Communications and Electronics Board).

K.B.E.

A. H. Mumford, O.B.E., B.Sc.(Eng.), M.I.E.E. (Engineer-in-Chief, General Post Office).

C.B.E.

C. Riley, O.B.E. (Vice-Chairman and General Manager, General Electric Co. (Telecommunications) Ltd.).
Capt. R. F. T. Stannard, O.B.E., D.S.C., R.N. (Rtd.) (Director, London Communications-Electronic Security Agency).
R. V. Whelpton (Deputy Chief Scientific Officer, Ministry of Aviation).

O.B.E.

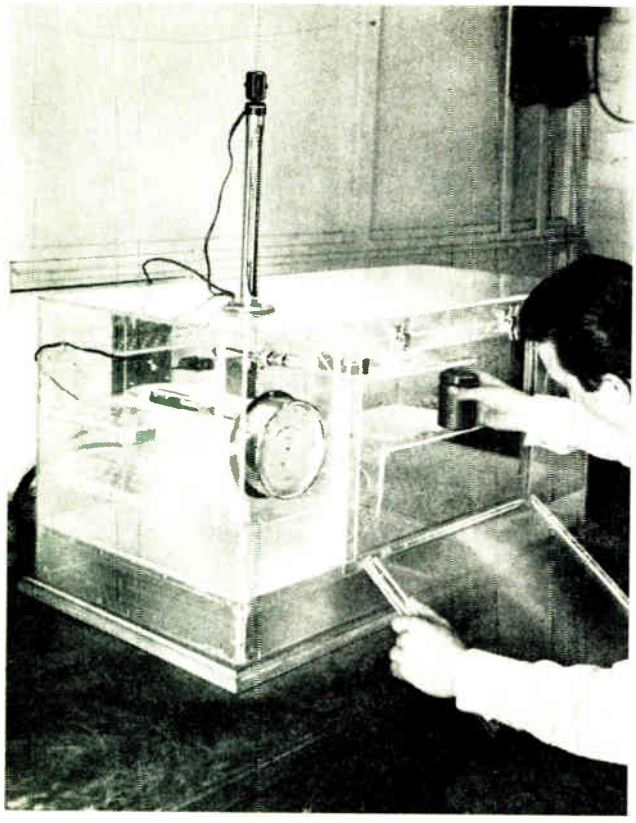
D. Best (Chief Engineer, Ferranti Ltd.).
R. J. Murgatroyd, B.Sc.(Eng.), A.M.I.E.E. (Senior Principal Scientific Officer, Air Ministry).
G. A. Whitfield, B.Sc., M.I.E.E. (Professor and Head of Department of Control and Electrical Engineering, College of Aeronautics).
G. H. Goldsack (Assistant Production Manager, Muirhead & Co. Ltd.).
A. P. Hunt (Head of Wiring Unit, Planning and Installation Dept., B.B.C.).
H. T. Johnson (Chief Test Engineer, Clifford and Snell Ltd.).
L. R. Spicer (Cable Research and Development Engineer, Standard Telephones & Cables Ltd.).
A. G. Stainsby (Member of the Scientific Staff, General Electric Co. Ltd.).

I.S.O.

S. W. Broadhurst, A.M.I.E.E. (Assistant Staff Engineer, Post Office Research Station).

B.E.M.

G. E. Elliott (Production Superintendent, Plessey Co. Ltd.).
M. W. Hicks (Foreman, Electric & Musical Industries Ltd.).



A humidity cabinet at the environmental test laboratories of E.M.I. Electronics Ltd. It is used for testing mould growth

The Television Society

An International Television Engineering Award is being instituted by The Television Society. It will be presented annually beginning in 1964 and will be either to an individual or to a team in recognition of an outstanding contribution to television engineering or an associated science. Details of the terms of the award will be given early in 1964.

The award will be known as The Geoffrey Parr Award in recognition of Geoffrey Parr's long association with The Television Society.

Long-Term Credit Offer

U.S. Industries Inc. Engineering Ltd., of Burtonwood, Lancs., are offering credit terms for the purchase of their industrial machinery and equipment, apart from oil seals. The arrangements are through United Dominion Trust and cater for repayments in up to three years.

This is being done to enable firms to renew or modernize plant without having to tie up large amounts of capital.

Institute of Physics and Physical Society

A conference on 'Some aspects of surface behaviour' will be held at the University of Bristol on 16th and 17th September 1963.

A conference on the 'Electrical and magnetic properties of thin films in relation to their structure' is being held at Imperial College, London, from 16th to 18th December 1963.

Registration is necessary for attending the conferences and details are available from the Administration Secretary, The Institute of Physics and The Physical Society, 47 Belgrave Square, London, S.W.1.

Aerial Reconnaissance

E.M.I. Electronics Ltd. have completed tests on two new forms of aerial reconnaissance equipment. One is called a Sideways-Looking Radar and can provide an accurate map of the territory over which the aircraft is passing. A feature is that forward radiation is a minimum, so reducing the chances of the arrival of the plane being known in advance to an enemy.

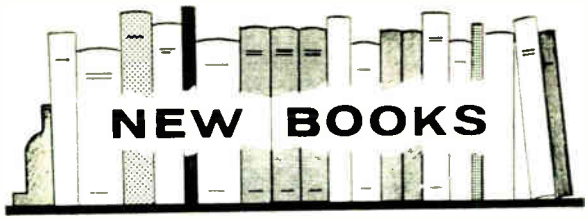
The second system is called Line Scan. This includes an optical scanner the information from which can be recorded in the aircraft or transmitted to the ground; there it produces automatically a pictorial record of the ground over which the aircraft is flying.

Institution of Electronics

The 18th annual Electronics, Instruments and Components Exhibition and Convention is being held in the Renold Building of the Manchester College of Science and Technology from 11th to 17th July, excluding Sunday, 14th. It is open to members and ticket holders from 2 p.m. to 9 p.m. on 11th July, but from 10 a.m. to 9 p.m. on the other days.

Complimentary tickets are available from exhibitors or from the General Secretary of the Institution, 78 Shaw Road, Rochdale, Lancs. The catalogue, which includes summaries of the lectures to be given during the Convention, is to be available from 1st July.

Testing a Swartout control unit which is part of instrumentation and control equipment which Elliott-Automation are supplying to Montecatini of Italy for an ammonium synthesis plant which they are building for Russia



Physics in the Soviet Union

By A. S. KOMPANEYETS. Pp. 592. Peter Owen Ltd., 50 Old Brompton Road, London, S.W.7. Price 45s.

This is a translation from the Russian of the second edition of this book. It is divided into four parts, Mechanics, Electrodynamics, Quantum Mechanics and Statistical Physics. The starting point is generalized co-ordinates and they are used to derive Lagrange's equations from Newton's. Mechanics then proceeds through conservation laws, motion in a central field, collision of particles and so on to the dynamics of a rigid body and the general principles of mechanics.

Electrodynamics starts with vector analysis and goes on through electromagnetic and electrostatic fields, electromagnetic waves and radiation, to relativity and relativistic dynamics. Under quantum mechanics, electron diffraction and the wave equation form the starting points and the section finishes with the relativistic wave equation for an electron.

The last part of the book starts off with the equilibrium distribution of molecules in an ideal gas, goes on to Boltzmann statistics, treats of the Bose and Fermi distributions and continues by way of thermodynamics to chemical equilibria and surface phenomena.

The treatment is highly mathematical and yet there is a good deal of description and explanation. As a result, even those with but elementary mathematical knowledge can gain a good deal of information from the book, but it is essentially one for those who are at home with advanced mathematics. The book has an index.

Famous Problems and Other Monographs

Pp. 374. Chelsea Publishing Co., 50 E. Fordham Road, New York 68. Price, Paper $1.95, Cloth $3.50.

This is actually four books bound as one. The first is 'Famous Problems of Elementary Geometry', by F. KLEIN. It was originally published in 1895 and translated into English only two years later. It covers algebraic equations solvable by square roots, the Delian problem and the trisection of an angle, the division of the circle into equal parts, transcendental numbers and the quadrature of the circle, among other things.

The second book is 'From Determinant to Tensor', by W. F. SHEPPARD, Sc.D., LL.M. This goes back to 1923 and its title is explanatory of its content. The third book is 'An Introduction to Combinatory Analysis', by MAJOR P. A. MACMAHON, D.Sc., LL.D., F.R.S., and was originally published in 1920. As the title implies it deals chiefly with distributions. The fourth book is 'Three Lectures on Fermat's Last Theorem', by L. J. MORDELL.

Physical Principles and Applications of Junction Transistors

By J. H. SIMPSON and R. S. RICHARDS. Pp. 519 + xiv. Clarendon Press: Oxford University Press, Amen House, Warwick Square, London, E.C.4. Price 63s.

There are 18 chapters and 13 appendices in this book. The first four chapters cover the electrical properties of semiconductors, the properties of minority carriers, the construction of p-n junctions and transistors, and the p-n junction. Chapter 5 covers low-frequency equivalent circuits and Chapter 6 deals with the physical factors affecting the d.c. and low-frequency operation of transistors.

The next two chapters together cover high-frequency and switching phenomena and devices as well as power transistors. Succeeding chapters take a more practical turn and cover bias circuits, noise, small l.f. amplifiers, power amplifiers, tuned h.f. amplifiers, video amplifiers, switching oscillators and non-linear applications. A chapter on negative feedback is included.

The general treatment is good and not unduly mathematical. The authors repeat an old fallacy about the type of push-pull phase splitter which has equal emitter and collector loads. This is that the stage is unbalanced because the output impedances viewed from collector and emitter are unequal.

Bump Testing Machines: For Testing Electronic Equipment (B.S. 3585 : 1963)

Pp. 12. Published by the British Standards Institution, 2 Park Street, London, W.1. Price 4s.

It is common practice nowadays to subject sensitive telecommunication and similar electronic equipment to 'bump tests', designed to test the resistance of these components to the repeated mechanical bumps which may be met with, for instance, during transport by land. Experience in the use of bump tests has shown that, though they are not necessarily related to actual conditions, equipment which has passed the machine tests satisfactorily may quite safely be transported.

A new British Standard has recently been published for the performance of bump testing machines for testing electronic equipment. B.S. 3585 specifies the essential design and performance requirements for bump test machines, which will ensure reproducibility of bump testing. It is based on a study of the 50-lb bump test machine developed by the Ministry of Aviation. Although most of the experience in bump testing has been obtained using free-falling table machines, the requirements of the standard have been drafted to take in other types of bump machine.

The severity of bump tests on components (as determined by the number of bumps) will be specified in the British Standards for the individual components.

The standard is divided into three parts, covering (1) performance requirements for 40 *g* bump test machines, (2) performance requirements for the accelerometer used for measuring the performance of bump test machines, and (3) the method of measuring the performance of the machines.

Appendices give information on the installation and use of bump test machines, and describe one type of bump test machine and an accelerometer which meet the requirements of this standard.

Basic Theory and Application of Tunnel Diodes

By SYLVESTER P. GENTILE, B.S.E.E. Pp. 295 + x. D. Van Nostrand Co. Ltd., 358 Kensington High Street, London, W.14. Price 70s.

The first part of the book deals with the theory of tunnel diodes in a fairly elementary and non-mathematical manner. Chapter 3 covers amplification and oscillation using a.c. negative resistance. The treatment here is based on simple equivalent circuits embodying negative resistance and the usual simple algebra is employed. Amplifiers are considered in Chapter 4 and the cascading of such amplifiers in Chapter 5.

Combinations of tunnel diodes with other semiconductor devices are next considered and in Chapter 7 oscillators

are covered. The final chapters deal with pulse and switching circuits and modulators, demodulators and heterodyne detectors.

The book gives a good coverage of the subject in a by no means highbrow way and should be very useful to the newcomer to the tunnel diode.

Electrons in Metals

By J. M. ZIMAN. Pp. 80. Taylor & Francis Ltd., Red Lion Court, Fleet Street, London, E.C.4. Price 20s.

The little book has the sub-title of 'A Short Guide to the Fermi Surface' and its five chapters have the headings:—The electron gas, Bands and zones, Dynamics of Bloch electrons and the calculation of band structure, The properties of real metals, and Gauging the Fermi surface.

There is a fair amount of mathematics, but the book is well written and gives one a clearer account of a rather difficult subject than is commonly available.

A Dictionary of Electronics

By S. HANDEL. Pp. 384. Penguin Books Ltd., Harmondsworth, Middlesex. Price 7s. 6d.

Introduction to Electronics

By WALTER H. EVANS. Pp. 518 + vii. Prentice-Hall International Inc., 28 Welbeck Street, London, W.1. Price 63s.

A Survey of Switching Circuit Theory

Edited by E. J. MCCLUSKEY, Jr., and T. C. BARTEE. Pp. 205 + ix. McGraw-Hill Publishing Co. Ltd., 95 Farringdon Street, London. E.C.4. Price 60s.

Transistoren Taschenbuch

By WERNER TAEGER. Pp. 280. Fachverlag Schiele & Schön GmbH, Markgrafenstrasse 11, Berlin, S.W.61. Price DM22.

Missile Guidance

By J. CLEMOW, M.A., A.M.I.E.E. Pp. 87. Temple Press Books Ltd., Bowling Green Lane. London. E.C.1. Price 15s.

Étude des Circuits Électriques. Vol. 1. Méthodes Générales d'Analyse.

By JEAN LAGASSE. Pp. 223. Editions Eyrolles. 61 boulevard Saint-Germain. Paris 5. Price NF43.55.

Useful Electronic Shop Hints

Pp. 103 + vii. John F. Rider Publisher Inc., 116 West 14th Street, New York 11. Price $1.95.

Printed Wiring and Printed Circuit Techniques

Pp. 49. Published for the Electronic Engineering Association by Iliffe Books Ltd., Dorset House, Stamford Street, London, S.E.1. Price 5s.

Radio Data Reference Book

Compiled by G. R. JESSOP, A.M.Brit.I.R.E. Pp. 136. Radio Society of Great Britain, 28 Little Russell Street, London. W.C.1. Price 12s. 6d.

Vier Jahre Radioastronomie an der Universität Bonn & Grosse Richtantennen.

Pp. 69. Westdeutscher Verlag GmbH, Ophovener Strasse 3, Opladen/Rhld. Price DM 8.10.

This booklet contains lectures by FRIEDRICH BECKER and WERNER RUPPEL together with a discussion of them.

Manufacturers' Literature

A Quick Reference Guide to Mullard Components. To provide users with a rapid appreciation of the salient features of Mullard components this 40-page brochure has been produced. It includes capacitors, resistors, electromechanical components, magnets, computer cores, inductors, TV components and thin-film circuits.
Mullard Ltd., Mullard House, Torrington Place, London, W.C.2.

For further information circle 50 on Service Card

Copper-Clad Bakelite Laminated for Printed Circuits. In this 10-page booklet information is given on printed circuit material, including sheet sizes, thicknesses and tolerances.
Bakelite Ltd., 12-18 Grosvenor Gardens, London, S.W.1.

For further information circle 51 on Service Card

Semitronic Transistors. This 16 × 20 in. wall chart replacement guide includes approximately 2,000 transistors, both U.S. and foreign.
Semitronics Corporation, 265 Canal Street, New York 13, N.Y., U.S.A.

For further information circle 52 on Service Card

A.E.I. Radio and Electronic Components. Details are given in this 60-page catalogue, publication number 5887-71, of over 330 components designed for the radio, television and electronic industry. These include sockets, connectors, fuseholders, valve bases, screening cans, tag strips, etc., etc. Where applicable, relevant mechanical dimensions and electrical specifications are quoted.
Associated Electrical Industries Ltd., 33 Grosvenor Place, London, S.W.1.

For further information circle 53 on Service Card

M.O.M. Photoelectric Equipment. A simple 8-page fold-out leaflet briefly describing the photoelectric components and equipment produced by
Photoelectronics (M.O.M.) Holdings Ltd., 19 Oldfields Trading Estate, Oldfields Road, Sutton, Surrey.

For further information circle 54 on Service Card

Brush's 4200 Series Solid-State Preamplifiers. Five 2-page leaflets describing their preamplifiers for use with oscillograph recording systems have been published by Brush. Available in the U.K. from:
Aveley Electric Ltd., South Ockendon, Essex.

For further information circle 55 on Service Card

Westinghouse Rectifiers with Transformers for D.C. Power Supply. This 16-page Engineering Publication 17-2/2 describes a range of full-wave rectifiers, mounted in substantial cases, and including transformers. They are designed for the operation of d.c. motors, excitation of magnets, battery charging and similar applications.
Westinghouse Brake and Signal Co. Ltd., 82 York Way, London, N.1.

For further information circle 56 on Service Card

T.M.C. Scrambler Type S2P. A 4-page leaflet describing the type S2P scrambler for mobile radio telephone equipment.
Telephone Manufacturing Co. Ltd., Sevenoaks Way, Orpington, Kent.

For further information circle 57 on Service Card

'Feedback' Short Form Catalogue of Instruments and Equipment. This 6-page leaflet carries brief details of the complete range of servo and simulation equipment produced by
Feedback Ltd., Crowborough, Sussex.

For further information circle 58 on Service Card

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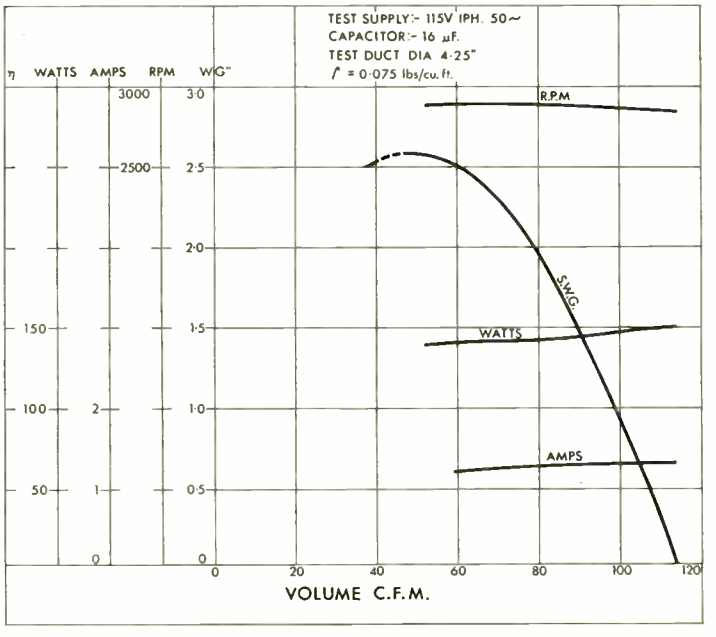

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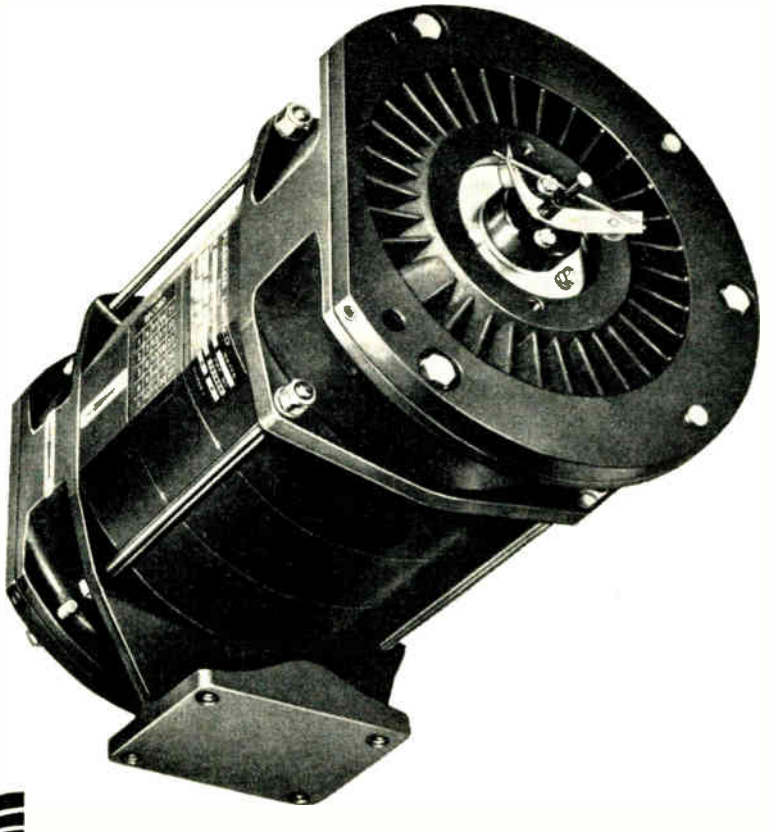

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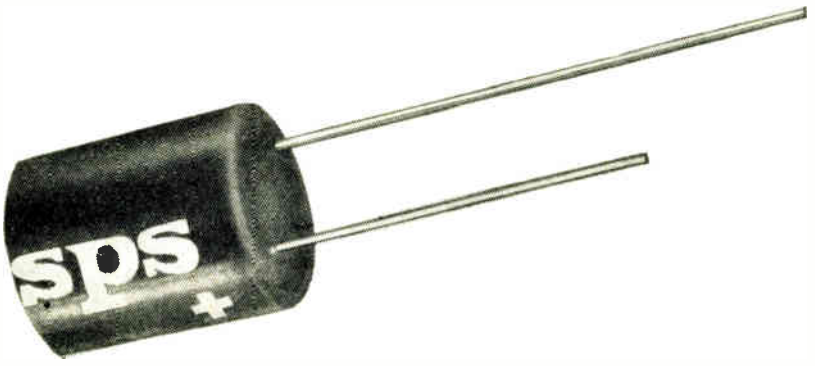

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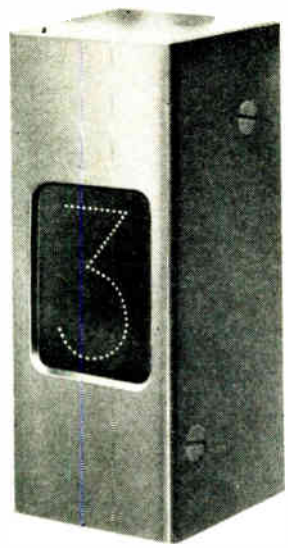

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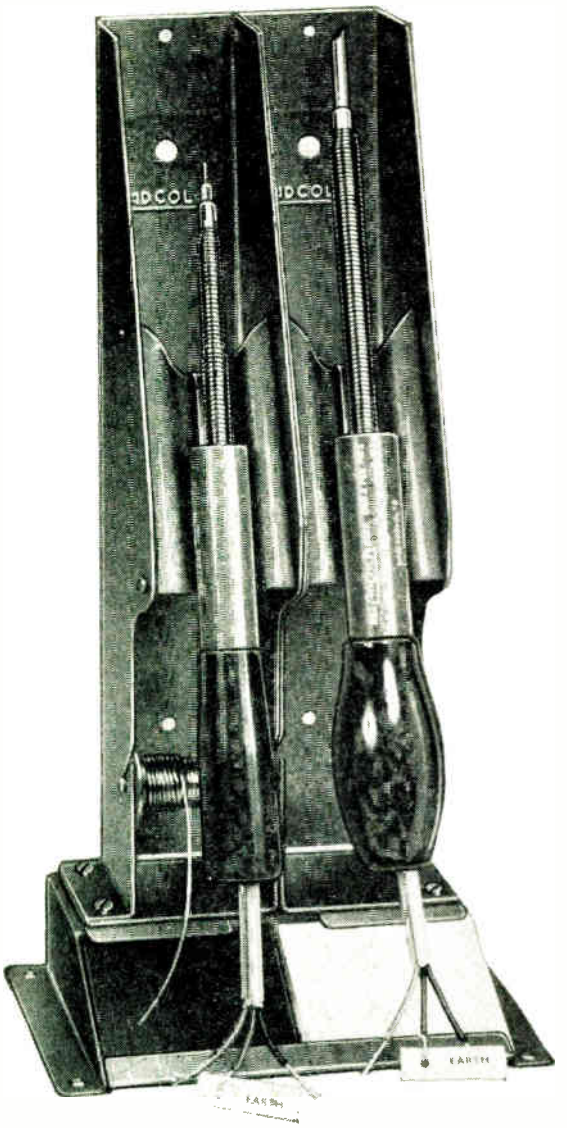

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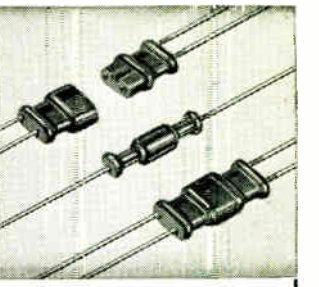

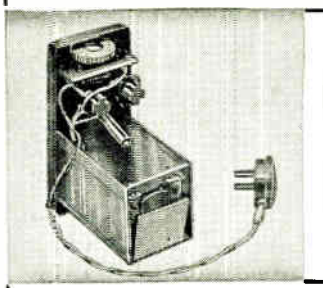

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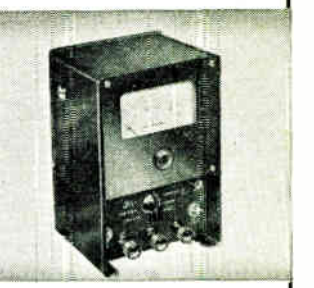

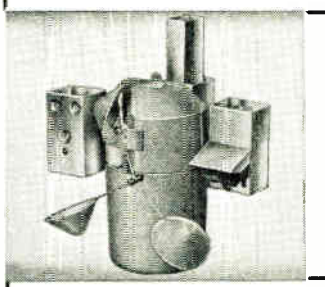

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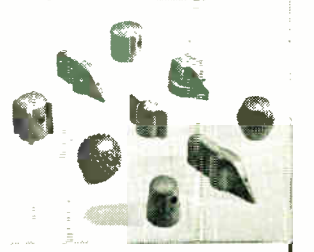

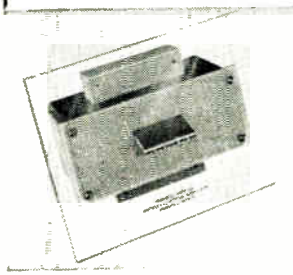

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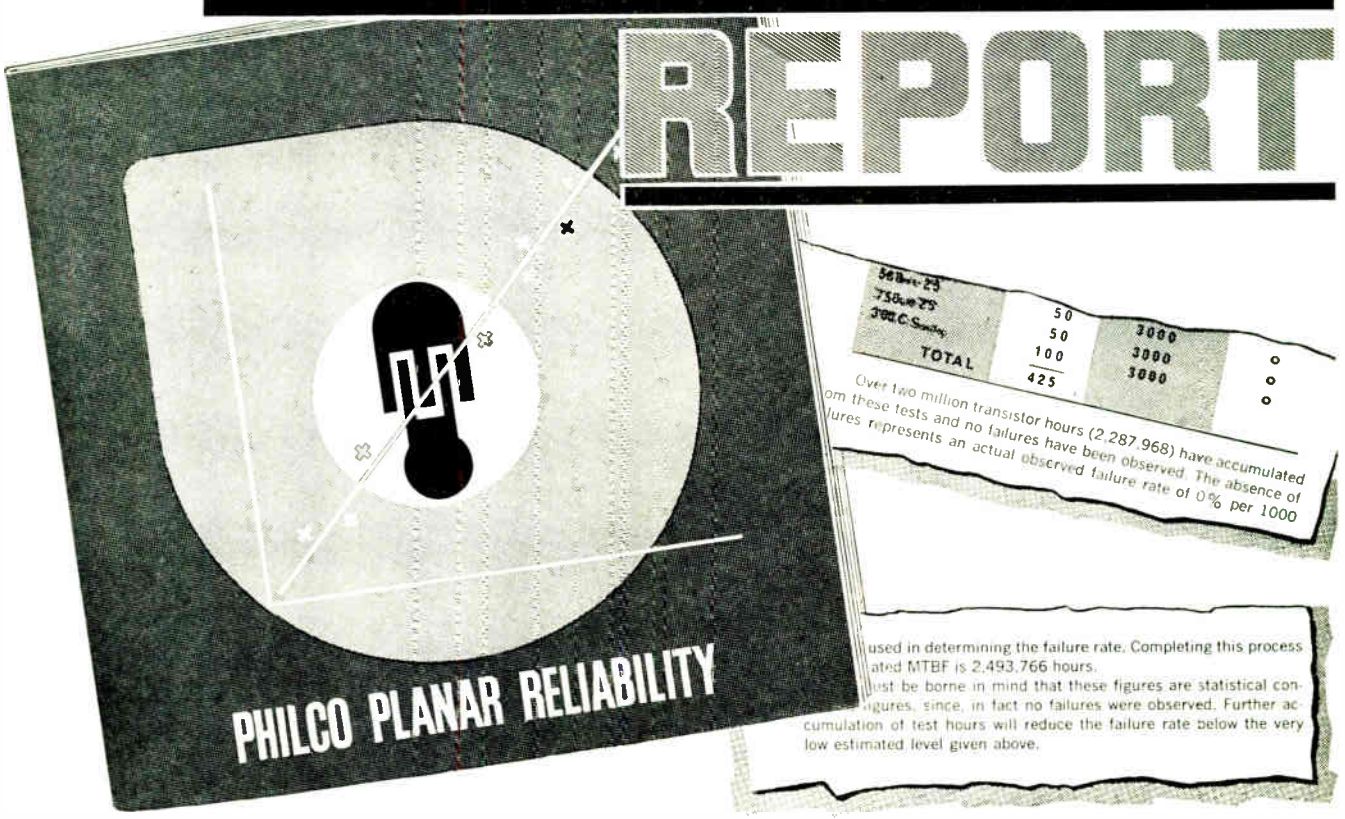

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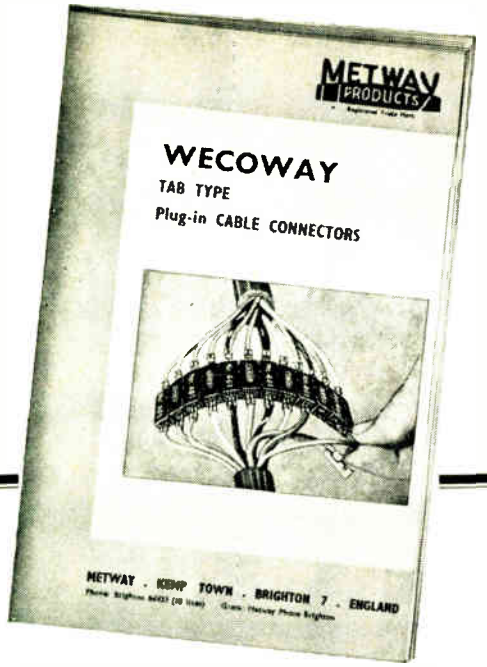

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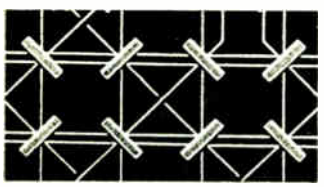

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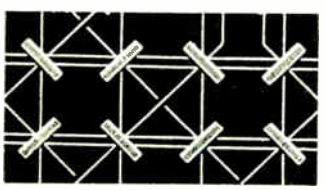

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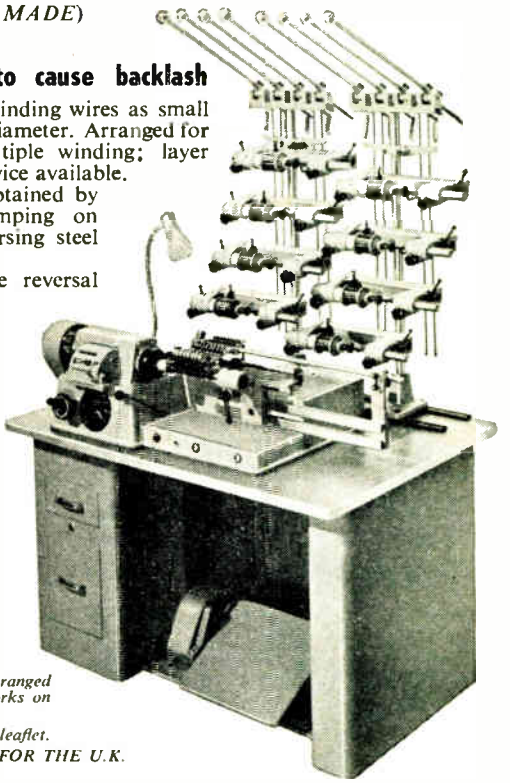

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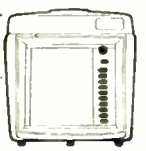

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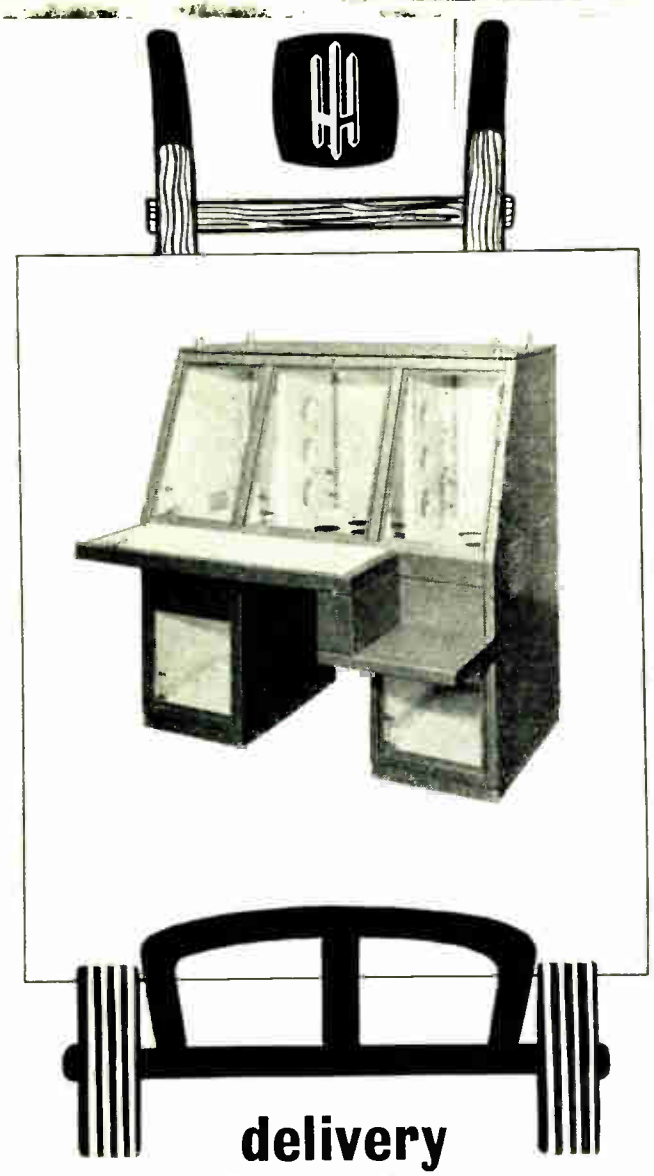

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Profit before Tax *(being 18.0% on Net Tangible Assets)*	**£2,862,000**
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Depreciation	**£736,000**
Cash Flow *(Retained Profits plus Depreciation)*	**£1,516,000**
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