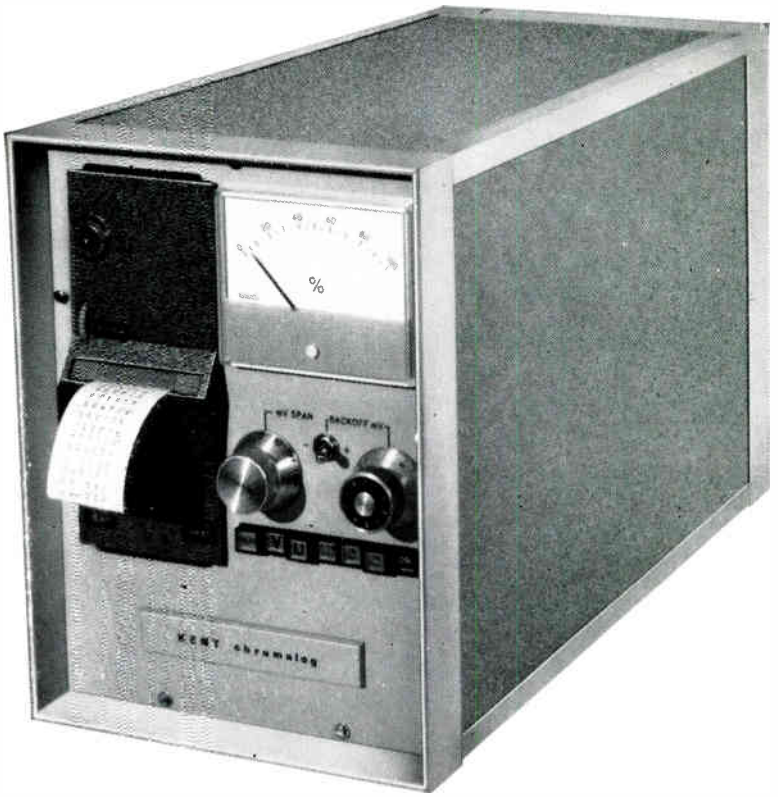
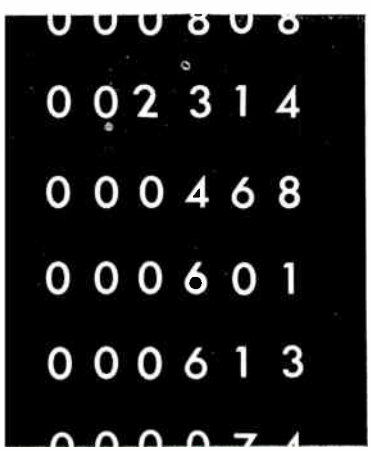
INDUSTRIAL ELECTRONICS

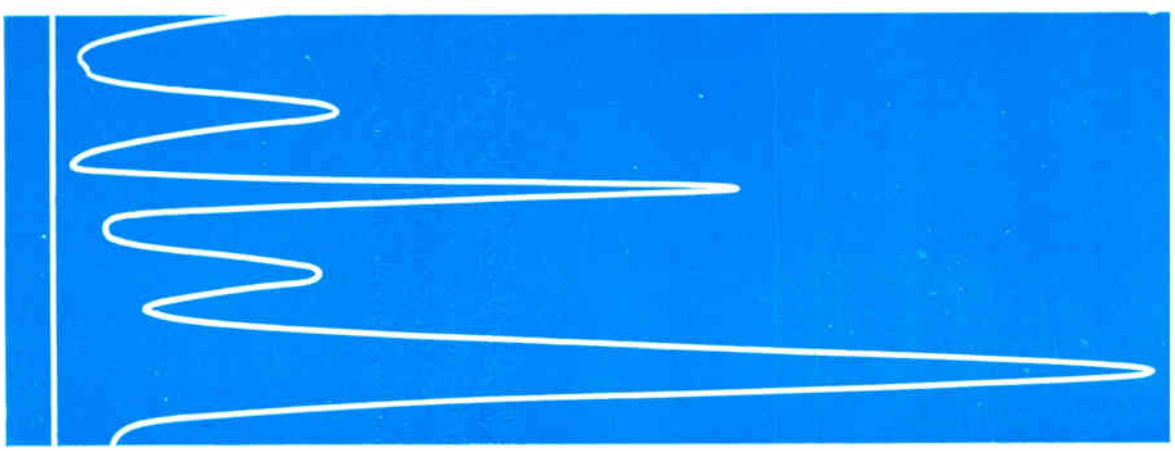
SEPTEMBER 1966 5s 0d



KENT chromalog

automatic digital integrator for faster, more accurate gas chromatography





The Kent Chromalog evaluates chromatograms accurately, immediately and automatically, by providing direct digital print-out of peak areas. It renders obsolete the tedious manual methods of integration and gives far more accurate and reliable results.

A completely self-contained, solid-state electronic system, the Chromalog has only to be connected directly—and independently of a recorder—to any proprietary analyser or ionization amplifier and to a mains supply, and it is ready for use. The incorporation of a field-effect transistor chopper-amplifier ensures stability and obviates the need for a lengthy 'warm-up' period. A minimum number of controls are used throughout all five ranges and the unit is easily operated by non-specialized personnel.

Further Kent gas chromatography equipment now available includes electronic 'Mark 3' chromatogram recorders with special-application facilities such as right-hand zero and operations pen, miniature recorders and, from the extensive Transdata solid-state range, a low-drift Analogue Integrator and a wide selection of 'Minicard' plug-in elements for controlling, computing and storing.

Comprehensive technical literature available by return.

Kent Industrial Instruments Limited Luton Bedfordshire England

Industrial Instrument Division of George Kent Limited

KENT

For further information circle 200 on Service Card

INDUSTRIAL ELECTRONICS

Incorporating **British Communications and Electronics**

Communications Automation Instrumentation Control

Contents September 1966

continued overleaf

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INDUSTRIAL ELECTRONICS

Incorporating **British Communications and Electronics**

Communications Automation Instrumentation Control

OUR COVER

The television coverage of the recent World Cup football series emphasized the usefulness of video recorders for recording programmes. This month's front cover picture, taken in the B.B.C. Engineering Dept., London, shows a video recorder being used for experimental colour television work. In this issue, starting on page 406, an article deals with the development of video-type recorders up to the present time and indicates the state-of-the-art.

INDEX TO PRODUCTS

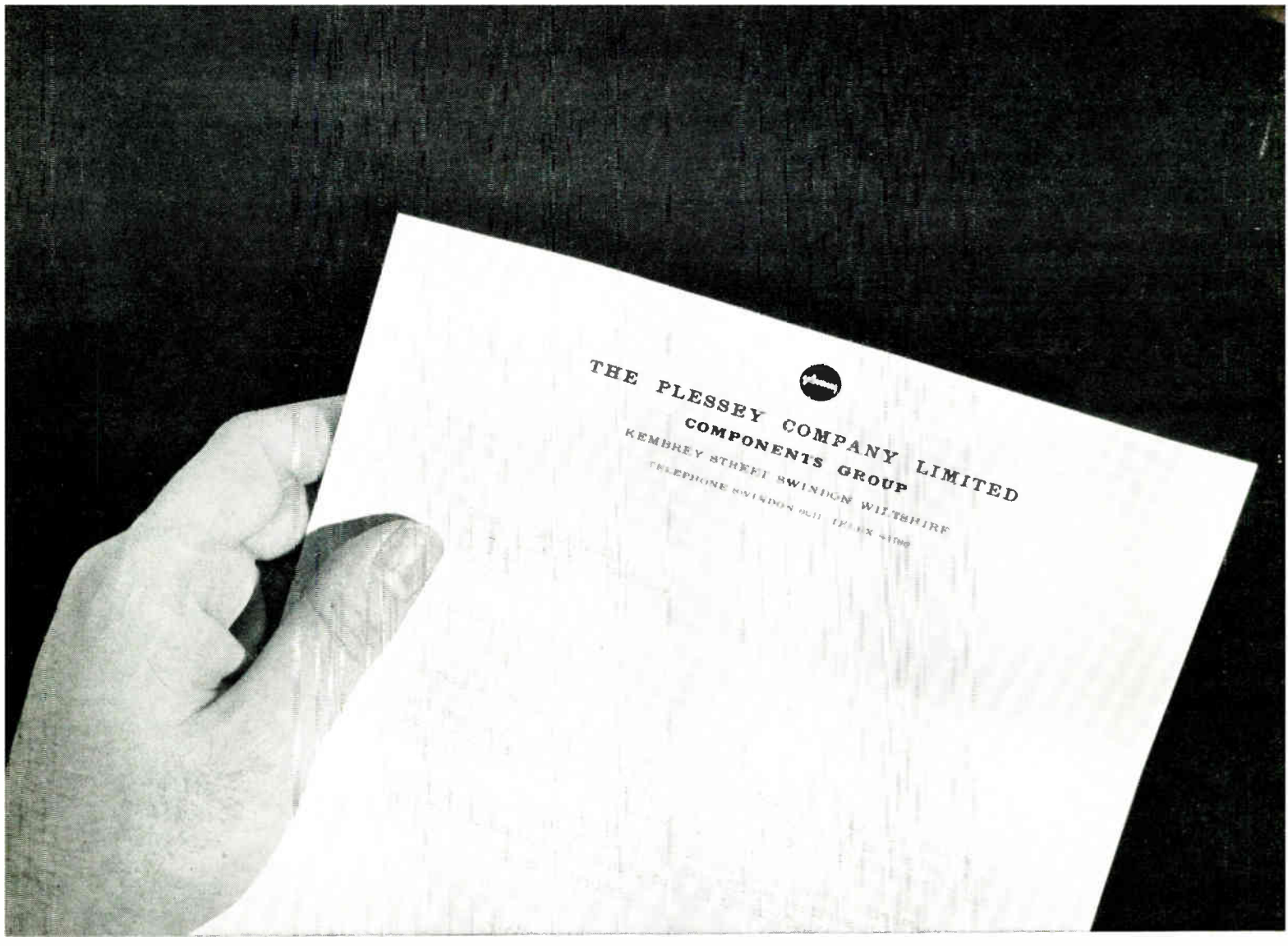
For the convenience of the reader who requires rapid access to information on specific products, an 'index to products' is provided on the same sheet as the reader enquiry cards.

Contents *continued*

Features

Next Month

One article discusses the control of all types of machine tool by standard switching units. Another, the third in the series 'Computers in Industry', discusses back-up systems for direct digital control of industrial plant. Also included is a report on the Farnborough Show 66.



The Plessey man who sends you this letter...

Behind every Plessey representative stands the most comprehensive electronic-component capability in the world. In the new Plessey Components Group there are specialised Divisions, modern production plants, development laboratories, 16,000 skilled employees, and more than 40 years of experience. Plessey can meet practically every component requirement for commercial, industrial and military electronic equipment.
As well as producing one of the widest ranges of electronic components available, Plessey also offers you the highest possible component reliability. Incomparable Plessey test facilities include one of Europe's most extensive and up-to-date environmental laboratories. A separate research centre, among the most advanced in Europe, has originated many new components and materials. The expert from Plessey will be happy to tell you about Plessey components the next time he visits you. If there is a particular problem you would like to discuss, or particular components on which you want advance information, just fill out the coupon below, and post it to Plessey.

For more information fill in and post this coupon

Please send me data on the Plessey components ticked below I would like a Plessey specialist to visit and tell me about them

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- ☐ diffused silicon rectifiers
- ☐ dry reed relay inserts
- ☐ electrical connectors
- ☐ electroluminescent devices & mimic diagrams
- ☐ electrolytic capacitors
- ☐ ferrite memory cores & matrices
- ☐ filters
- ☐ infra-red detectors
- ☐ loudspeakers
- ☐ new subminiature rotary switch
- ☐ micro-alloy & micro-alloy diffused transistors
- ☐ miniature silicon rectifiers
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- ☐ planar switching diodes
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- ☐ pick-up cartridges
- ☐ rectifier stacks
- ☐ **relays**
- ☐ resistors & potentiometers
- ☐ silicon alloys
- ☐ solar cells
- ☐ **new rotary solenoid**
- ☐ solid circuits
- ☐ switches
- ☐ **tantalum capacitors**
- ☐ tape decks
- ☐ timing & regulating devices
- ☐ transformers & inductors
- ☐ transistors
- ☐ wound components
- ☐ new printed-circuit connectors
- ☐ subminiature valves & neon lamps
- ☐ valveholders & ceramic components

Name _____

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Company _____

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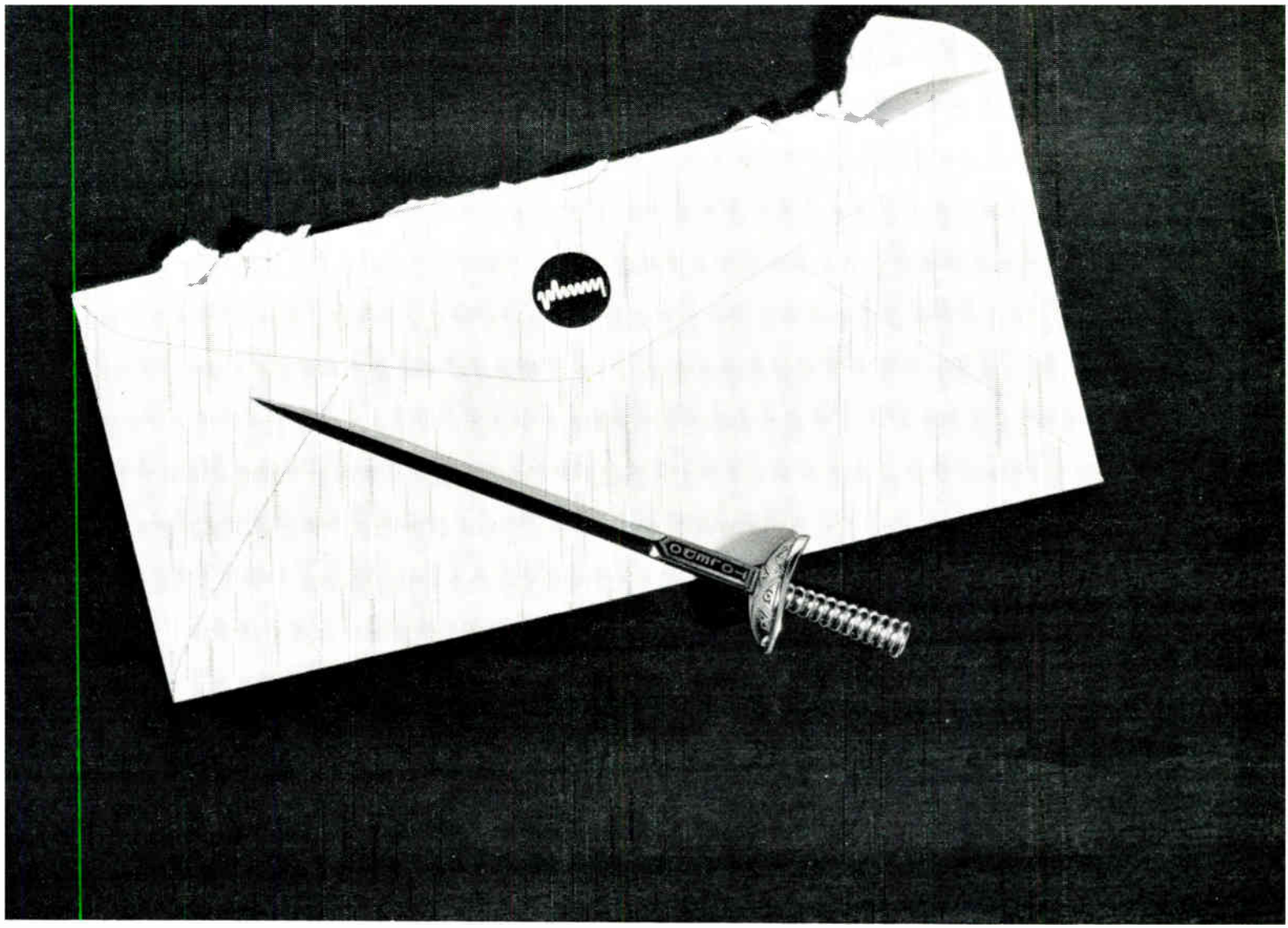
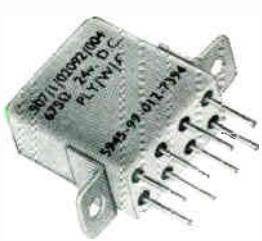
CG16



offers you 39 different categories of electronic components. Here are three of the newest:

New Sub-miniature Relay



Fully sealed and with a balanced armature and high contact pressures, the new CF Relay operates from —65° C to +125° C. Twin gold-plated contacts make it specially suitable for switching in low-level circuits.
Contact action: 2-pole changeover
Contact rating: 3 Amps at 28 volts d.c. or 115 volts a.c. 400 c/s 10^5 operations at 3 amps.
Standard coil values: 6, 12, 24, 48 and 110 volts d.c
Weight: 14.8 gm max.
Size: 22.35 mm x 20.45 mm x 10.18 mm.

New Approved Tantalum Capacitors

The 'Castanet' range of high stability low power factor tantalum capacitors has recently been granted Type Approval by the Forsvaretf Teletekniska Laboratorium (military Electronics Laboratory Research Institute of National Defence), Stockholm.
With capacitance values from 33-470μF their stability is exceptionally high over the temperature range —55° C to +150° C and under certain conditions this can be extended to —60° C to +200° C. A particular feature of this range is the minimal change of parameters experienced with orientation.

New Rotary Solenoid

Designed for reliability and long life, this Rotenoid is particularly suited to the operation of multi-bank wafer switches where extra force is often required to overcome initial loads due to high static friction and indexing mechanisms. It will operate at a temperature of 180° C. DC operating range 2V to 440V dissipation 12W continuous or up to 100W, according to function.

PLESSEY Components Group

The Plessey Company Limited, Kembrey Street, Swindon, Wiltshire. Telephone: Swindon 6211. Telex: 44180

For further information circle 207 on Service Card

No loss of performance under severe vibration, and nylon clad

–That's Hunts T41 Capacitor

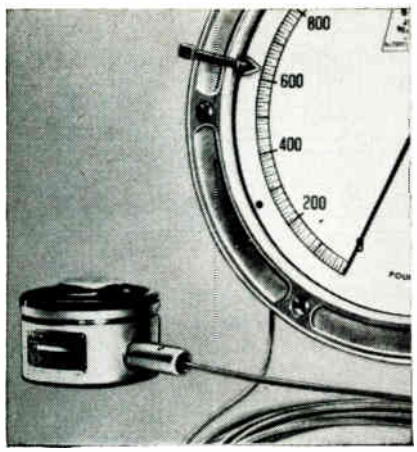
Hunts T41 solid tantalum capacitors have all the supreme advantages of solid tantalum together with a unique construction — clad in a modified nylon case which requires no additional insulation; built to withstand the most severe internal vibration and acceleration conditions; and designed to take advantage of the flat rectangular package form which facilitates high density component construction.

HUNTS CAPACITORS

Full details freely available on request from
A. H. Hunt (Capacitors) Limited
Bendon Valley, Garratt Lane, London SW18
Telephone VANdyke 6454, Telex 25640
Factories also in Surrey and North Wales

Your questions answered

WEIGHT?



Hydrostatic Weighing Unit

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

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

ANGLE?

Minitac Optical Shaft Encoder

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

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

TOTAL?

Bi-directional Electronic Counter

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

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

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

Brown

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

A HAWKER SIDDELEY COMPANY

For further information circle 211 on Service Card

ask about *Sellotape* electrical tapes

Trying to simplify an awkward component assembly operation? Looking for an extra-thin insulating material for miniaturised components? You'll find what you want in the "Sellotape" electrical range. And the solution to many other tricky jobs too . . . jobs, for instance, that may require material with high insulation properties and rugged tenacity. Or processes where resistance to solvents, high temperatures and physical stress is essential. See the simplifying touch of "Sellotape" Electrical Tapes at work in the illustrations below. Then call in our technical representative to give you more details—or ask for a copy of "Electrical Taping", a 16 page brochure that explains many of the latest taping techniques.

1 *Production is stepped up when "Sellotape" Electrical grade double-sided tape is used as an insulating film and holding medium for the copper acting as an electrostactic screen between transformer windings. Neither screen nor insulation can slip to cause failure of the coil through shorting.*

2 *A "Sellotape" electrical product acts as a neat, secure replacement for the usual metal lamination clamp for a printed circuit component. And double-sided electrical tape secures the component to the circuit board prior to and during soldering operations.*

3 *Several layers of "Sellotape" electrical tape wound on a mandrel adhesive outermost provide an inexpensive insulating former for small chokes, I.F., tuning and wave wind coils as well as a convenient method for securing the winding wire.*

4 *Moisture and chemical resistant "Sellotape" electrical grade tape provides an inexpensive, easy-to-apply insulating and protecting medium for flexible printed wiring systems.*

5 *"Sellotape" Polyester Thermosetting 1607 secures the windings on a stick-wound coil.*

Sellotape ELECTRICAL TAPES simplify component production

"Sellotape" Electrical Tapes

TAPE	COLOURS	DIMENSIONS		AVERAGE PROPERTIES				
		Roll Length	Thickness (in)	Tensile strength (per inch width)	Elongation at break	Adhesion to Metal (oz in width)	Breakdown voltage	Volume resistivity at 50% R.H. ohms cm
Polyester Silicone 1601	Transparent	36 yds	0.0025	22 lbs	60%	23	6,000 v	1×10^{15}
Polyester Thermosetting 1607	Yellow	72 yds	0.0022	22 lbs	60%	42 uncured	5,000 v	5×10^{15}
Heavy Duty Polyester Thermosetting 1608	Yellow	72 yds	0.0031	44 lbs	100%	42 uncured	7,000 v	5×10^{15}
Double-sided Polyester Thermosetting 1609	Yellow	36 yds	0.0035	22 lbs	60%	35 uncured	5,000 v	3×10^{15}
Polyester Electrical 1610	Transparent	72 yds	0.0018	22 lbs	60%	32	5,000 v	1×10^{15}
Extra Thin Polyester Thermosetting 1613	Yellow	72 yds	0.0014	10 lbs	60%	32 uncured	3,000 v	9.4×10^{15}
High Strength Polyester Thermosetting 1614	Yellow	36 yds	0.007	100 lbs	80%	71 uncured	13,000 v	2×10^{16}
Creped Paper Thermosetting 2701	Buff	60 yds	0.009	18 lbs	10%	42 uncured	1,300 v	1×10^{12}
Acetate Electrical 1314	Transparent	72 yds	0.0028	18 lbs	15%	32	5,000 v	1×10^{14}
Heavy Duty Polythene Electrical 1408	Black and Grey	100 ft	0.013	21 lbs	200-250%	30	22,000 v	1×10^{16}
Polythene Electrical 1409	Black, Blue, Green, Red, White, Yellow *To special order—* Grey, Brown, Light Green, Violet, Pink, Cream, Orange	36 yds	0.0065	13 lbs	175%	32	11,500 v	5×10^{16}
Vinyl Electrical 1503 (Transparent) 1514 (Coloured)	Transparent, White, Blue, Green Yellow, Red, Black	72 yds	0.0021	19 lbs	25%	30	3,500 v	1×10^{14}
P.V.C. Electrical 1702	White, Black, Blue, Light Green, Red	25 yds	0.008	15 lbs	100%	23	8,500 v	1×10^{13}
Aluminium Foil 4801		50 yds	0.0032	20 lbs	7%	53		

Polyester Silicone—1601
Having a silicone polymer adhesive, this tape has excellent insulation resistance and retains its electrical properties during continuous usage at 140°C. Adhesive remains stable at much higher temperatures and is therefore ideal for masking during resin coating and bonding processes. Also used for "stopping-off" in chemical etching and plating processes.

Polyester Thermosetting—1607
Has an adhesive which cures at elevated temperatures to give high bond strength with good solvent resistance. The tough 0.001" polyester film provides high insulation properties and the tape has a working temperature range of —50°C to —180°C. Unique 'anti-static' treatment reduces curling. For use in transformers, chokes, relays, solenoids etc.

Heavy Duty Polyester Thermosetting—1608
Having the general properties of Polyester Thermosetting—1607 (above) with increased strength and insulation values given by ·002" film. Used in motor and switch-gear production where higher strength, abrasion resistance, rigidity and electrical insulation is necessary.

Double-Sided Polyester Thermosetting—1609
Thermosetting adhesive is bonded to both sides of pure 0.001" polyester film, one surface being protected by an easily removed paper interleave. Heat stable for short periods up to 180°C, the bond strength and solvent resistance will increase on curing. Used in stick-wound coil production, this tape will secure and insulate lead-out posts, primary windings and leads.

Polyester Electrical—1610
A 0.001" polyester film coated with thermoplastic adhesive, this release coated tape has excellent insulation properties and is chemical and abrasion resistant. Non-corrosive, it is extremely thin and therefore ideal for use where space is limited. It is used on components subjected to impregnation and potting procedures, for inter-winding insulation, solder joint insulation and the binding and finishing of relays, transformers, chokes etc.

Extra-thin Polyester Thermosetting—1613
Employing 0.0005" polyester film and a thermosetting adhesive structure, 1613 is specially developed for securing, holding, binding and interleaving insulation on miniaturised and small wound components. Only 0.0014" thick it is capable of continuous operation at 130-155°C and for short periods up to 180°C. Though thin, a special treatment ensures ease of handling.

High Strength Polyester Thermosetting—1614
Specially developed for the heavy electrical industry for binding armature windings and cables on large motors, alternators, generators etc. and as a slot liner. Its 0.005" polyester base, coated with a tenacious thermosetting adhesive ensures high tensile strength, abrasion resistance and insulation values.

Creped Paper Thermosetting—2701
An impregnated, creped paper backing coated with a thermosetting adhesive. 2701 will withstand processing temperatures of 180°C and is suitable for continuous electrical operation at 105°C. Used in production of coils, transformers, motors, relays etc. for holding, lead binding, insulation, slot liner binding and coil finishing.

Acetate Electrical—1314
Based on 0.002" cellulose acetate film with thermo plastic adhesive, the extreme purity, high insulation properties and moisture resistance makes this tape invaluable for coil-winding applications. Release coating makes it easy to unwind and eliminates breaking. 1314 will withstand all normal impregnation procedures.

Heavy Duty Polythene Electrical—1408
A tough electrical insulation tape having a heavy corrosion-resistant adhesive mass on an 0.010" thick polythene film. It will not crack or craze and since it is unaffected by weathering it is used for such rugged applications as underground cable splicings, underground cable wrapping and overwrapping junction boxes in wet or corrosive conditions.

Polythene Electrical—1409
Most advanced of general purpose insulation tapes, 1409 is based on stable 0.005" polythene film coated with a long-ageing adhesive. It has excellent insulation properties, is moisture and chemical resistant and moulds well to irregular surfaces. Available in thirteen colours to B.S. 2746 for coding purposes.

Vinyl Electrical—1503 and 1514
Consisting of unplasticised p.v.c. film (0.0012" thick) coated with thermo-plastic adhesive, it is used as a low cost insulation medium in non-corrosive conditions. It retains electrical properties even when subject to 50°C. Available in colours for coding and identification of leads, electrical parts etc. and can be printed with circuit diagrams, part numbers, warning notices and advertising matter.

P.V.C. Electrical—1702
A waterproof general-purpose tape with a working temperature range of 0°C to 50°C. Used in component finishing and for insulating cables, buss-bars etc. in damp and oily conditions. Colour range makes it ideal for coding and identification.

Aluminium Foil—4801
Based on conductive aluminium foil coated with a thermoplastic adhesive, 4801 is used as an earthing strip on fluorescent tubes and, because of its reflective properties, as a heat shield for electronic components and for thermal insulation wrapping. It is also ideal for electrostatic screening on radio equipment and for current pick-up lines for model racing circuits.

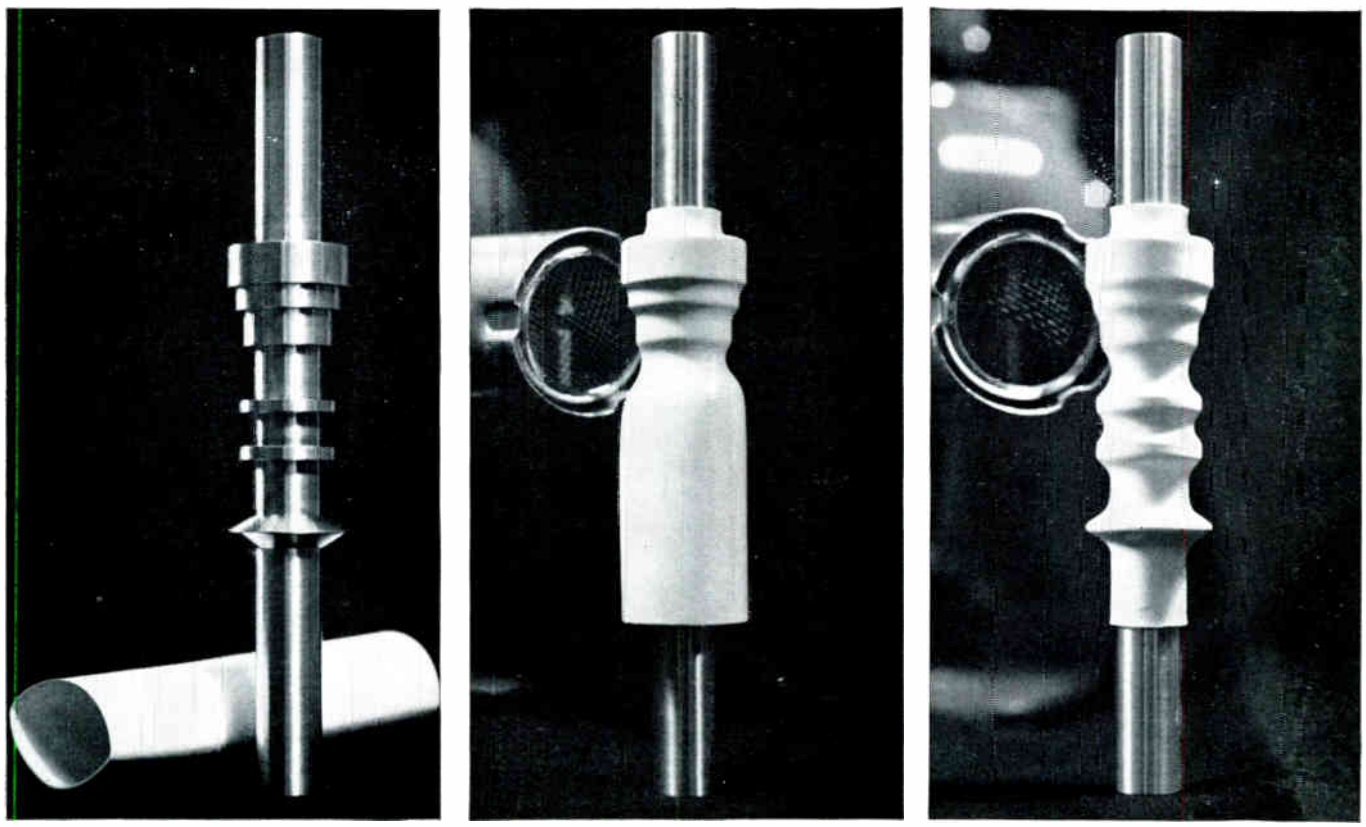
"Sellotape" Electrical Tapes belong to a varied range of self-adhesive products and tape applying systems, all contributing to increased industrial efficiency. The range includes printed and plain tapes for packaging; heavy duty tapes that prevent corrosion in many situations and others that help to impart and preserve finish on metals and plastics.
To find out more, call in the "Sellotape" industrial representative; his wide experience is backed by the research facilities of the most go-ahead marketing organisation for self-adhesive products in Europe.

Sellotape products—
a plus on every production line

SELLOTAPE PRODUCTS LIMITED, INDUSTRIAL DIVISION, SELLOTAPE HOUSE, 54-58 HIGH STREET, EDGWARE, MIDDLESEX. Phone: EDGware 2345 Telex: 262462
Dublin Office: 1-2 Lower Mount Street, Dublin 2. Tel. 61108-9. Associated Manufacturing Companies in Australia, Canada, Eire, New Zealand and South Africa.

Planning your next move?

THERMOFIT
HEAT-SHRINKABLE TUBING



slip on...heat...it shrinks to fit

...giving immediate insulation and environmental protection

THERMOFIT heat-shrinkable tubings are among many innovations pioneered by Raychem in the field of radiation chemistry to meet the exacting demands of the aero-space industry. Today irradiated plastic tubings are widely used in an extensive range of electronic, electrical, and mechanical applications.

THERMOFIT heat-shrinkable tubing is available from stock in a wide range of materials including Polyolefin, PVC, Neoprene, PTFE, and Kynar in a variety of sizes, lengths and colours.

Write or phone for Raychem Bulletin RU-7000 — a comprehensive summary of types available and their uses.

RAYCHEM

RAYCHEM LIMITED · CHENEY MANOR · SWINDON · WILTSHIRE
TELEPHONE SWINDON 27146 · TELEX 44732

IE/2/9/6

For further information circle 213 on Service Card

THINK SOLARTRON FOR FREQUENCY COUNTERS

NEW!

The LM 1450 Digital Voltmeter and EM 1616 Frequency Counter are the latest additions to a wide range of Solartron instruments designed to meet every laboratory and industrial requirement for precision measurement. Both continue the Solartron concept of high performance at minimum cost.

The LM 1450 embodies most of the features previously associated only with instruments of two or three times its cost. Highly portable, its advanced measurement capability and extreme simplicity of operation make it equally suitable for laboratory, factory test, or field service use.

The EM 1616, a compact, medium-priced counter, provides a wide range of frequency and time measurements. Overall simplicity of operation, and extreme reliability, were key points in the Solartron design concept.

The **EM 1616** provides direct readings on all parameters to five significant figures by means of neon number tubes. Risk of misinterpretation is completely eliminated by the automatic positioning of the decimal point coupled with an illuminated annunciator display of measurement units. For most measurements only two controls need be adjusted — the mode selector and the range switch. An 'overflow' indicator warns when the capacity of the counter has been exceeded. This simplicity of operation and read-out makes the instrument particularly suitable for use by inexperienced operators.

A major feature of the EM 1616 is the absence of sensitivity controls or attenuators. A sensitivity of 100mV r.m.s. is provided but it is capable of accepting input signals up to 250V r.m.s. without adjustment.

- Frequency 0–15 Mc/s; 100 sec. maximum gate time.
- Period measurement of HF signals; milli-nano-second (mnSec.) resolution.
- Duration of 99,999 seconds, local or remote control.
- Counting of random or repetitive events from 1 to 10^{10}.
- Extreme simplicity of operation.

SEG

THE SOLARTRON ELECTRONIC GROUP LTD.

FARNBOROUGH, HANTS, ENGLAND
TEL: FARNBOROUGH (HANTS) 44433
TELEX: 85254 SOLARTRON FARNBOROUGH
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THINK SOLARTRON FOR DIGITAL VOLTMETERS

SOLARTRON— SUPREMACY IN DIGITAL INSTRUMENTATION!

The **LM 1450** has been created with the specific aim of widening the application of digital voltmeters into all fields of d.c. measurement. A fully isolated input, high stability and incisive jitter-free readings down to 10 μV contribute to this end and a new charge transfer digitising technique provides high speed, guarded input and exceptional accuracy. For most measurements only one switch, the range-finder, is involved and push buttons control other functions such as command operation and calibration check. The polarity of the input signal is automatically sensed and displayed together with correct indications of the decimal point.

- 10 μV sensitivity—1,000V maximum.
- Accuracy ± 0.05% of reading ± 0.05% of range.
- Isolated input — 140dB common mode rejection.
- 50 conversions per second.
- Plug-in BCD or decimal fan out.
- 60dB filter.
- Low cost — small size.

M & P S225

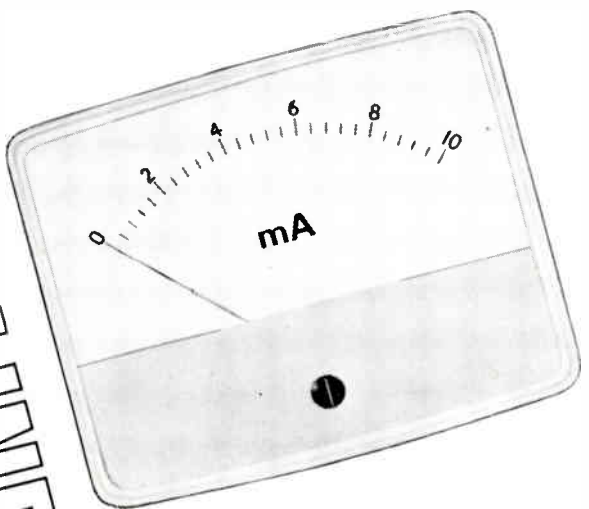
For further information circle 215 on Service Card

IMMEDIATE DELIVERIES
COMPETITIVE PRICES
NEW 4mm MINIATURE CAPTIVE TERMINAL
with Continental Socket

NEW TAYLOR FYNELINE

STOP LOOKING FOR A BETTER PANEL METER

YOU'VE FOUND IT



Better for these reasons. New Fyneline Panel Meters have all the features which have built Taylor leadership. The proven centrepole movement, high torque to weight ratio, shock-proof jewel bearings, magnetic shielding, exceptional coil clearance. Now Taylor Fyneline offers all this in a wider, more adaptable range of exceptional versatility and clean styling, scale lengths from $1\frac{3}{4}$ in to $4\frac{1}{2}$ in, with a choice of unbreakable fronts, black or coloured matt finished masking (Models 37, 47, 57, 67) or transparent front mouldings with coloured insets (Models 36, 46, 56, 66) for instant recognition on crowded panels.

Shadow-free readings are ensured by the completely flat mouldings. Identical mountings to the Vista range are provided for maximum interchange facilities. Rear of panel mounting can be readily achieved with the bezels available. Accuracy of the range is to BS 89/54 Industrial Limits. *Improved deliveries can be made on this new range. Write now for detailed data sheets and for information on Taylor Vista and Clarity ranges.*

Taylor Fyneline Scale Lengths:
Models 36/37, $1\frac{3}{4}$ in (45 mm)
Models 46/47, $2\frac{1}{2}$ in (63 mm)
Models 56/57, $3\frac{3}{4}$ in (95 mm)
Models 66/67, $4\frac{1}{2}$ in (114 mm)

The complete Taylor range of Signal Generators, Electronic Instruments and Multimeters is now available from Stock.

IF IT'S **TAYLOR** MADE, IT'S CLEARLY BETTER

766/9

TAYLOR ELECTRICAL INSTRUMENTS LTD. Montrose Avenue, Slough, Bucks.
Phone: Slough 21381 - Grams: Taylins, Slough.

For further information circle 216 on Service Card

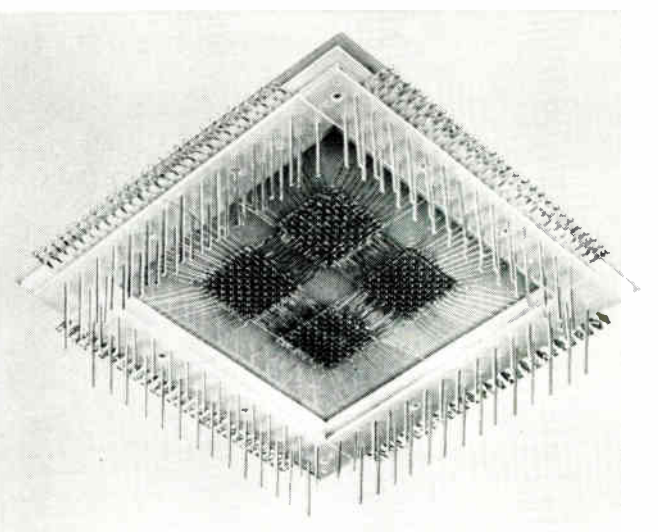
Inexpensive single-plane matrices for low-cost data storage

Mullard's latest release in its wide range of magnetic matrix assemblies is a series of inexpensive single-plane matrices designed to meet the technical and economic storage requirements of small electronic digital equipment. Used for storage in such equipment, in small calculating machines for example, magnetic matrices offer important advantages over semiconductor stores, not only in cost and space occupied per stored digit, but also in the fact that, once data is in the store, it is not lost even though the equipment is disconnected from the mains supply.

The operational stability of these matrices is assured by the wide temperature range (0 to 70°C) of the lithium nickel ferrite cores used in their construction. This permits operation without current compensation over a wider temperature range than is possible with most other conventional cores. Low drive current operation (190mA) is obtained by using 2-turn X, Y and Z windings, to reduce the drive requirements and thus permit relatively simple drive and selection circuits to be used. Wiring is in accordance with the well-known MIT system.

To ensure that the matrices withstand the rough treatment sometimes given to industrial and business equipment, a rugged constructional technique has been used in which the core assembly is supported in a rigid frame with the cores secured to a paper-laminated backing plate by a special lacquer. Intended to be directly soldered into printed wiring boards, the matrix pin-connectors are firmly secured in the frame in an arrangement directly compatible with a 0.1 in. grid circuit board. Matrices can also be supplied with pin-connector arrangements designed for German DIN standard 2.5mm grid circuit boards.

The keen prices at which these planes are offered result from extensive standardisation—frame sizes are limited to four basic dimensions—although non-standard frames can be supplied for mass production requirements. Epoxy frames capable of withstanding more humid conditions can be supplied at a small extra cost. Stacks of assembled plane matrices—up to four planes—with series connected drive wires can also be supplied.



Type AW3529 single-plane matrix.

The standard range of single planes is shown below.

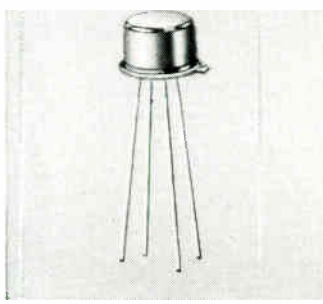
Type No.	Plane layout (No. of cores)	Total No. of bits	Outer dimensions
AW3526	One—16 x 16	256	82 x 82mm
AW3527	Four— 8 x 8	256	82 x 82mm
AW3529	Four—12 x 12	576	102 x 102mm
AW3531	Four—16 x 16	1024	122 x 122mm
AW3532	One—32 x 32	1024	122 x 122mm

For further details of Mullard single plane matrices please use the reply card of this journal (see reference opposite).

What's new . . . . . from Mullard

Integrated 10mW linear amplifier

An integrated linear amplifier, type 260TAA, is the latest addition to Mullard's wide range of silicon monolithic circuits. This device has been introduced to meet the growing demand for general purpose integrated amplifiers. Meeting this requirement, the 260TAA is suitable for an extensive range of audio amplification requirements in telecommunication applications and L.F. roles in general instrumentation.



The 260TAA operates from a 6V line with a maximum current drain of 15mA to give a power output of 10mW. Encapsulation is in standard TO-72 outline.

Brief Data:

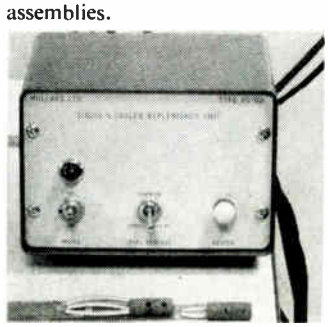
Supply voltage max.	8V
Output voltage max.	8V
Transducer gain typ.	75dB
T_{stg} range	−65 to +100°C
T_{amb} operating range	−10 to +65°C

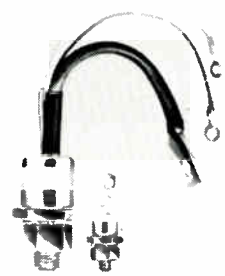
Liquid Nitrogen Replenisher

One of the special problems associated with vacuum sorption and general research work is that of maintaining a constant level of liquid nitrogen in a dewar or cold trap while the associated apparatus is unattended for long periods. Mullard has overcome this problem by introducing a simple, cheap, positive-action liquid nitrogen replenishing system, type VC-601, which is extremely versatile and may consequently be used in either conventional dewar systems or almost any of the other nitrogen cooling systems in general use.

Fundamentally, the replenisher is a simple heat-operated pumping system controlled by a level sensing thermistor circuit: pumping is effected by pressure build-up in the nitrogen reservoir.

Features of the replenishing system are, solid-state control, low voltage heater system, operation from a normal mains supply (200 to 240V a.c.) and an indication of the pumping state. PTFE leads and glass-fibre formers ensure long-life for the thermistor assemblies.





1-INCH ELECTROSTATIC VIDICON INTRODUCED

A 1-inch electrostatic vidicon, type XQ1010, has recently been added to the Mullard range of these tubes for colour and black and white television cameras. Electrostatic deflection allows camera sizes, and component costs, to be reduced by the elimination of the usual magnetic deflection components. This type of deflection also eliminates the signal electrode capacitance increase normally associated with the presence of magnetic deflection components. Compatibility with transistorised designs is assured both by the extremely small dimensions of this tube and by its low heater supply requirements, 0.6W.

Picture quality on the new vidicons is extremely good under normal industrial lighting arrangements: resolution is better than 700 lines at the image centre under usual working conditions. Applications for these high quality tubes will be found in all television systems designed to realise top quality pictures, typically, in detailed industrial surveillance and airborne systems.

The XQ1010 is a ruggedised tube conforming in every detail to the stringent requirements of MIL standards. Spectral response covers the complete visible band and peaks at 0.425μm at the violet end of the blue spectrum; an extensive coverage obtained by using an antimony trisulphide photocathode.

Typical operating conditions:

Resolution capability (at picture centre)	700 lines
Deflection voltages:	
x	50Vp-to-p (11.2mm)
y	50Vp-to-p (11.2mm)
Highlight signal electrode current	0.3μA

New controlled turn-off time thyristors

Two new thyristors, BTX64 and BTX66, have recently been added to the already comprehensive Mullard range of these devices. Low values of turn-off time make these thyristors eminently suitable for operation in inverters, d.c. choppers and other applications where commutation is required from a d.c. supply.

The first of these new thyristors, the BTX64, has an average current rating of 16A, with a turn-off time at maximum junction temperature of less than 10μs. This device is in the TO-48 (BS3934 SO-36) outline.

The BTX66 is a larger device in the SO-30C outline with a current rating of 70A average and controlled turn-off time of less than 15μs at maximum junction temperature.

The above parameters mean that overall efficiency of the order of 75% can be achieved at frequencies up to 10kc/s. This figure includes the efficiency of the transformer; at lower operating frequencies higher efficiency will obviously be achievable.

Both of these new types are available with ratings up to 500V in voltage steps of 100V. The type numbering system for voltage grades is identical to that of other Mullard thyristors in which a voltage suffix is added to the basic type number, e.g., BTX64-100R.

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

Single-plane Matrices..... IE 334
260TAA Linear Amplifier..... IE 335
Liquid Nitrogen Replenisher ..... IE 336
XQ1010 Electrostatic Vidicon... IE 337
BTX64, BTX66 Thyristors..... IE 338

Mullard

Mullard Limited, Mullard House, Torrington Place, London, WC1. Telephone: LANgham 6633

CAM40

TESTED AND APPROVED

TO

DEFENCE

SPECIFICATION

DEF. 133

THE D-890-B

MUIRHEAD DECADE

OSCILLATOR CCA

NO. 6625-99-952-8895

NEW

TYPE APPROVED

VERSION OF

MUIRHEAD

DECADE

OSCILLATOR

REPLACES

STANDARD MODEL

The D-890-B Muirhead Decade Oscillator has been developed from the well-known laboratory oscillator, which it replaces Bumped 4000 times at 40g — temperature and humidity cycled — it passed the rigorous environmental tests called for in DEF. 133 and is now available for second line service with the armed forces.

Generating frequencies lc/s — 111·1kc/s, it is used for research, production testing and trouble-shooting in servo-mechanisms, hydraulic equipment, amplifiers and modulators. The D-890-B also provides a source of accurately repeatable signals for vibration analysis.

Controlled negative feedback over the oscillatory circuit ensures:
Harmonic distortion down to 0.6%
Frequency stability 0.02% per hour
Amplitude stability better than 0.2dB

A built-in 2kc/s crystal oscillator with an accuracy of 50 parts per million permits checks to be made over the whole frequency band at multiples and sub-multiples of 2kc/s. Within the same decade, interpolation accuracies are better than 0.05%
Maximum output is 2 watts into 8k ohm or 1 watt into 600 ohm.

MUIRHEAD TECHNIQUE

MUIRHEAD & CO. LIMITED

BECKENHAM, KENT BECKENHAM 4888

**Please send me full details of the D-890-B Muirhead Decade Oscillator* ☐

**Please ask your engineer to call for consultation* ☐

NAME .....

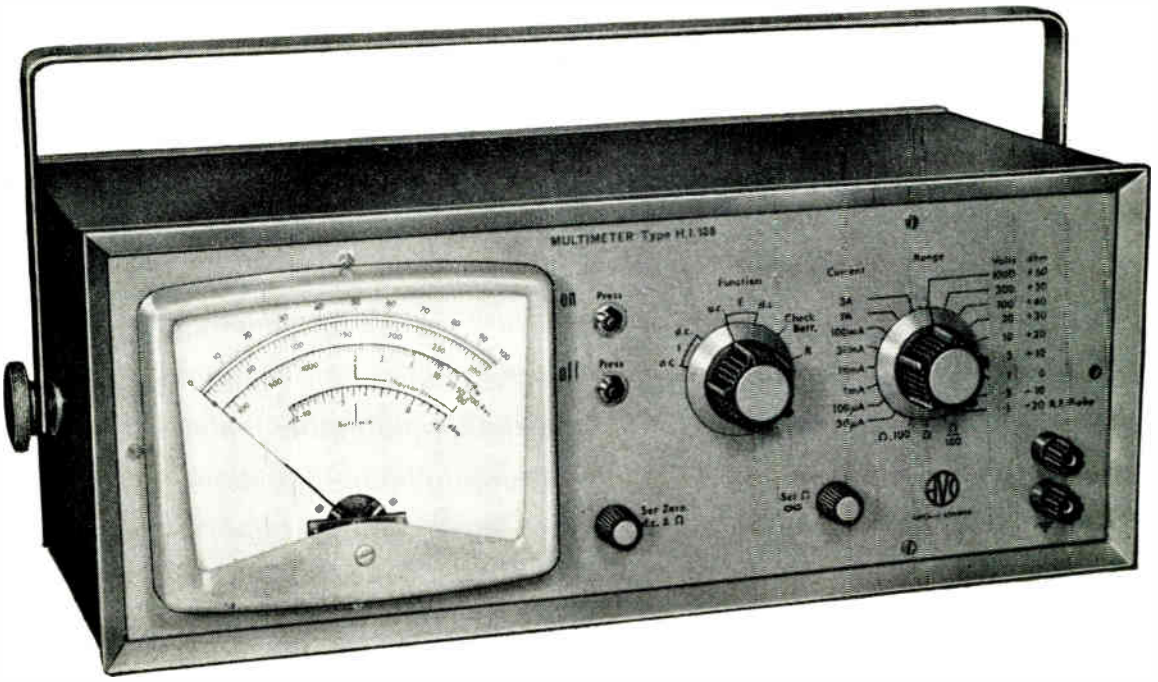
POSITION .....

ADDRESS .....

.....

SD 1255/760

For further information circle 223 on Service Card



Electronics Engineers! Use the

MULTIMETER Type HI 108

The Multimeter Type HI 108 is a recently-introduced Avo multi-range instrument for measurement of a.c./d.c. voltage, a.c./d.c. current, resistance and decibels with a maximum input resistance of 30 megohms, and provision for the measurement of r.f. voltage (up to 10 volts at a frequency of 250 Mc/s) using an external probe.

The instrument, with its clean modern lines, is fully transistorised and, being battery-operated, is light in weight. Self explanatory panel switches make the Avo Multimeter Type HI 108 extremely simple to use.

BRIEF SPECIFICATION

ACCURACY: ± 3% of f. s. d. on all d.c. ranges and ± 4% of f. s. d. on all a.c. ranges.

STABILITY: Zero Drift with temperature does not exceed 24μV/°C.

FREQUENCY RESPONSE: a.c. voltage rms, a.c. current rms } 25 c/s to 50 kc/s.
r.f. voltage, 40 kc/s to 250 Mc/s.

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M GROUP

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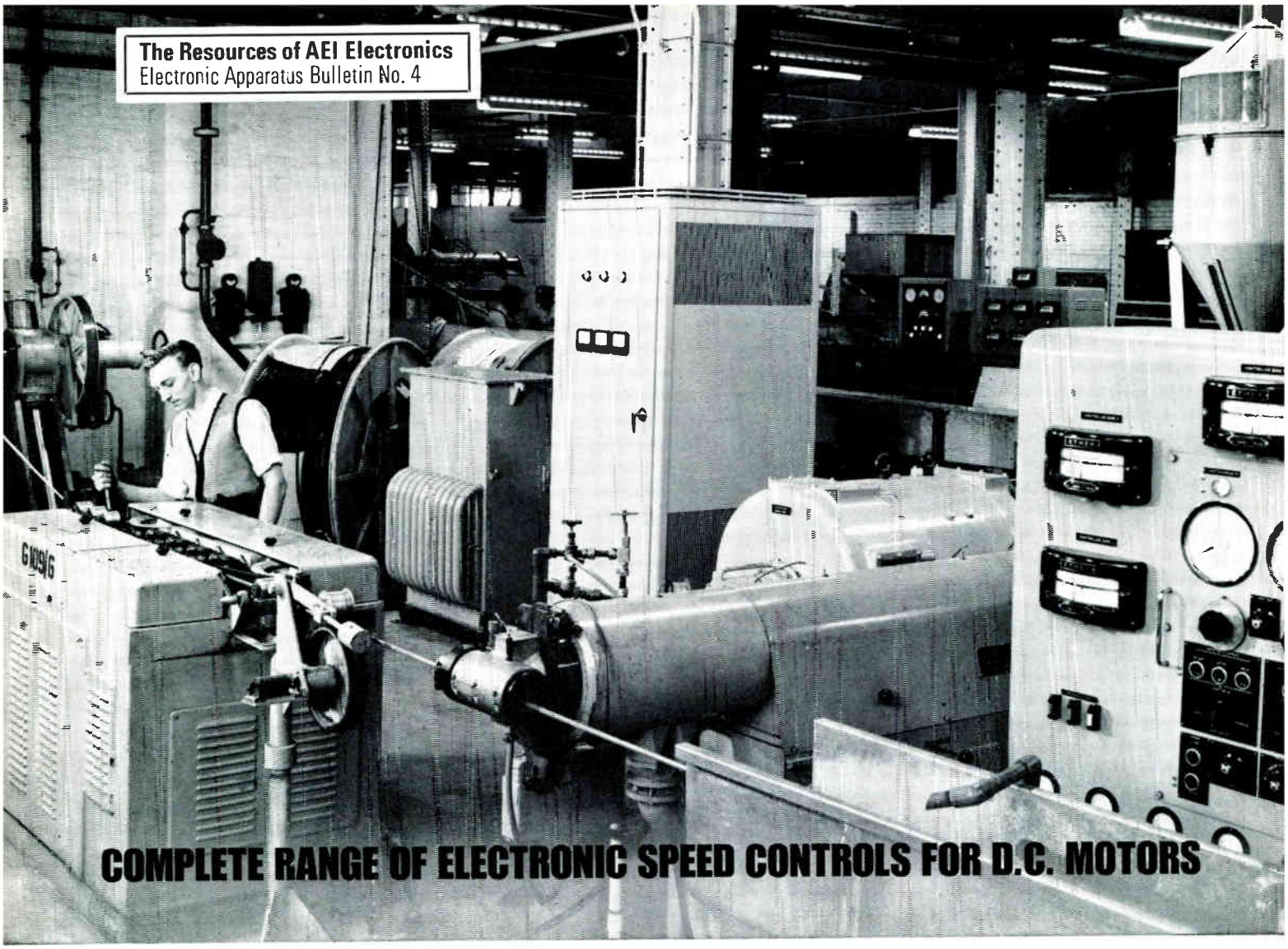
The Resources of AEI Electronics
Electronic Apparatus Bulletin No. 4



COMPLETE RANGE OF ELECTRONIC SPEED CONTROLS FOR D.C. MOTORS

Part of an extrusion line for the continuous coating of electrical wire. Each section of the line is driven by a variable speed d.c. motor controlled AEI Emotrol equipment. To keep the thickness of the plastics coating constant, the drives are coupled so that the whole line speed can be adjusted by one master control.

Many modern industries—particularly those which, like wire coating and printing, involve line processes—require a means of controlling electric motor speeds with considerable precision. On an extrusion line for the coating of wire, for example, variations in electric motor speeds can result in variations in the thickness of the plastics coating. On printing machines the web is easily torn if the speed is not closely controlled during acceleration whilst on paper making machines not only must the overall speed be closely controlled but also the speed between sections of the machine.

To meet the growing need for accurate, infinitely variable speed controls for such applications, AEI Electronics has developed a complete range of D.C. speed controls for all ratings from 0.5 to 120 horsepower. The lower ratings (0.5-5.0 h.p.) are covered by four standard units which are available from stock-up to 3 h.p. complete with motors. Where the higher power ratings are concerned, the panels are available from stock but since customers motor specifications differ considerably these are built to order. Where necessary the stock units can be modified to meet the individual requirements.

Accuracy and Speed Range

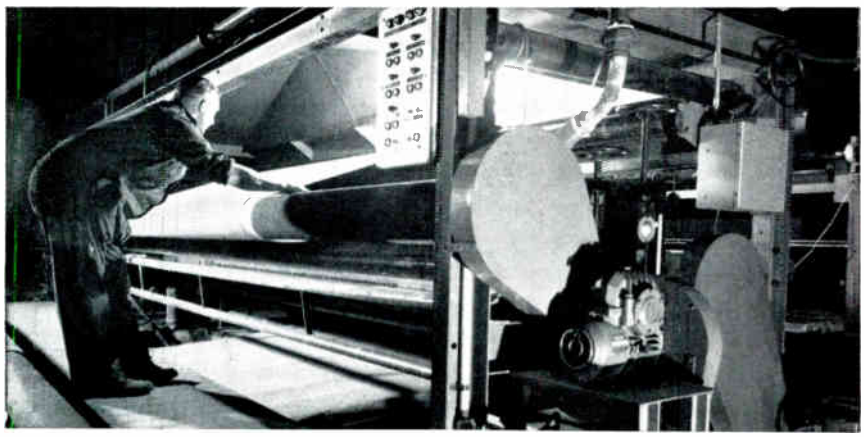
The four standard units up to 5 h.p. are for a speed range of 10:1 and an accuracy of 2% of top speed. Current limit, IR compensation, and dynamic braking are standard features. An accuracy of within 2% of top speed can also be achieved in the 3-120 h.p. range. Where accuracy is particularly important it could be made as high as 0.2% of top speed and if required the speed range can be extended to 60:1. This means that the units can easily be adapted to the most critical of control applications. An example of such applications is the control of printing press drives. The rotary presses used by newspapers are large, complex, and run very fast. They normally have as many printings going on as the paper has spreads, and in the most common type of press each printing unit is driven by its own motor. A unit consists of a type roller, ink roller and an impression roller, and the unit's motor can be clutched in and out of a common line shaft as required.

Each unit must be capable of inching at 7.5 r.p.m., when the plate is being fixed to the type roller, then accelerating smoothly to operating speed which may mean as many as 35,000—55,000 papers per hour—in about 45 seconds. It must also be capable of smooth deceleration so that the press can be stopped in the shortest possible time in an emergency.

There is no doubt that thyristor-based d.c. motor control units provide the best available means of meeting these requirements. And AEI have, in fact, supplied thyristor press control systems to a number of leading newspaper publishers in Great Britain.

Adaptable to computer-integrated control

Basically, newspaper printing press drives are manually controlled, but thyristor motor controls are equally suitable for more sophisticated arrangements such as those which involve integration with a computer. This fact is particularly relevant from the standpoint of steel production. For the current trend in steelmills is emphatically and unequivocally toward complete automation. And one of the most important functions in the contemporary steelmill is the regulation of the speed of the calender motors, and whether a computer is being used or only remote manual control, electronic controllers provide the ideal means of achieving the precise speed control necessary.



In the manufacture of tufted carpets, Emotrol equipment is used to control the passage of the latex backed carpet through the curing oven. As in the case of wire coating, the drives are coupled. Here, however, the object is to prevent the carpet being subjected to stretching or wrinkling.

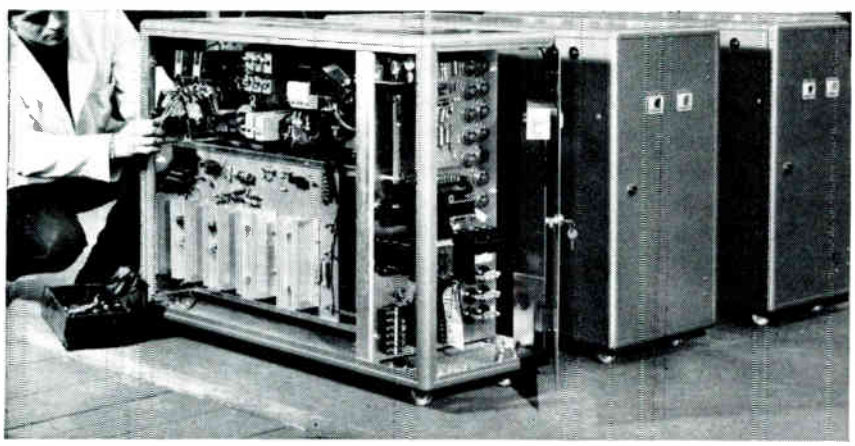
Economical proposition

It should not, however, be assumed that the fact that thyristor-based controls are suitable for use in conjunction with a costly process computer automatically precludes their use in more conventional applications. They are, in reality, a perfectly economical proposition even when capital outlay must, of necessity, be kept to a minimum. They have for instance, proved of immense value in modern carpet production.

Fig. 2 shows a typical example of the kind of application in which AEI Emotrol equipment is rapidly coming to be regarded as indispensable. This photograph was taken in a mill producing foam-backed carpeting. The unbacked carpet is pulled from a large roll on the left, passes under the operator's feet and over the latex bath where the latex is applied to the back of the carpet via a roller rotating in the bath. From the bath the carpet passes to an oven where the latex is cured. Each section of the oven is driven by a d.c. motor controlled through AEI Emotrols. These Emotrols are electrically coupled so that the carpet is not subjected to stretching or crinkling while being processed. This is very important, since stretching or crinkling in the curing oven inevitably results in a carpet that obstinately refuses to lay flat.

Most versatile d.c. controls available

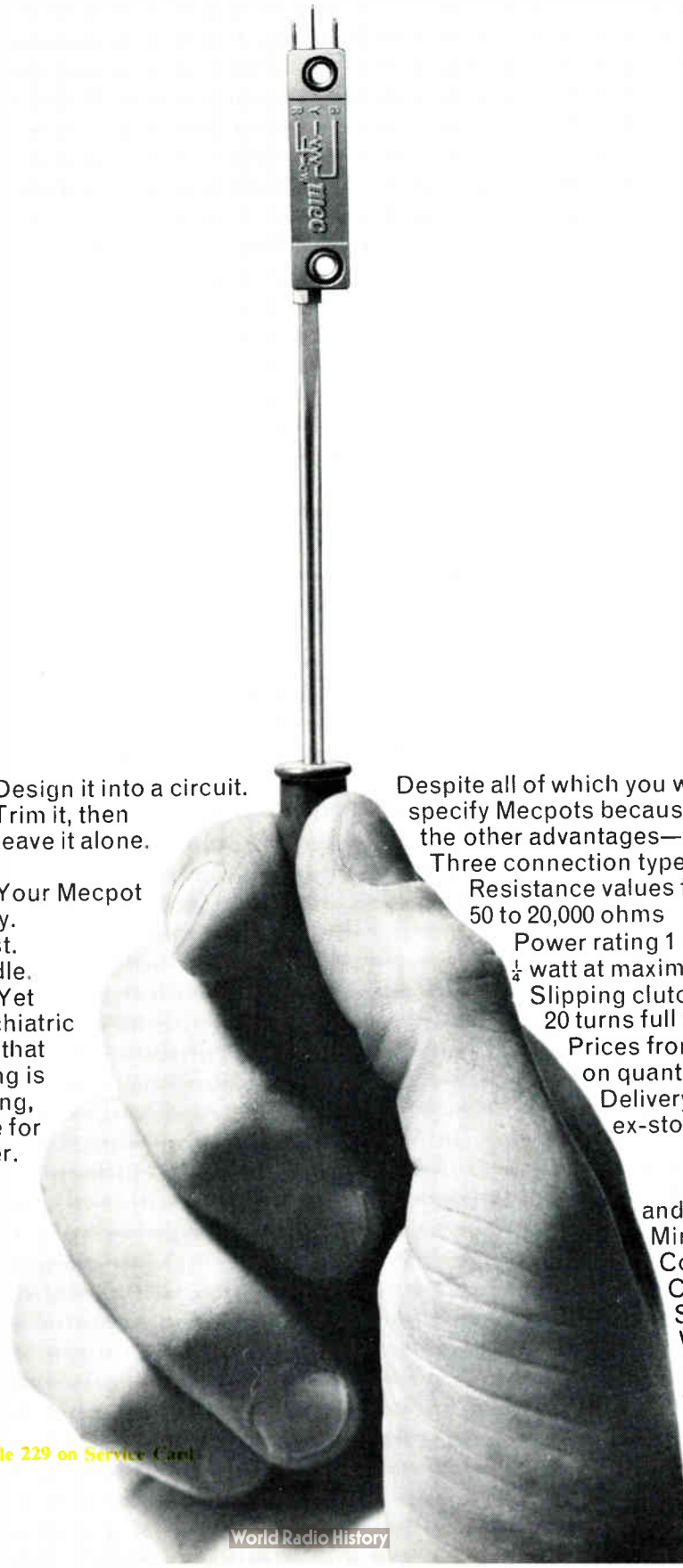
If any one fact emerges from this brief survey of Emotrol applications, it is that the equipment must rank among the most versatile of its kind. And as this implies, the potential is great particularly where a manufacturer requires accurate motor controls which can subsequently be integrated with a more sophisticated automation scheme.



Castor-mounted Emotrol equipment currently being produced by AEI for the control of d.c. motors in flat-bed knitting machines.

Are Mecpots too stable?

(unfair to compulsive twiddlers)



Take a Mecpot. Design it into a circuit. Trim it, then leave it alone.

What happens? Your Mecpot stays rock steady. Nothing to adjust. No need to twiddle. Yet authorative psychiatric research shows that trimmer-twiddling is definitely soothing, relaxing and fine for the morning after.

Despite all of which you will still want to specify Mecpots because of all the other advantages—

Three connection types
Resistance values from 50 to 20,000 ohms
Power rating 1 watt at 20°C, ¼ watt at maximum temperature 85°C
Slipping clutch
20 turns full travel
Prices from 11 3 depending on quantity
Delivery of most values ex-stock

Full specification and samples from
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Trimmer Potentiometers
Wire-wound Resistors
Miniature Switches
Elapsed Time Meters

ME24

Don't choose a temperature controller until you've seen the Sunvette range

62011

AEI, pursuing their policy of extending their range of solid state temperature controllers, has now entered the 'low cost' market with the 'Sunvette' range. Designed to replace industrial thermostats, Sunvette units provide precise control from −50 °C to +300 °C by means of thermistors.

There are three types:

- ON/OFF—the lowest cost of all.
- FULLY PROPORTIONAL—the most sophisticated of all.
- SIGNAL OUTPUT—for driving AEI thyristor power regulators—the most flexible of all.

'Sunvette' Type TH1

The ON/OFF Temperature Controller with a future.

- fully transistorized with self-contained 2kW power vacuum switch.
- mean differential less than 0.1 °C.

'Sunvette' Type TH2

The FULLY PROPORTIONAL Temperature Controller for best performance

- all solid state with built-in thyristors for 1kW loads.
- adjustable proportional band width down to 2%.

'Sunvette' Type TH3

The FULLY PROPORTIONAL Temperature Controller for power unlimited

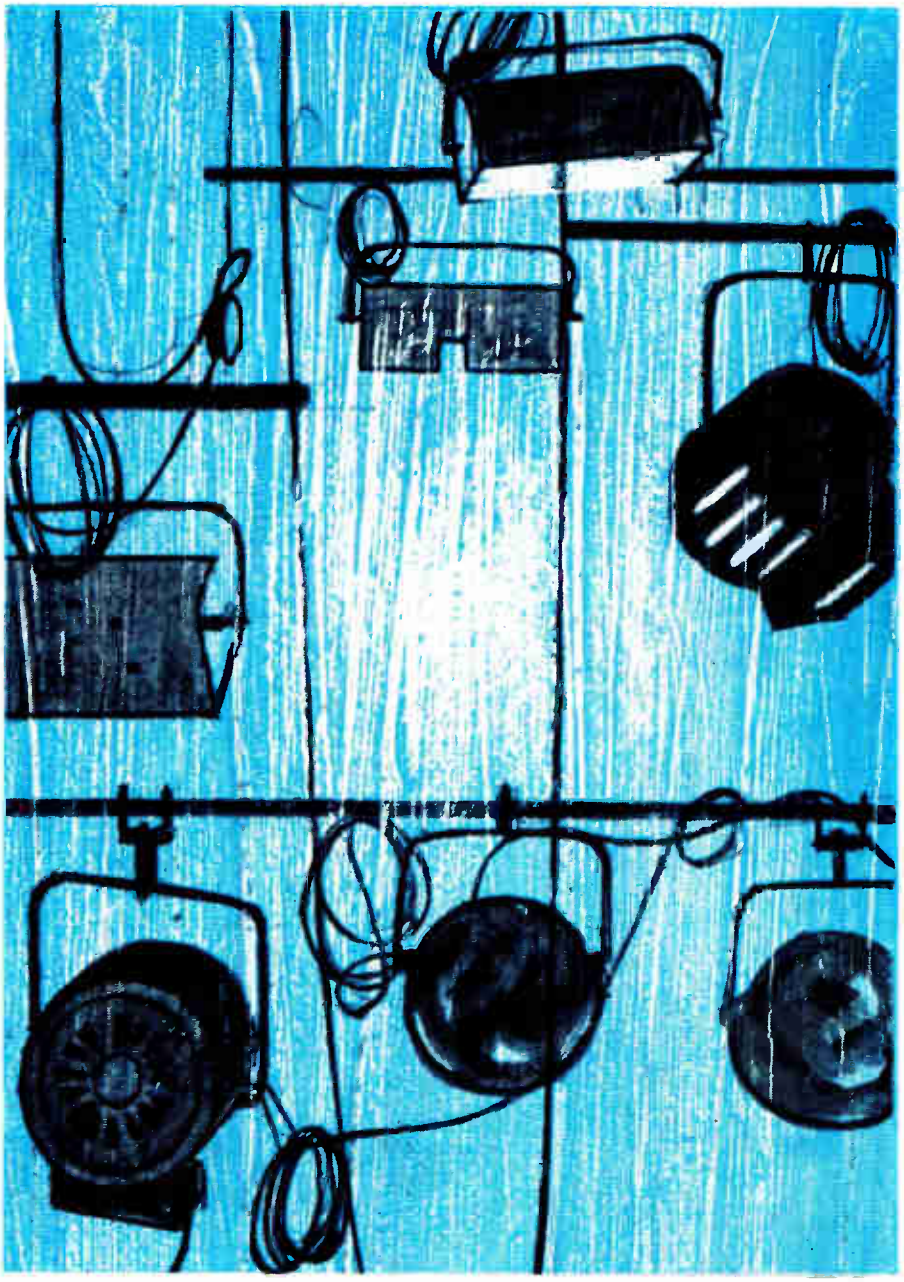
- the output signal drives any of the AEI thyristor power regulators—4, 6 and 10kW standard—or more if you want it.
- adjustable proportional band width down to ½%.
- adjustable rate of "run up" too.

TEMPERATURE CONTROL

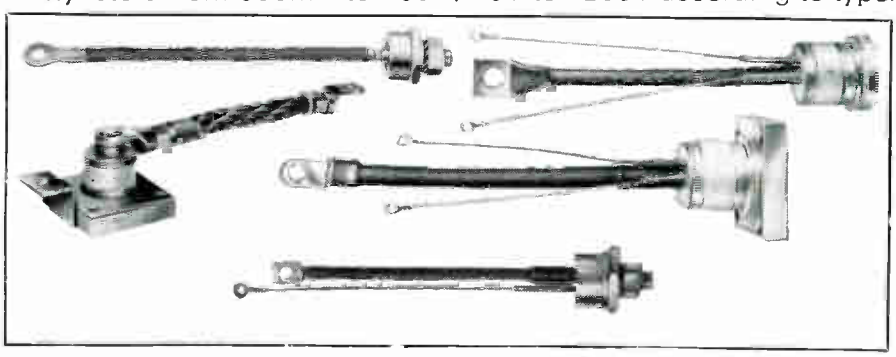
For further information please write to Associated Electrical Industries Ltd., **Industrial Components Dept.**, P.O. Box 1, Harlow, Essex. Tel: Harlow 26761 (STD 0855 26). Telex 81291—ASSOCELECT HRLW, or your nearest AEI office.

AEI ELECTRONICS

For further information circle 233 on Service Card



* **The Westinghouse brochure** gives abridged information about: Silicon Diodes ranging from 200mA to 300A at 100 to 1800V and Thyristors from 500mA to 250A, 25V to 1200V according to type.



For further information circle 237 on Service Card

In the hp 7190B — two independent recording and controlling channels for maximum flexibility in industrial process or laboratory test applications.

For recording — full scale sensitivities from 5 mV to 1600 V may be separately chosen for each channel. A broad selection of current and temperature recording ranges are also available.

For controlling — a wide variety of options may be included in one or both channels. Dual contact limit switches (up to three pairs per channel), proportional outputs and linear or rotary control potentiometers are some of the independent control possibilities.

Brief Specifications of 7190B	
Chart Magazine:	Contains supply roll, drive sprocket, feed roll and take-up roll. Locks at 22.5°, 45° and in the vertical position. Removable assembly. Maximum grid width of paper: 120 mm Maximum length of paper: 16 m
Chart speed:	One speed is supplied. By manually changing gears three speeds can typically be obtained. Common chart speeds: 20, 60 or 120 mm per hour Maximum chart speed: 200 mm per minute
Maximum input-sensitivity:	5 mV full scale deflection
Minimum temperature range:	100°C F.s.d. with Fe. Const. thermo-couple
Input impedance:	Potentiometric mode off balance: 4,5 KΩ at balance: 10 MΩ
Source impedance:	Up to 20 KΩ source impedance will not affect accuracy
Accuracy:	Scale: 0,25% Recording: 2% (includes paper positioning errors) Hysteresis: < 0.1%
	Fulfills requirements of DIN classification 0.25

7190C recording head which contains six solonoid-driven pens mounted in an aluminium core.

Six channel version
For six channel recording the hp 7190C sequentially samples all six data sources and records their instantaneous values in contrasting colour on the recorder chart. Wide selection of options also available. Other 7190C specifications are similar to the two-channel model.

Single channel version
For single channel recording use the 7190A with its full compliment of recording and controlling options. This instrument is identical in basic characteristics to the two channel 7190B and may be converted to a two-channel version.

Prices:		
	Model 7190A (single pen)	£ 297
	Model 7190B (dual pen)	£ 395
	Model 7190C (six channels)	£ 414

*control elements are optional at extra cost.
Data and prices are subject to change without notice.

HEWLETT hp PACKARD LIMITED

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Headquarters in USA: Palo Alto (Calif.)
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European Plants: South Queensferry (Scotland)
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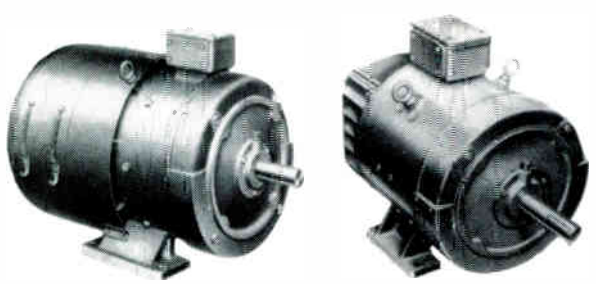
For further information circle 239 on Service Card

D.C. Motors

for electronic speed control



¼—100 h.p.

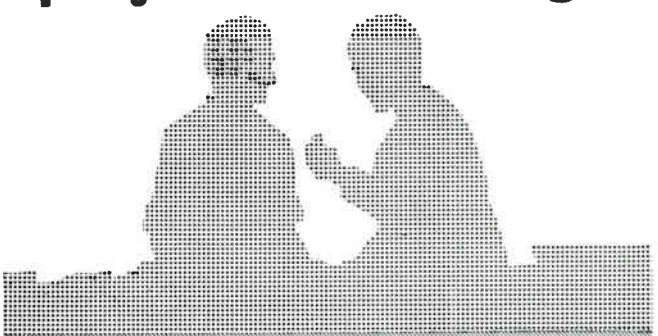
E·P·E

THE ELECTRICAL POWER ENGINEERING CO. (B'HAM) LTD.,
EPE WORKS 558, BROMFORD LANE BIRMINGHAM 8.
Telephone: STEchford 2261. Grams: Torque Phone, Birmingham.

For further information circle 240 on Service Card

WHITELEY
ELECTRICAL RADIO CO. LTD.

Epoxy Resin Mouldings



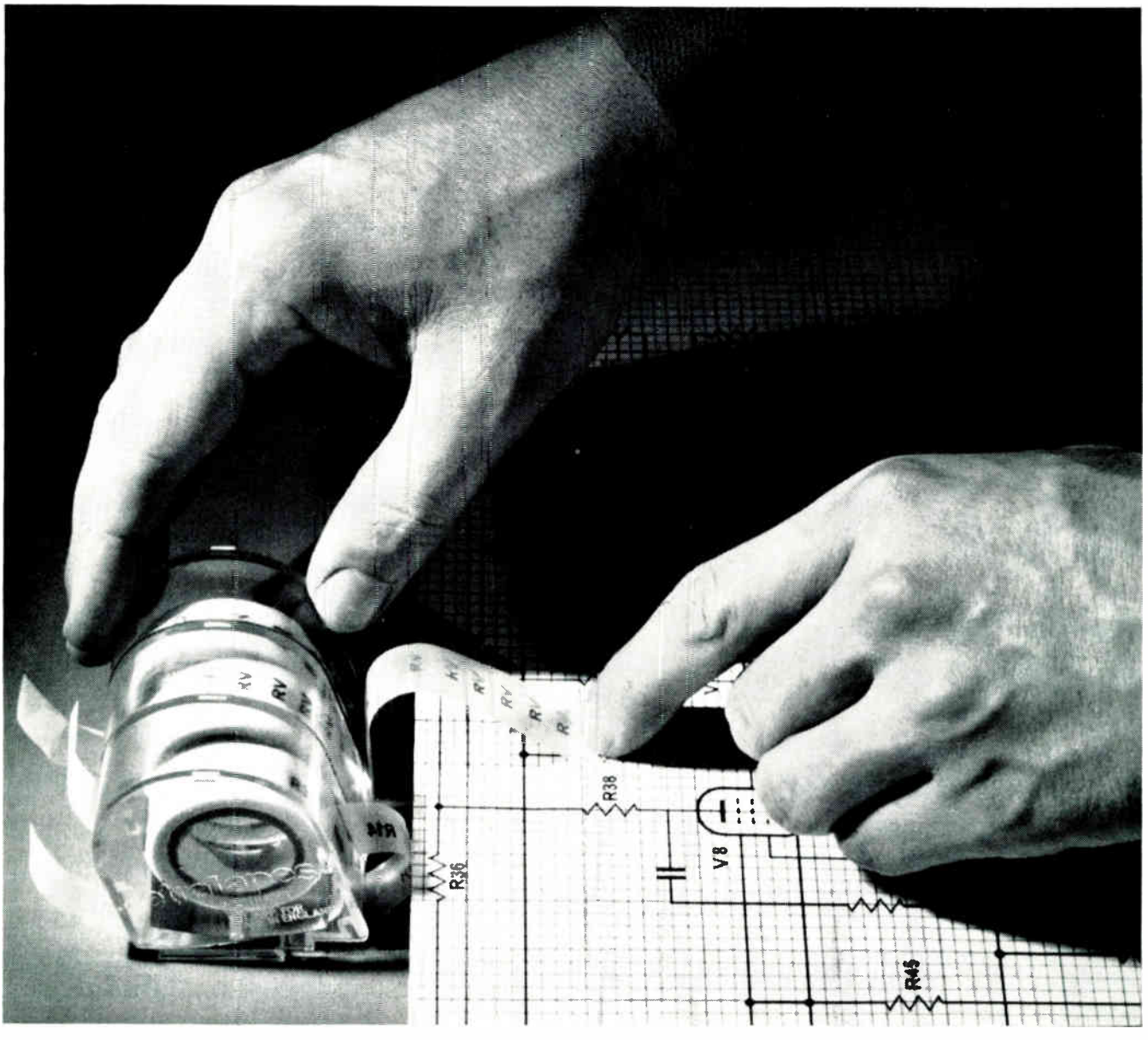
Great mechanical strength, excellent electrical insulation and complete climatic protection are ensured in Whiteley Epoxy Resin mouldings. Low shrinkage and strong adhesion to components and leads renders these Resins particularly suitable for encapsulation. Full details will be gladly sent on request.

Line Isolating Transformer

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

WHITELEY ELECTRICAL RADIO CO. LTD
MANSFIELD · NOTTS · ENGLAND Tel: Mansfield 1762/5
London Office: 109 KINGSWAY, W.C.2 Tel: HOLborn 3074

For further information circle 241 on Service Card



Letraset tapes the new repetitive marking technique

Instant Lettering is fast, but Letraset Tapes are faster. No rubbing down, simply pull from the special tape dispenser; the symbols are automatically "released" and only light finger-tip pressure is required to ensure complete adhesion to any surface.

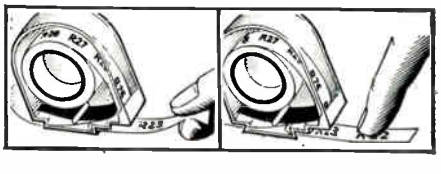
Letratapes provide a new and convenient method of repetitive marking in the many stages of production of electronic equipment. Letratapes can be used on circuit drawings, printed circuits, chassis and panel markings, and for architectural and engineering drawings. The Letratape range of 120 tapes includes all commonly used component references for electronic codings, numerical sequencies and frequently used set words.

Two letter sizes are available, $\frac{1}{8}$" and $\frac{3}{16}$". Type face Grotesque 216, Black only. All characters are dyeline (diazo) heat resistant.

Think quality, think Letraset

A Letraset Product, produced & manufactured by Letraset Limited, St. George's House, 195-203 Waterloo Road, London, SE1, England.

Pull out Press down



Please send me further information

name

address

company

L12

Letraset

For further information circle 243 on Service Card

3 POLE POWER CONNECTOR L1722 P&S

finger-proof shrouds on plug and socket contacts. Rating 7amp AC 5 amp DC 250 volts.
Send for Leaflet P703

STACKING PLUGS

4 mm. 'DZ' contacts – single L1708 double L1706. provide fully shrouded tap-off points for cable and plug-in connections on all types of instruments
Send for Leaflet P676

YOU SHOULD KNOW ABOUT THESE **NEW**

BELLING-LEE components

Write for leaflets mentioned above or telephone Miss Woolgar at Enfield 5393 Ext. 27
Belling & Lee Limited · Great Cambridge Road · Enfield · Middlesex · Telephone: Enfield 5393 · Telex: 263265

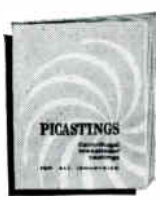
For further information circle 244 on Service Card

Complex steel and non-ferrous investment castings straight-from-the-mould

CUT MACHINING COSTS — SAVE SKILLED MAN HOURS!

PICASTINGS emerge as accurate components straight from the mould. Minimise machining costs and save valuable time. Bring a new design freedom to the shape and complexity of parts ranging from fractions of an ounce to a few pounds in weight. Fine detail, small holes, cavities with high length-to-bore ratios, and thin wall sections are faithfully reproduced in virtually every grade of cast steel, and in a wide range of non-ferrous alloys. For a typical component and full details of what PICASTINGS can offer you, fill in the coupon.

Send for leaflet IE.1



PICASTINGS

Send to
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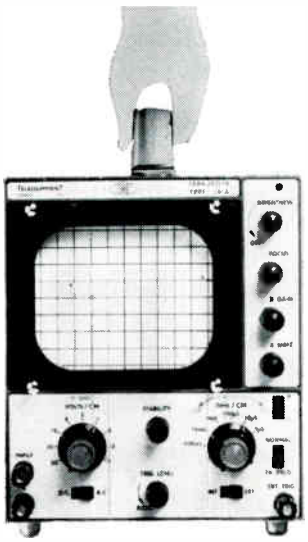

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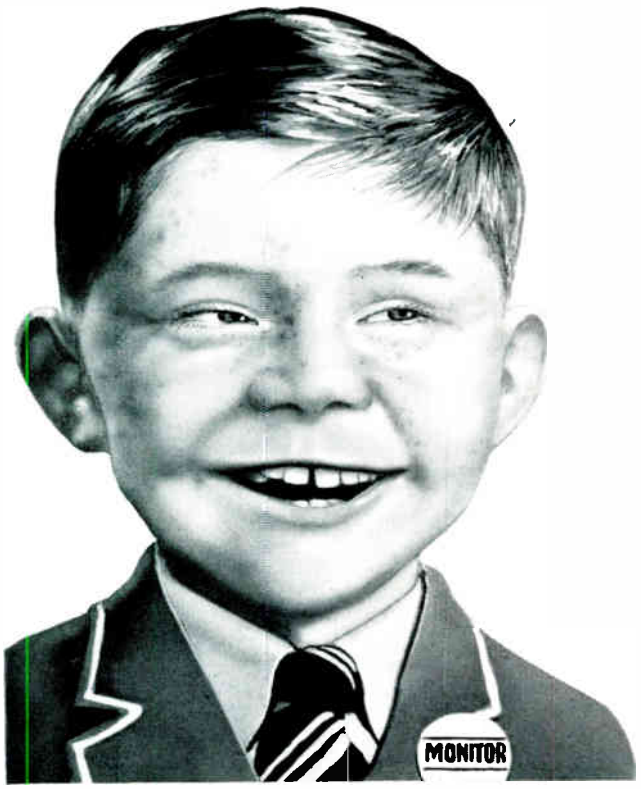

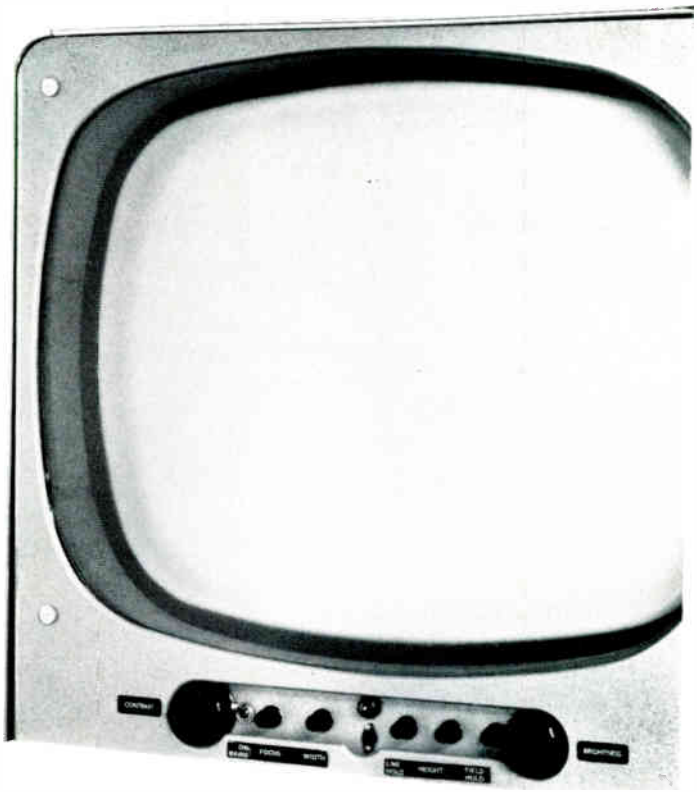

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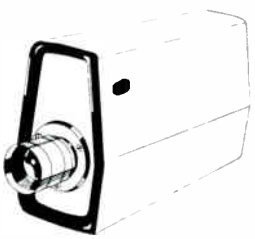

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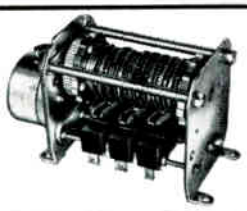

TIMERS

SERIES 807 TIMER
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TIMERS

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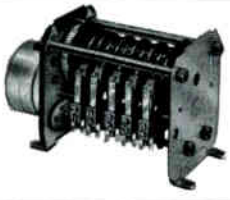

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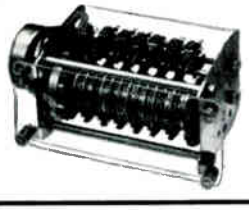

TIMERS

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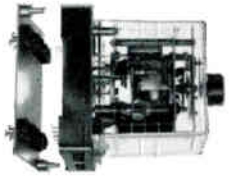

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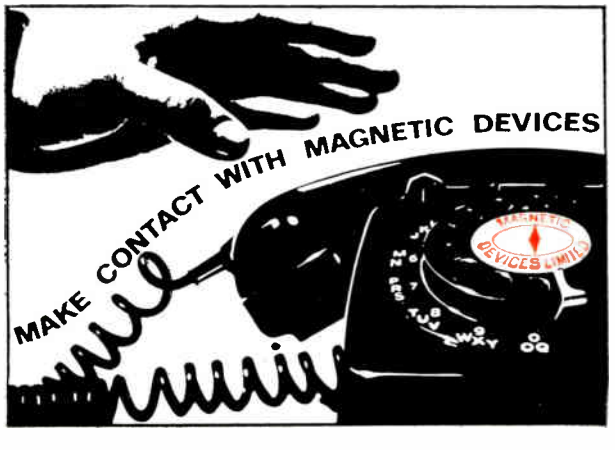

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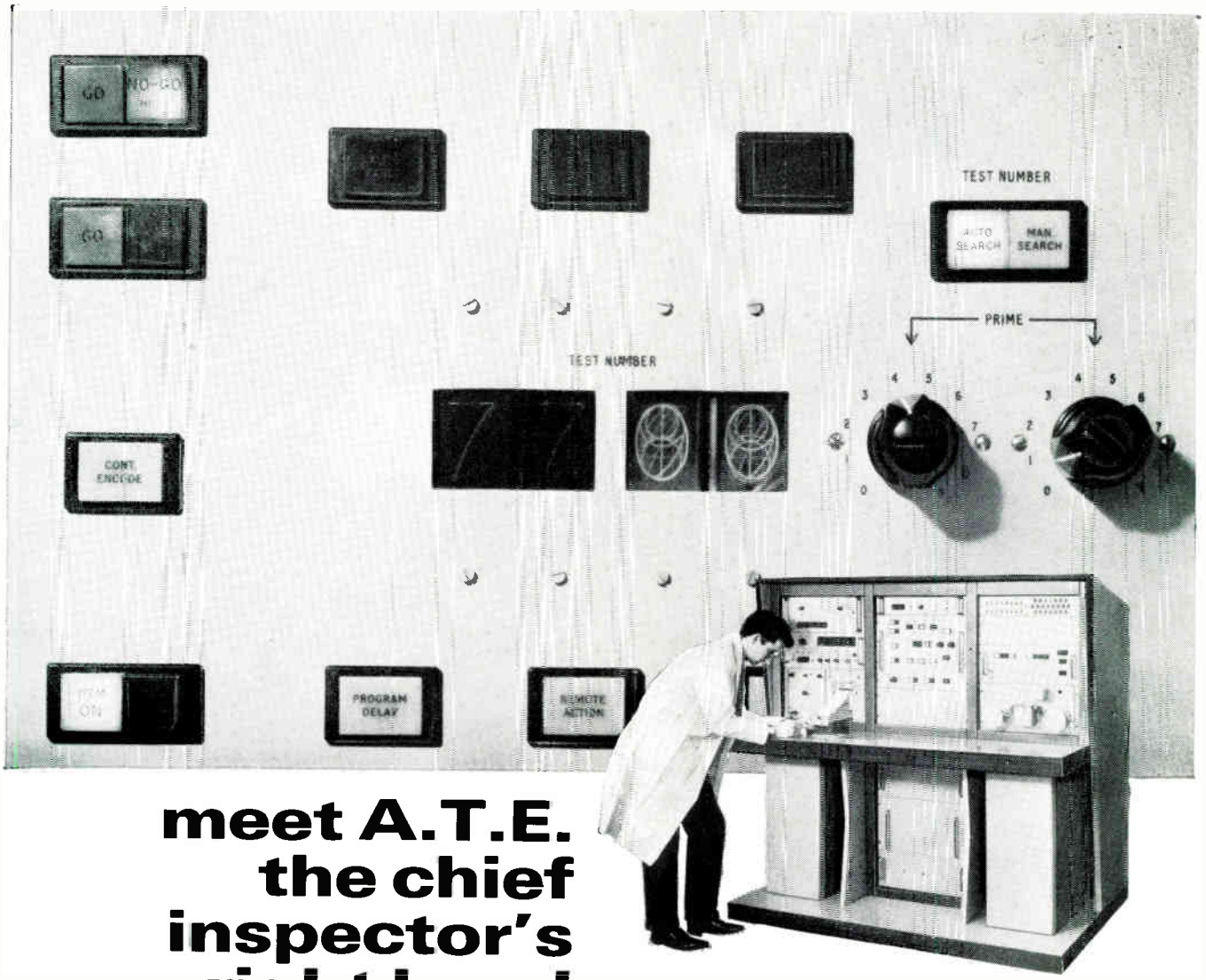

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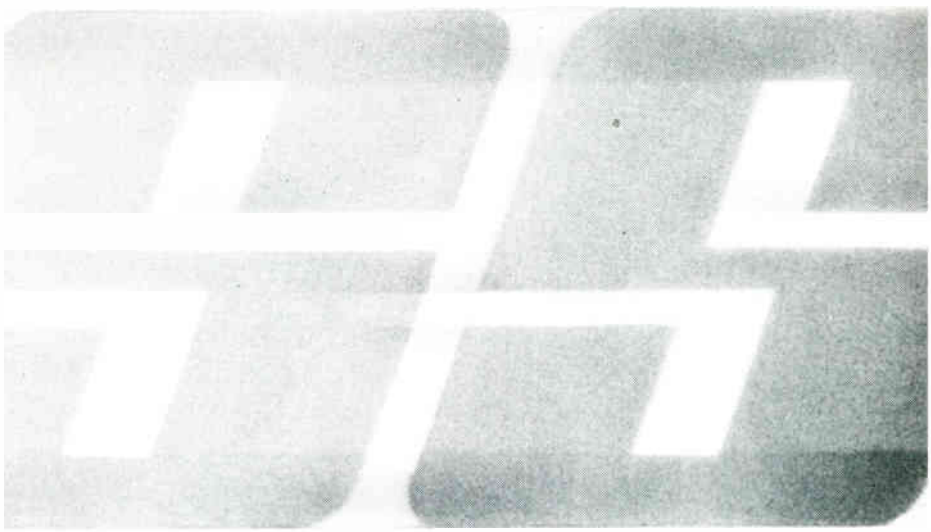
How Spaulding



Spaulding always made parts work better and more economically by fabricating them in their own cheaper, lighter, more durable materials. New, twice-as-big Edenbridge factory now gives customers even quicker access to Spaulding benefits with an extra-fast, extra-efficient delivery and after sales service.
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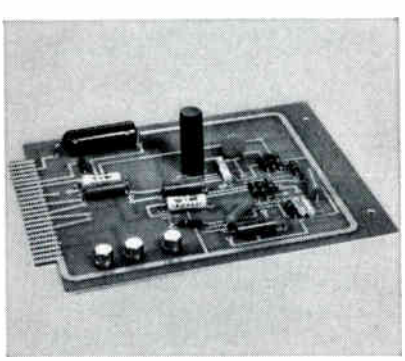
SPAULDING MATERIALS—AT WORK FOR ECONOMY

Spaulding Armite

Problem: Two pieces of pressure-sensitive, varnished cambric had to be cut and placed to electrically insulate the cover of a small transformer. Process was time consuming and did not provide satisfactory insulation.
Solution: Cambric was replaced with a part made of punched and creased Spaulding Armite which can be easily pressed into place by hand and gives more complete insulation.
Result: Less assembly time reduced cost by 37%.



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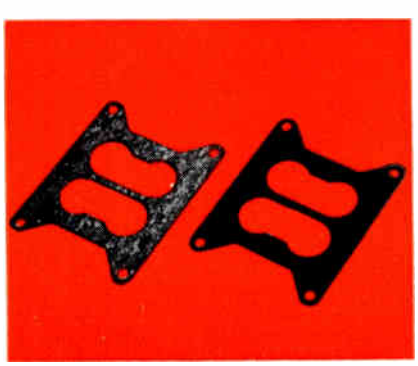

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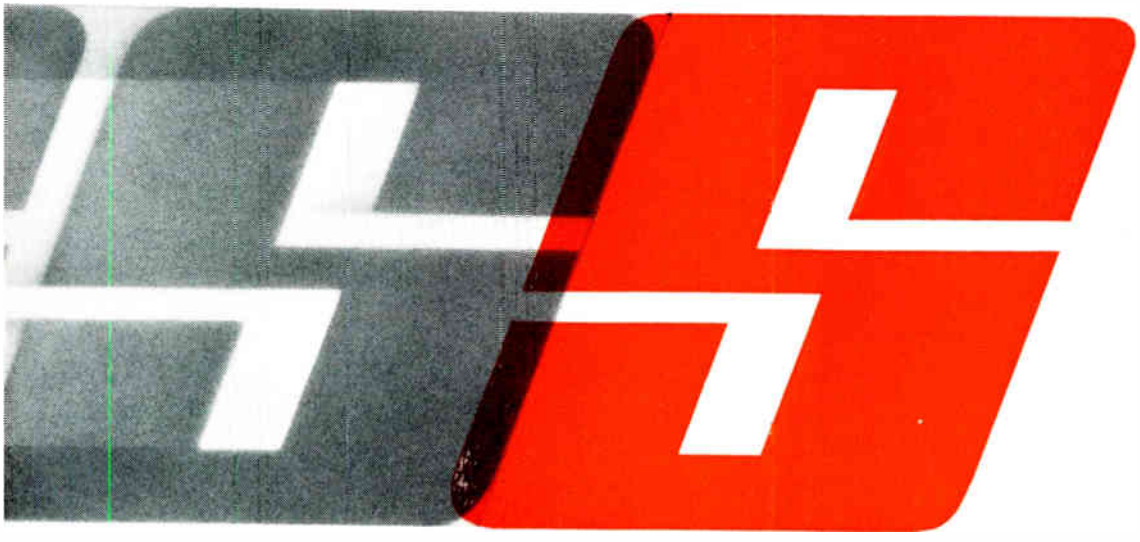

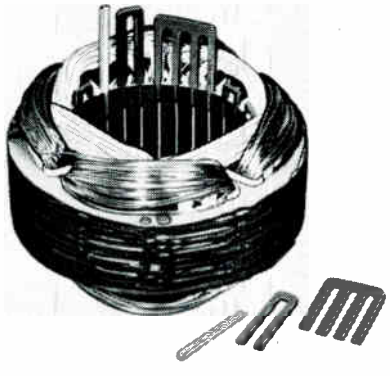

Value Analysis — puts parts-efficiency into overdrive

Problem: In general purpose electric motors, maple pegs were used as slot wedges to hold field winding. In addition to causing splinters in the assemblers' hands, the pegs also often slipped out and required special inspection and reinsertion.

Solution: The maple pegs were replaced by two-pronged "hair-pins" made of Spaulding Vulcanized Fibre which allow the pegging of more than one cell at a time. In some cases, these have been further refined to four-pronged "comb" wedges which even more reduce assembly time.

Result: Faster assembly, less inspection, no splinter hazard, saving of 4d to 7d per stator.

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The cable, British made by The Telegraph Construction and Maintenance Co., was a telecommunications engineering achievement comparable in its day with the launching of a satellite.

The first telegram to be sent over the cable was from R. A. Glass (managing director, The T.C. & M. Co.) and it read simply 'All right'. This was followed, a few days later, by a message of 405 letters from the President of the United States, replying to a message from Queen Victoria, at an operating speed of 37 letters per minute.

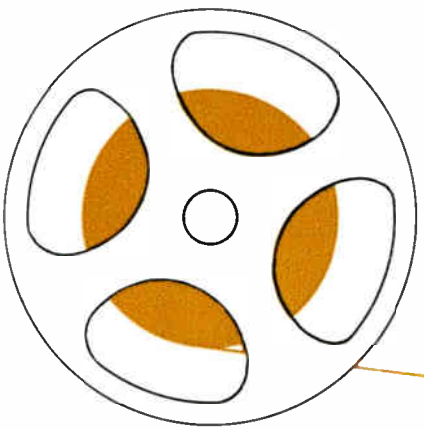
In the years that have since elapsed all forms of telecommunications have progressed enormously. The first transatlantic telephone cable between Scotland and Newfoundland was established 10 years ago. Since then, no less than five more transatlantic and several transpacific links have been made operational. This year a link between Australia, New Guinea, Guam, Hong Kong and Singapore will be completed. Now telephone operators at the International Exchange in London can directly dial numbers in Hong Kong. In the reverse direction, telephone operators in Hong Kong are able to connect directly calls to subscribers on most automatic exchanges in Britain.

Improvements in cables and associated equipment have made possible increased traffic-carrying capacities and operating speeds. Whereas the first transatlantic telephone cable installed in 1956 carried only 36 circuits, systems can now handle 640 circuits. The telegraph operating speeds of the Victorian era, of about 37 letters per minute, have long ago been forgotten and on land the transmission of data at speeds of 150 characters per second is now commonplace; by special channel grouping techniques data transmission is possible at speeds of up to about 4,000 characters per second. More recently, the G.P.O. have ordered about £1 million worth of pulse code modulation equipment to alleviate the congestion on links between some telephone exchanges. By electronically processing speech signals and converting these into coded pulses it is possible to carry twelve separate conversations over only two pairs of wires.

In many of these developments Britain has led the world and, given the opportunity, there is no doubt that the British telecommunications industry will continue in the forefront of the field.

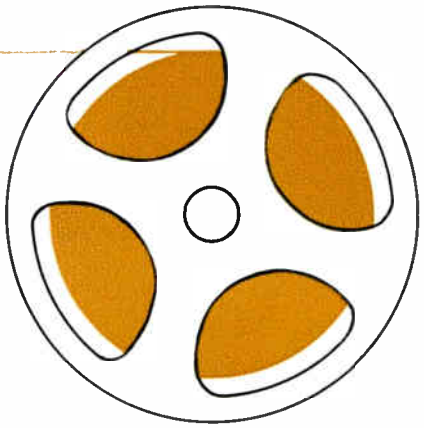
For the future, we shall see communication satellites being used to a greater extent to complement existing facilities and provide new services.

It is to be hoped that Britain will be able to participate actively in this new field of communications as she has done in past developments.



MAGNETIC TAPE RECORDING

By W. SILVIE, B.Sc., A.M.I.E.E.*



Moving-Head Techniques

In a previous article†, the author discussed the original approach to magnetic tape recording—that of drawing tape past a stationary head. In this article, he describes the operation and applications of two derivatives of this technique (transverse-scan and helical-scan recording), in which scanning heads are moved rapidly across a slowly-moving tape, thus achieving the high head-to-tape speeds required for v.h.f. recording.

ALTHOUGH considerable strides have been made in the development of longitudinal recorders, equal strides have been taken in the development of scanning recorders in which a video head, or heads, scan a slowly-moving tape at high speeds. This type of recorder was first introduced commercially in 1956, and even at that time was capable of recording 3 Mc/s using a frequency-modulation system. Since that time, many types of scanning recorder have been introduced, all with their advantages and disadvantages. In general they all fall within the categories illustrated in Figs. 1 and 3.

* Chief Engineer, Ampex International, Europe, Africa & Middle East Area.
† Magnetic Tape Recording: Stationary-Head Techniques. *Industrial Electronics*, Aug. 66.

Transverse-Scan Recording

In the transverse-scan recorder (see Fig. 1), four heads are mounted equidistant around the periphery of a drum rotating at approximately 15,000 r.p.m. The tape is 2-in. wide and is drawn past the head at speeds ranging from 7½ to 15 in. per sec, the resultant relative head-to-tape speed being of the order of 1,500 in. per sec. With such high tape/head speeds, it is theoretically possible to record over 10 Mc/s with convention gap widths of 50 μin.

In practice, the required signals are often recorded within the protection of a frequency-modulation system, resulting in a usable bandwidth of up to 6 Mc/s. Where sufficient protection is available from a signal-coding system itself (for example, in many pulse-code-modulation systems), there is no need to adopt frequency modulation, and up to 10 Mc/s can be made available. Apart from the wide-band information recorded transversely across the tape, at least two tracks of auxiliary information (extending to 15

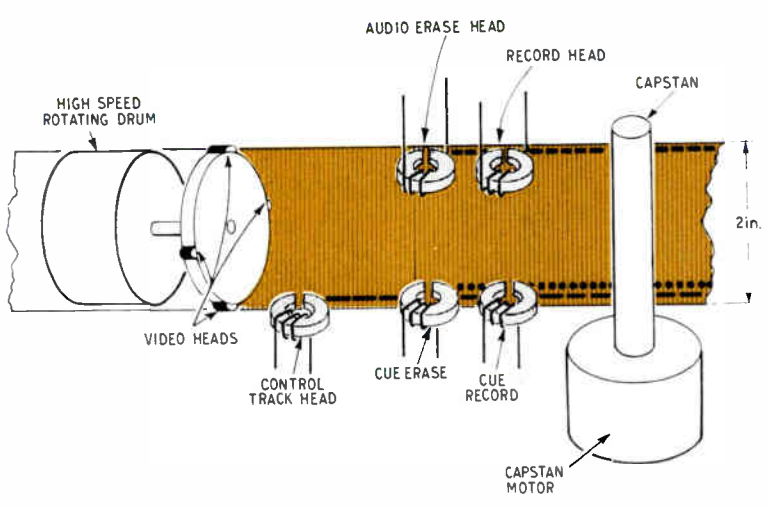


Fig. 1. A schematic diagram of a transverse-scan recording-head assembly. The high speed of the rotating drum (on which are mounted four recording heads) results in tracks being scanned across the tape at an angle only slightly removed from 90° to the direction of the tape motion

kc/s) can be recorded longitudinally along the edge of the tape, together with a control track for monitoring the tape speed.

Television Applications

Perhaps the most glamorous application of this recording technique is television—the original application for which it was developed. Performance has now increased to the point where it is virtually impossible to detect a recording from a live broadcast, and in fact a large percentage of transmitted programmes now come from video tape. Apart from the more obvious improvements to picture quality resulting from years of refinement, the time-base stability has also been improved dramatically. The action of scanning transversely across tape inherently leads to a small component of longitudinal wow and flutter in the video tracks, and even in early recorders a time-base error of only ± 10 μsec was present in the reproduced waveform.

In a television system, however, errors of this magnitude can be serious in many ways. Fortunately, the rate of change of this displacement was sufficiently slow to allow the signal to be transmitted and received in the home without noticeable distortion, but in the television studio the recorder could not be used as a synchronous source of picture like a television camera, and this complicated productions. Accordingly, the next stage of development was a refinement of the servo mechanisms leading to time-base stabilities in the order of $\pm 0{\cdot}1$ μsec—the practical limit of electro-mechanical servo control. Further refinement has come through the use of electronically-controlled variable-delay lines, which are capable of correcting instantaneous changes in time-base and reducing errors to no greater than 30 nanosec.

With the advent of colour television, even this order of stability was insufficient to reproduce the colour sub-carrier of the N.T.S.C. system with an acceptable error; further electronic time-base correction was undertaken using the colour sub-carrier itself as a reference, and this led to final errors not exceeding $\pm$ 5 nanosec—virtually time-base error free for most applications. This last step, together with accompanying improvements in the whole signal system, have made it possible to record any of the existing colour-television systems without resorting to hours of adjustment and setting up. To make matters more straightforward for the operator, an accessory has been designed to monitor automatically the amount of colour in a reproduced picture and correct for any colour-saturation deficiency noticed. In addition, drop-out (i.e., absence of signal) can be detected and replaced by a virtually identical segment from the previous television line, thereby completely eliminating the subjective disturbance of the occurrence.

To improve the value of the video tape recorder as a television-production tool, facilities can now be provided to allow completely electronic editing of video tapes, thereby eliminating the time-consuming and expensive business of developing and cutting tapes mechanically. It is even possible to rehearse complete sequences and pre-select the desired programme in advance, running through the proposed sequences as many times as required before finally recording the composite programme automatically. The procedure may also be adapted to record single television frames, thereby allowing animated programmes to be made on video tape recorders for the first time. This is achieved by using a small computer to control the electronic editing circuitry.

In short, the television recorder is now a sophisticated production tool of high fidelity, and not just a means for storing television programmes; a typical broadcast video recorder is shown in Fig. 2.

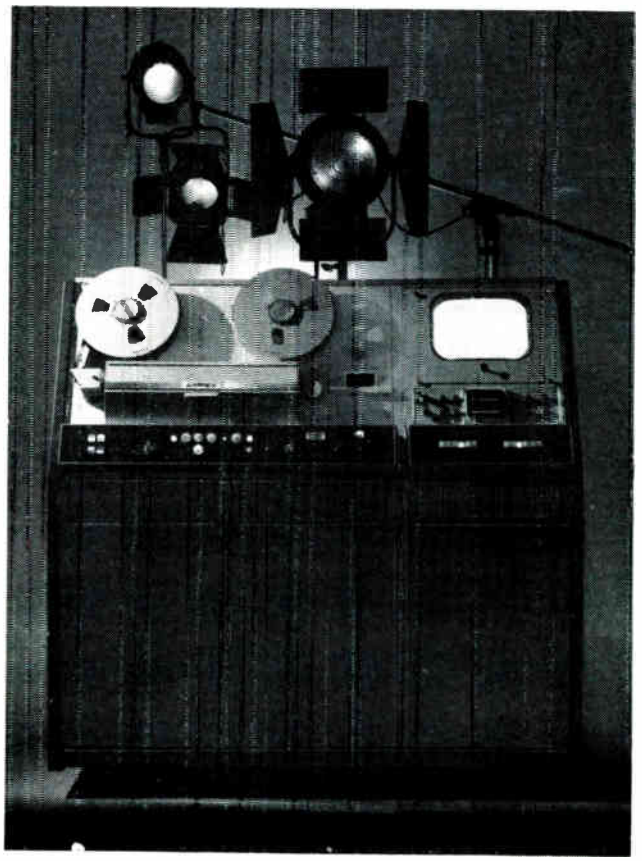
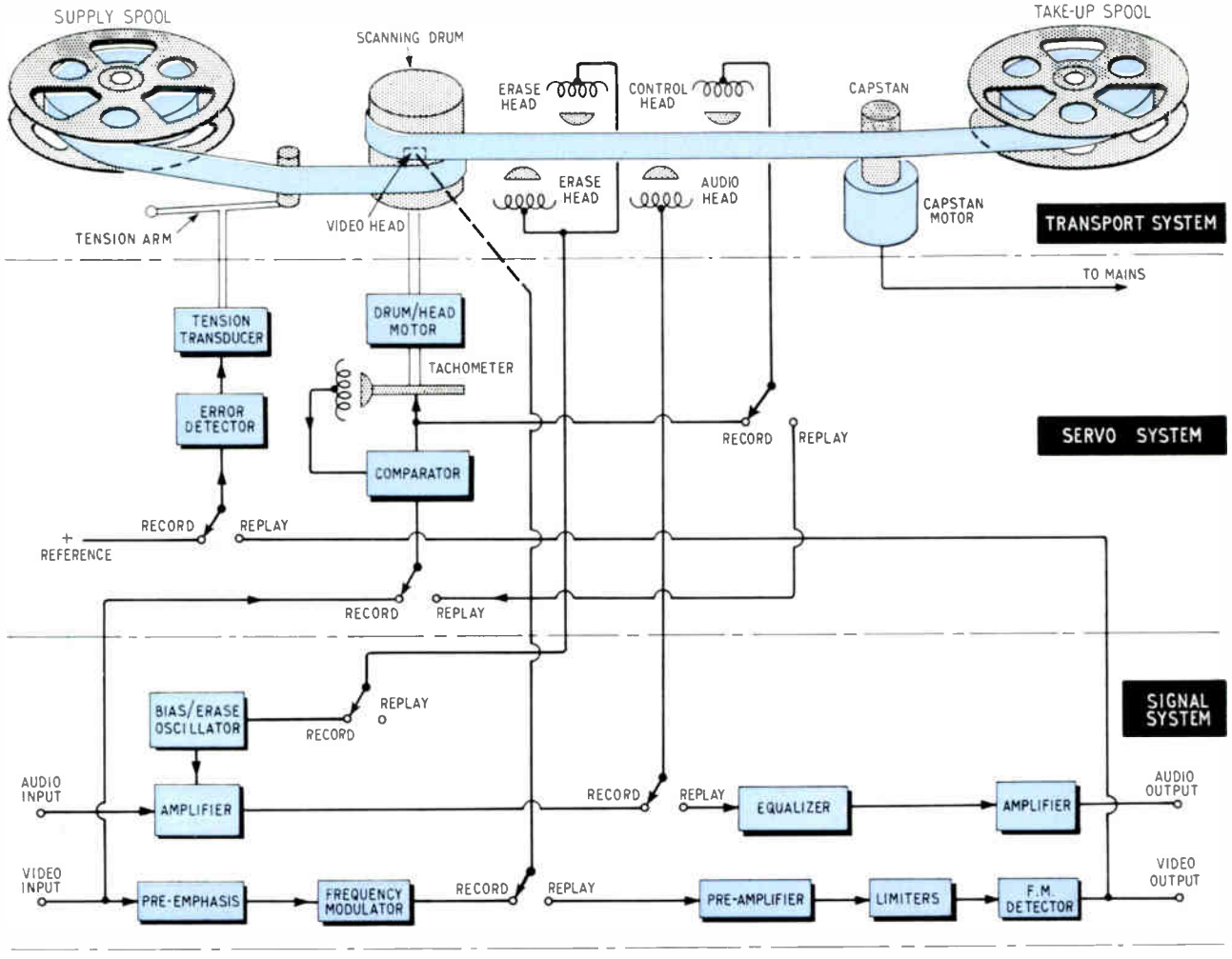


Fig. 2. Introduced in 1964, this wide-band colour video tape recorder (the VR 2000) was designed for professional studio applications. Six such recorders were delivered to the B.B.C. last year for use in programme production and research into colour-television recording (see front-cover picture)

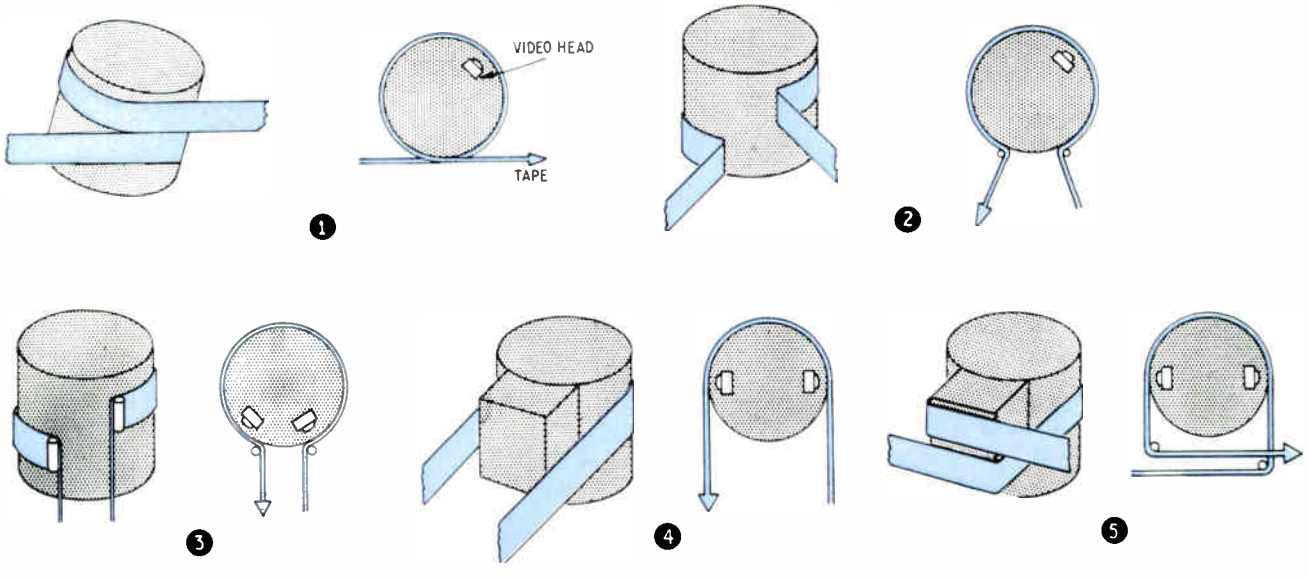
Obviously, this capability can be extended into other fields and, in fact, widespread use is made of transverse-scan recorders to store radar information for operator training, signal analysis, radar-circuitry development and the like; wideband telemetry and similar information can also be recorded in the same way. Previously, recording was possible only after decoding into a form suitable for recording on longitudinal recorders with their lower-bandwidth capability. The transverse recorder minimizes the signal processing necessary before the record is made permanent, thereby taking an important step towards improved reliability for the total system. Although these equipments use the same basic techniques as the television recorder, they are often designed to operate under stringent environmental conditions and to record up to two tracks of video information on one tape.

Equipment employing the same basic techniques has even been developed for earth satellites. In a typical recorder (occupying less than 1 cu ft) a concentric-reel arrangement is used, the electronics being contained within the hub of the reels. With this configuration, it is possible to record for up to 30 min with a bandwidth of 4 Mc/s, and to rewind or replay upon command from the ground. Similar recorders for manned space gliders have also been developed, where the weight penalty is even more severe; in this



This block/schematic diagram indicates the operation of a typical helical-scan video tape recorder. The scanning head, which rotates within the drum, is controlled by a servo mechanism that derives a reference signal from the tape during replay. This reference signal is normally locked to the picture-repetition rate. To protect the video signal against dropouts and interference, it is normally recorded using a frequency-modulated system

Fig. 3. These schematic diagrams indicate the principal head configurations of helical-scanning assemblies being manufactured today



instance a relatively-simple tape transport had to be used in the aircraft, the resulting timing errors being corrected to within ± 20 nanosec in the complex ground installation.

One of the more interesting techniques now employed on transverse-scan recorders is the use of air bearings in the motor driving the video-head drum. Even the best ball-bearings will result in minor variations (due to progression of the bearing cages etc.), but the use of high-pressure air as a bearing completely eliminates these effects, resulting in a drive system more amenable to control and less inherently unstable.

Helical-Scanning Techniques

Although the transverse-scan recorder was the first to be used on a wide scale commercially, and is still the only recorder really suited to broadcast television, alternative scanning techniques have also been investigated; although their development was not so rapid, they are now in wide use in other fields. All these recorders use the helical-scanning techniques illustrated in Fig. 3 Unfortunately, every recorder of this type uses a slightly different variation of the basic helical principle, and at the moment there is no sign of standardization. In all types, the tape is wrapped in a helix around a scanning drum, but the actual wrap, the width of tape, the tape speeds and the number of video heads are different in every case.

It can be seen that some configurations have an inherent gap in information at the point where the head leaves one edge of the tape and travels to the other: in practice, two heads must be used for continuous recording. It is normally arranged that the length of the scanned track across the tape is equal to a television field, or picture; any loss of information is positioned in the synchronizing-pulse period, the lost pulses being synthesized in the 'reproduce' electronics.

Common to all helical-scan recorders is the small scanning angle of approximately 20° with respect to tape motion, leading to a larger proportion of longitudinal wow and flutter superimposed on the video tracks. Fortunately, the effect of this superimposition is scaled down by the ratio of tape to scanning speed, but the principle of operation of a helical-scan recorder ensures that it will always have a poorer time-base stability than an equivalent transverse-scan recorder. The advantages of this type of equipment are simple construction, light weight, and general ease of operation; in practice, most recorders have controls very similar to a normal audio recorder and can be operated after only minimal instruction.

A typical professional helical-scan recorder, with sufficient time-base stability for transmission over broadcast networks and with sufficient bandwidth (3 Mc/s) to accommodate most outside broadcast and closed-circuit television requirements, is shown in Fig. 4. In this equipment, two video heads are used, with switching between them to ensure that there is no discontinuity in the reproduced signal.

Among the features offered with this category of equipment is the ability (during replay) to stop the tape motion while continuing the head-drum rotation. This results in the same recorded track being replayed over and over again, giving a still-frame presentation of the recorded picture. By controlling the tape speed from zero to normal, it is possible to have either stop motion, slow motion or normal television pictures at will. (Because of the relatively small number of television lines recorded during each sweep of a transverse-scan recorder head, it is not possible to operate such a recorder in the same way.) A recent improvement is the ability to edit electronically on even this small recorder, thereby overcoming the practical difficulty of editing helically scanned tapes by cutting and joining.

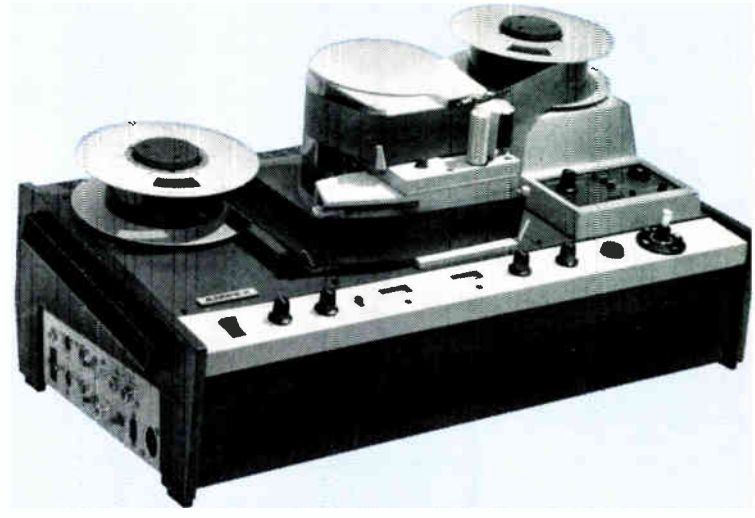


Fig. 4. A professional helical-scan recorder (the 96-lb VR-660B), was designed for mobile and studio use. It will provide almost five hours of continuous recording when operating at a tape speed of 3·7 in. per sec, and the main operating control is the five-position joy stick on the right-hand side of the control panel

Applications

Apart from its use as an outside-broadcast recorder (see Fig. 5), another application is its use on transatlantic or intercontinental jet aircraft to provide in-flight entertainment. A typical installation will provide almost five hours of continuous programme, and high-quality stereo-audio recorders are often supplied in addition, to supplement the television entertainment with a range of sound programmes.

Earlier it was stated that extremely good time-base stability is required to record many of the colour-television systems; in practice, this has been one of the main reasons

Fig. 5. A video recorder similar to that illustrated in Fig. 4 is here shown installed as part of a mobile recording system. The equipment also includes a camera unit, monitor screen and control apparatus

Fig. 6. This home video recorder unit—the 6200 HVR—will record programmes off the air, or pictures from a simple television camera, and will play them back (including a sound track) on most domestic television sets

why it has not been possible to record high-quality colour television on the helical recorder. However, recent studies with the SECAM colour-television system (which is not directly affected by time-base variations), have led to high-quality closed-circuit colour-television pictures being recorded successfully on this relatively simple type of recorder; consequently, many applications in the realms of education and medicine are foreseen.

Although helical-scan recorders were developed primarily for television, other applications such as X-ray and radar recording are becoming increasingly important. The relative simplicity of these recorders, together with their ability to record complex radar information and replay it at will (for operator training or subsequent analysis), is leading to widespread applications. It should be noted that, in this radar application, it is imperative that there be no gap in the information: hence a recorder with two video heads must be used.

Domestic Video Tape Recorders

Perhaps one of the most widely-discussed extensions of video tape recording has been the home video recorder—long promised, but only recently forthcoming. A typical home recorder is shown in Fig. 6, and a strong family resemblance can be seen to the previous equipment. Once again, it has been found that the helical-scanning technique is most amenable to this application, where extreme simplicity must be allied to high reliability, ease of operation and low running costs. As previously stated, the helical-scan recorder has the added advantage of a long playing time compared with more conventional recorders; even more important, the relatively high head-to-tape speed (approximately 1,000 in. per sec) ensures good picture quality.

A unique feature of the recorder illustrated is the rotation of the top half of the scanning assembly in an opposite direction to the tape motion. The rotation builds up an air film between the tape and the scanning assembly, thereby reducing the friction in the tape path (and thus the drive power required), while helping to increase the life of the video head. This equipment uses the 'Omega wrap' head configuration (see Fig. 3), which leads to loss of information during the television field-blanking period, but not during the active-picture period.

Future Developments

Obvious improvements one can foresee in scanning recorders include increased resolution (and therefore bandwidth) and improved signal-to-noise ratio, both following closely in the wake of improvements to the tape medium itself. It is fair to say that, for transverse-scan recorders, the equipment is now limited principally by the characteristics of the tape.

Another area of constant research is that of video heads. When scanning a magnetic tape with a head at speeds of up to 1,500 in. per sec, it is not surprising that relatively rapid wear occurs on the pole pieces of the head. On the early transverse-scan recorders, an average life of approximately 100 hours could be expected; it now exceeds 350 hours, due to continual development. Increasing use of glass-bonded ferrites and related materials will no doubt lead to a considerable improvement in these figures, but it is conceivable that even greater improvements may be realized by using air bearings to separate the tape from the head during the scanning process, assuming improvements are forthcoming from other areas to compensate for the resulting signal loss.

Another obvious solution to the head-wear problem is not to scan the tape mechanically, but to scan it by means of a travelling-wave head assembly, or one controlled by an electron beam; this would eliminate the mechanical problems and allow much greater control over the scanning process. Unfortunately, in the present state of the art, the use of purely electromagnetic-scanning techniques leads to degradation in other respects, and the best overall performance is still achieved with the original mechanical method. There is no doubt that this method will be supplanted by non-mechanical scanning in time, and when this does happen another great step forward will be possible.

In the meantime, extensive research is now being carried out into electron-beam recording of one form or another, and may very well lead to a new recording medium having all the advantages of magnetic tape and few of its disadvantages. This recording technique will be described by my colleague Mr. Spitzer in a future article.

ELECTRONICS
COMMUNICATIONS
INSTRUMENTATION
CONTROL

R.A.F. Computerize Stock Control

The R.A.F. at Hendon is proving that the Services are no laggards behind industry in introducing computers to control vital operations. With the aid of one of the largest automatic data processing configurations in Europe devoted to a single operation—stock control—the R.A.F. Supply Control Centre there is now working round the clock, seven days a week, ultimately to control the supply of around 750,000 different items of R.A.F. equipment, ranging in character from a split-pin to a Vulcan mainplane and in location from Hendon itself to Hong Kong.

This world-wide computerized stock control operation, linking some 150 R.A.F. units, is based on two AEI 1010 computers supported by a massive total of 24 tape decks and 18 other peripheral units.

An accurate indication of roll or linear speeds and speed-ratios is often necessary during the manufacture of such products as paper, steel and plastics. This article describes several ways of measuring and displaying such quantities, using modular digital-counting equipment.

IN the paper, steel and plastics industries, it is often necessary to have accurate measurements of roll or linear speed or speed-ratio at various stages in the manufacturing process. Accurate measurements are required for setting-up purposes, and continuous indication is required to ensure a finished product of uniform quality.

A range of A.E.I. modular digital counting equipment is now available which enables any special measurement requirements to be met from a standard range of modules. Where more than one measurement is required, the equipment can either be switched manually between the inputs or switched automatically in sequence around the inputs. The latter system, known as the time-division multiplex method, enables a continuous display of all the measurements involved to be given without the necessity of having one counter per measurement.

Indication may be required in the form of a speed, or as a percentage difference between two speeds; for some applications, the absolute speed difference between two speeds is required. Where percentage speed difference is large, it may be more convenient to express the difference as a ratio.

Principle of Operation

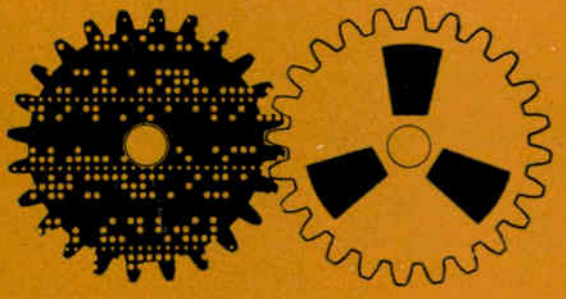
In most of the industries to which this equipment has been applied, the display is generally required in a dirty or dusty atmosphere, and desk space is also at a premium. To meet these problems, the A.E.I. equipment has been designed so that the electronics are usually mounted separately from the display. Fig. 1 shows diagrammatically two equipments each giving both speed and speed-difference displays on a control desk over 120 ft away.

The principle of any digital measurement is the conversion of the required information into pulses, each pulse accurately representing a known quantity. If these pulses are fed into an electronic counter, they can be totalled accurately to within one pulse, thus giving an inherent degree of accuracy far in excess of that obtainable by normal analogue equipment, such as d.c. tacho-generators.

Speed measurements are derived from electromagnetic transducers or impulse generators which are coupled to the motor or measuring rolls. Any number of pulses per revolution of the impulse generator may be obtained up to a maximum of 320 and, if required, gearing can be provided which will drive the impulse generator at a higher speed than the normal input speed. Each output pulse from the impulse generator represents a fixed proportion of one revolution, and measurement of rotational speed may be obtained by counting the number of pulses from an impulse generator during a fixed time period. Thus the number of pulses in one second from an impulse generator producing 60 impulses per revolution represents the r.p.m. of the impulse generator, and hence the rotational speed of the shaft driving it.

The gear ratios, the period of counting and the number of teeth on the impulse generator gears are so arranged that the number of pulses counted gives a direct reading of the speed measurement, either in r.p.m. or ft per min. The timing period is controlled by a clock counter (the 'A' counter) which is continuously driven by an accurate crystal-controlled oscillator. The 'A' counter produces logic signals which control the operation of a secondary 'B' counter. When the 'A' counter passes through a preset

* AEI Electronics.



COMPUTERS IN INDUSTRY

Direct Digital Control in Action

By J. A. ROBINSON*, B.Sc.
and N. L. LEECE*, B.Sc.

In an article last month, the factors which render computers suitable for controlling industrial processes were discussed. Here, the ways in which direct digital control can be applied in practice are described, the authors taking as an example the chemical-plant control system at I.C.I., Fleetwood.

* Ferranti Ltd.

BY way of illustrating how direct digital control (d.d.c.) can be applied in practice, it is proposed to describe some of the features of the world's first computer controlled chemical-plant, at I.C.I., Fleetwood, which was first controlled in 1962 and ran successfully until December 1964. Although a similar control system is unlikely to be reproduced, the fundamental principles still remain common to nearly all d.d.c. systems so far encountered and so it is our aim to illustrate principles rather than techniques.

The Concept of D.D.C.

Following early experiments in plant optimization with a digital computer, it was suggested that the computer ought, on economic grounds, to be as fully employed as possible. This was to be achieved in part by using the computer to replace conventional analogue control instrumentation, and thus was born the concept of direct digital control.

The Fleetwood plant, which produces soda-ash using a 'safe' process, was chosen since its instrumentation was due for replacement and because the control problems and their answers were known. The aims of the experiment were:

(a) To prove that d.d.c. was at least as good as conventional analogue control.
(b) To assess the reliability which could be obtained from an on-line computer control system.

Size and Nature of the Problem

The extent of the system was, considering the pioneer nature of the experiment, ambitious; this was intentional, being based on the philosophy that it would be cheaper to make maximum use of the computer.

Provision was made for 224 process measurements, 120 valve positions and control of 120 pneumatic valves. The process measurements included 100 temperatures, 90 flows, levels or pressures and a few pH and CO_2 analyses. In practice, about 90% of this capacity was employed.

Following the philosophy of maximum utilization, the computer was employed in the following tasks:

(a) Measurement of process variables and valve stem positions.
(b) Valve control.
(c) Alarm monitoring of all measurements.
(d) Display of process information and operators' insertions.
(e) Logging.
(f) Analysis and averaging of records.
(g) Self-checking.
(h) Valve checking for leakage.
(i) Control of packing plant.

Implementation of Tasks

(a) Measurements

All measurements were converted to digital form by a common high-speed analogue-to-digital converter (a.d.c.) working to 10 bits (0·1%) accuracy. Because of the need to interrogate measurements at high speeds and in random order, transistor switches were used to connect the measurement to the a.d.c. under program-address control.

An interesting feature of the switches was their built-in scale-changing facility, enabling the various forms of analogue measurement to be standardized to the range (0–15 mA) of the a.d.c.

Three principal types of measuring instruments were employed: resistance thermometers for temperatures; current transmitters for flows, levels and some pressures; and linear potentiometers for valve positions.

The thermometer bulbs were fed, via a high resistance, with a quasi-constant current derived from a common 100-V

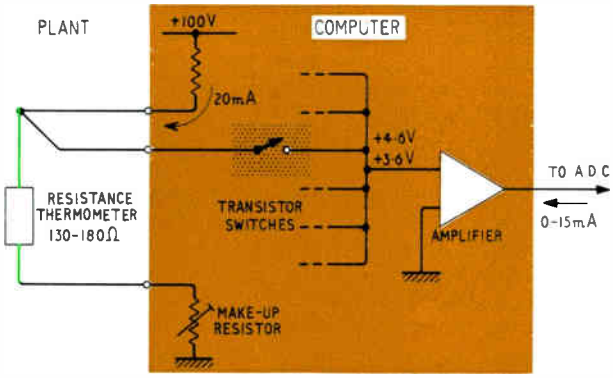


Fig. 1. The circuit diagram for the selection of resistance thermometers (one of the three principal types of measuring instruments employed in the control system)

supply; also included in the circuit was a make-up resistor (set on site) to standardize the earth-lead resistance of all thermometer circuits (see Fig. 1).

A 1-V change produced across the bulb corresponded to full scale and, after selection, this was converted by a common amplifier to a corresponding current range of 0–15 mA. A further interesting feature of this system was the use of fixed 'standard' temperatures to measure any drift which occurred in the amplifier. This drift and non-linearities in the bulb characteristic were corrected by the program. Fig. 2 shows a number of resistance thermometers installed in process vessels.

The current transmitters associated with flow and level were connected to a network as shown in Fig. 3. R_1 and C were chosen so that the change in potential across C was negligible while the switch pulsed 'closed'. R_2 was nominally equal to R_1, but included a factor allowing for the intrinsic resistance of the transistors.

The valve-position potentiometers were treated in a similar fashion to the resistance thermometers, but with the exception that scale changing and conversion to current were done in the switch circuit (see Fig. 4).

(b) Valve Control

Control of process flows in the Fleetwood system was by means of pneumatically-operated valves. This form of control valve is still the most common in present use, and although many electrically-operated actuators are now coming into use, the techniques for controlling them are similar.

In a closed-loop control system, the control action can be represented by the equation:

$$V_D = K_0\theta + K_1 \frac{d\theta}{dt} + K_{-1}\int \theta \, dt$$

where V_D is the required control action, θ is the difference between the desired value (set point) and the measured value of the controlled variable, and the Ks are constants whose values depend on the nature of the control loop (see Fig. 5).

Controllers, valve positioners and measuring instruments may be either electrically or pneumatically operated. Fig. 5 shows a mixed system, the measurement and control signals being electrical but the controlled variable (the valve) being pneumatically operated. The valves employed are often of the diaphragm type, as shown in Figures 6 (a) and 6 (b).

In d.d.c., the computer (by switching rapidly from one controlled point to the next) can replace all the controllers and valve positioners, at the expense of providing an analogue

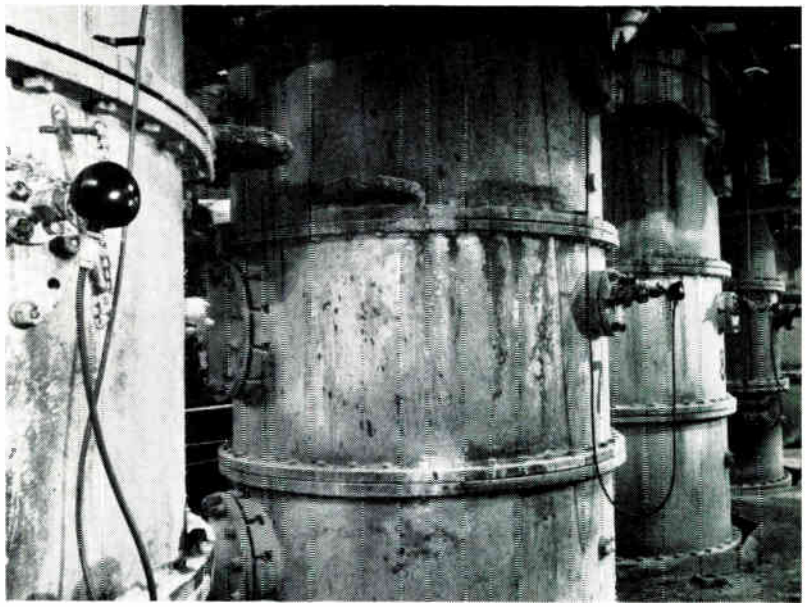


Fig. 2. A number of resistance thermometers installed in process vessels at I.C.I.'s soda-ash plant at Fleetwood

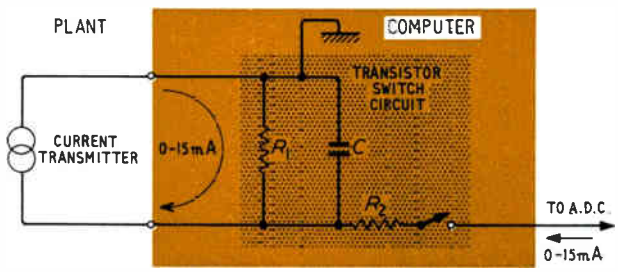


Fig. 3. A circuit diagram of the network to which the current transmitters associated with flow and level are connected

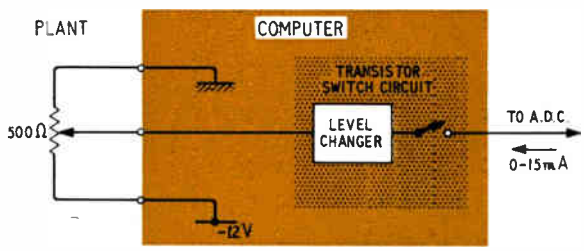
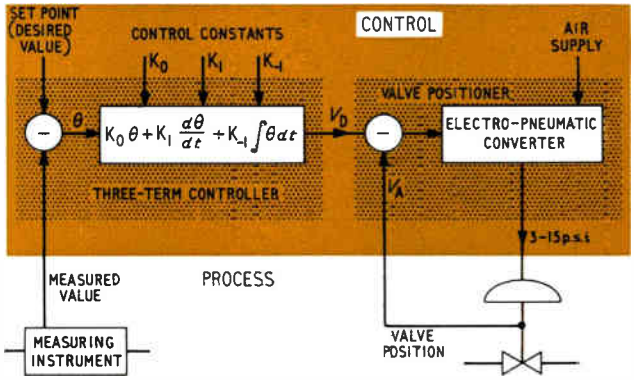


Fig. 4. Scale changing and the conversion to current of the valve-position potentiometer outputs are accomplished by means of this switch circuit

Fig. 5. This block diagram shows the usual form of a conventional three-term analogue control loop



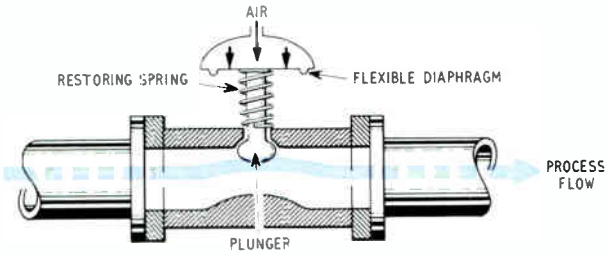
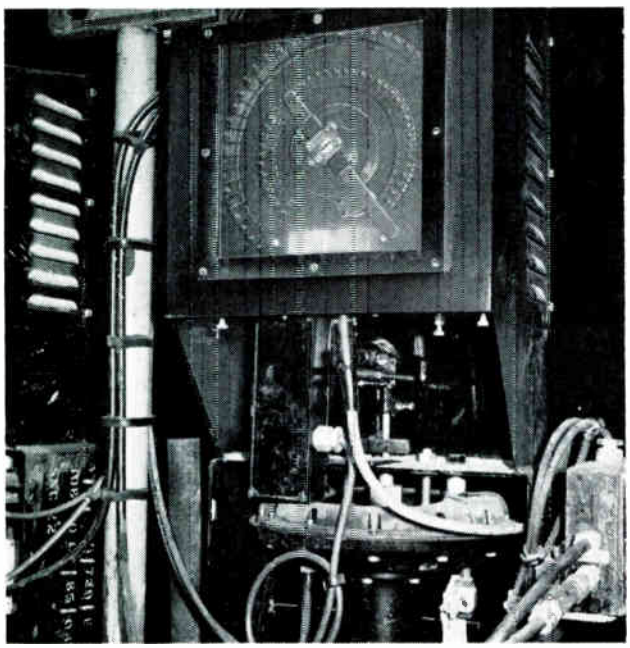


Fig. 6. (a), above. A schematic of a typical diaphragm-type pneumatic-control valve

(b), below. A pneumatic-control valve of the type illustrated in Fig. 6 (a) installed in the plant



measurement of valve position and two small solenoid-operated pilot valves to control the air flow to the bonnet. Fig. 7 (a) shows a typical control loop consisting of a flow transmitter and valve, and the control loop then takes the form shown in Fig. 7 (b).

The computer selects the appropriate measuring instrument and, after conversion to digital form, the difference between the measurement and the corresponding stored set point is calculated, giving the error (θ). From this and the stored control constants the three terms of the control equation are calculated arithmetically every second, using special smoothing techniques, to give the desired valve position (V_D) which is then stored. The actual valve position (V_A), given in this case by a potentiometer connected to the valve stem, is then selected and compared with V_D. The computer then merely has to take a decision based on the size of the difference and issues a simple 2-bit digital instruction which, after conversion to the required power level, is used to operate the solenoid valves according to the accompanying table.

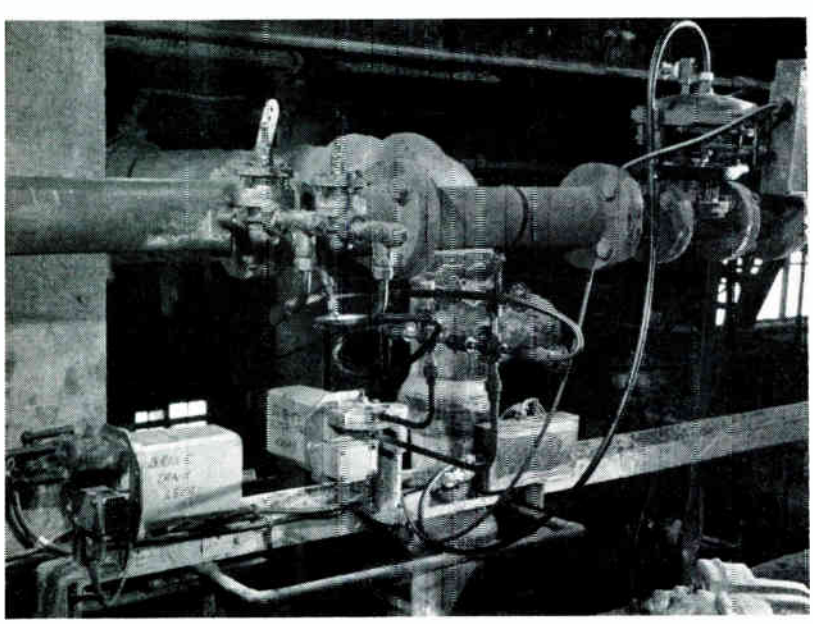
Condition	Required Valve Action	Computer Output
$V_A > V_D$	Open	01
$V_A < V_D$	Close	10
$V_A = V_D$	Stop	00

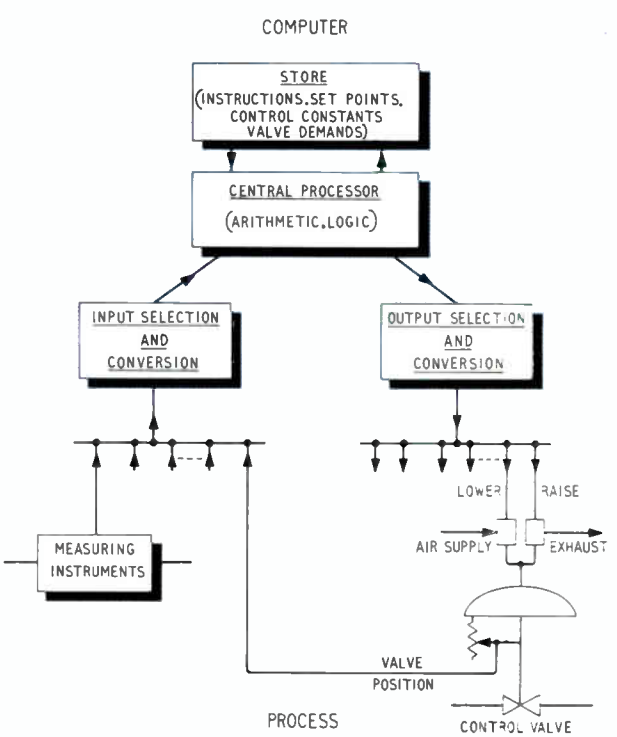
The time taken to issue control instructions to one valve is between $\frac{1}{3}$ and $\frac{1}{4}$ msec. but it varies, of course, with the fundamental speed of the machine.

Having launched a particular valve on its course, the computer then switches to the next valve and repeats the process. After completing the cycle with 120 valves—some of which do not exist—the computer returns to the original valve to determine its present position. If by then the difference between V_A and V_D is less than 1% of full travel, the 'stop' instruction is issued; otherwise, the *status quo* is maintained. The reason for the 1% dead band is to minimize

Fig. 7. (a), left. Here a typical control loop, consisting of a flow transmitter and valve, is shown installed in the plant

(b), right. A block diagram indicating the operation of the computer/process control loop





wear in the solenoid valves and measuring potentiometers. Figs. 8 (a) and 8 (b) illustrate the process.

The period between inspections (τ) is a function of the number of valves, their end-to-end travel time and the acceptable dead space; in the case of Fleetwood τ was 50 msec. Fig. 9 shows an assembly of control valves at the process-vessel outlets.

One principal disadvantage of this method of valve control was the large proportion (70%) of computing time involved in merely positioning valves, and as a result more refined techniques have now been developed involving a simple analogue comparator and a shifting-register store.

(c) Alarm Monitoring

Each measurement was checked every 150 msec against an upper and lower limit held in the computer store (see Fig. 10); in the case of valve position, these limits were 5% and 95% of full travel. Deviation from acceptable limits resulted in audible and visual alarms and a printed record. Provision was also made for automatically altering alarm limits so that noisy measurements would not cause multiple (and annoying) warnings.

(d) Display of Process Information and Operators' Insertions

The operator was provided with a control panel (see Fig. 11) to enable him to obtain information from the computer (e.g., the immediate value of any measurement) and to insert information (e.g., new set points to which the computer has to control). Since each measurement, set point and other relevant factors were allocated a unique four-decimal-digit address, it was possible to select these for display using a set of four rotary switches. In addition, the insertion of information coded —, —, and 0–99·9% was achieved using a further set of address and value switches.

Other keys were provided for the insertion of new information (to attract the program's attention as it were), acceptance of alarm and for demanding print-out. It was also possible to freeze the plant by de-energizing all solenoid pilots from another key.

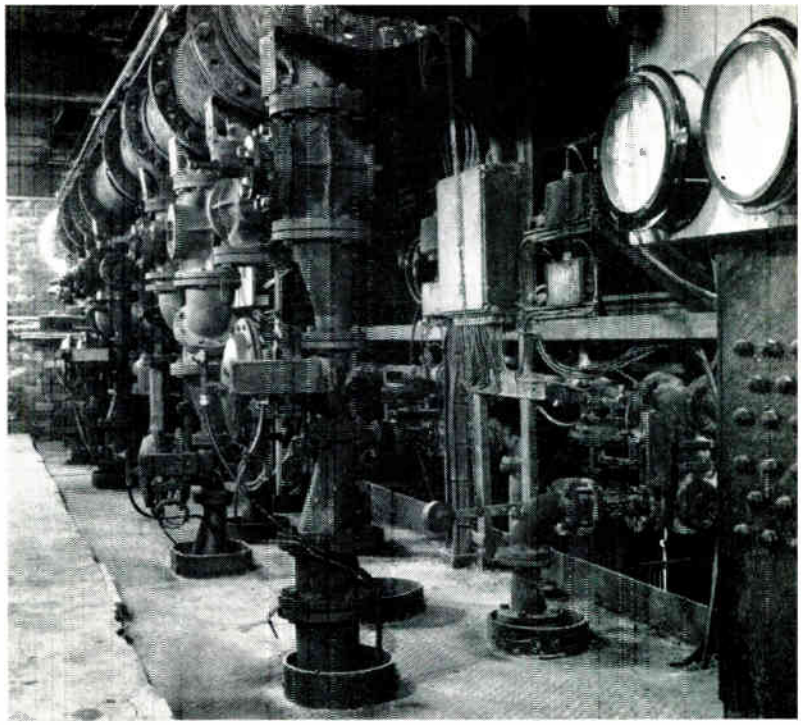


Fig. 9. An assembly of control valves at the process-vessel outlets

Lamps were provided (backed by audible alarms) to notify the operator that an insertion had been accepted by the program, that an alarm had been noted, or that the computer had failed and isolated.

(e) Logging

Although logging is strictly speaking not a feature of d.d.c., it plays an important part in enabling analysis of plant performance to be used as a means of improvement by selecting new control constants and set points.

Logging on a teleprinter of all alarms and operators' insertions was supplemented by an hourly print-out of all measured variables, arranged as a matrix of 16 rows each of

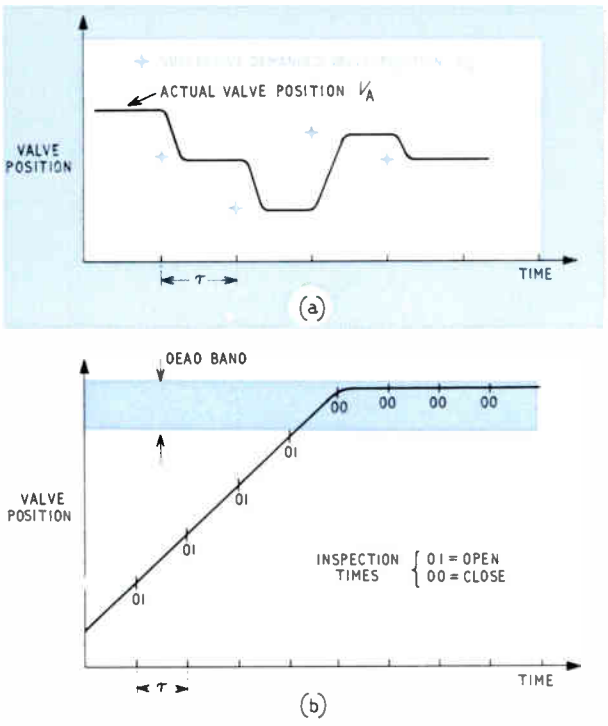


Fig. 8, left. (a) and (b). These two graphs illustrate the process whereby the computer operates the solenoid valves to set the desired valve positions

Fig. 10. Measurements for alarm monitoring are checked against upper and lower limits every 150 msec. A graphical representation of the process, together with a typical alarm print-out, is given here

	TIME	ADDRESS	SIGN	VALUE
PRINT-OUT A →	0920	0743	→	952
PRINT-OUT B →	0927	0743	*	940

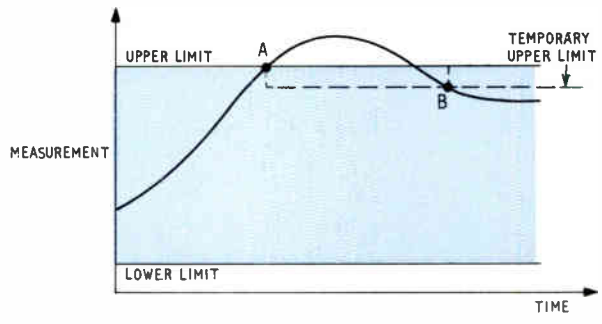


Fig. 11. This operator's control panel enables information to be obtained from, and instructions to be inserted into, the computer

16 values to three decimal figures. In addition, the same information could be obtained on demand, together with a log of all valve positions including an indication of which valves were on manual control.

(f) Analysis and Averaging of Records

Furthermore, all variables were logged on to magnetic tape every 4 minutes, the tape running for 13 seconds. After 24 hours recording, the tape was transferred to a replay deck and fed back into the computer by a method known as direct store access (d.s.a.); this depends upon the fact that the core store is used for only a fraction of the computer arithmetic period, the remaining time being available for autonomous transfers of data into and out of the store. The program averages 15 × 4-min readings for each of 16 measurements and prints the result as an hourly figure on a second teleprinter. By this means, 14 log sheets can be produced, which cover all 224 measured variables.

In addition, a graphical record of the performance of a single measurement can be extracted from the magnetic tape, the information being displayed on a graph plotter. Multiple plots on the same sheet enable comparisons of cause and effect.

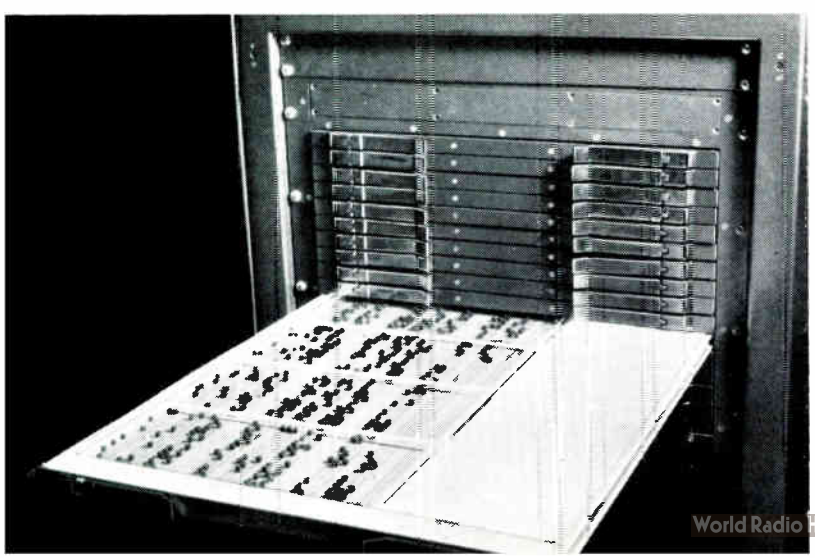
(g) Self-Checking

As a precaution against failure in the computer and common input/output channels, the computer is programmed to carry out a series of arithmetic and logical procedures, the answers to which are known and stored. By comparing these measurements against known and stored limits it was possible to check the a.d.c. and certain common power supplies. A failure in any of these checks would cause 'isolation', which in this case merely removed the power from the pilot valves, allowing the control valves to 'freeze' at their last position.

In the event of a prolonged shut-down, the operators could take over the manual control of each valve, though this method was only applicable to this docile plant. The type of reversionary action varies with the plant and will be discussed in a later article.

It is perhaps worth noting that, at the time (1958) at which this equipment was conceived, it was not thought that program and data could be stored in a 'non-volatile' fashion in core storage. Accordingly, a form of permanent storage using ferrite pegs (see Fig. 12) was employed, together with a small core store for working space The relative inflexibility and cost of peg-board storage, together with improvements in core storage techniques which have now reached a high degree of sophistication, has rendered such permanent storage almost unnecessary.

Fig. 12. One of the ferrite peg-board stores used as a form of permanent storage in the computer



Other Features

As with life, so with computers, a form of Parkinson's Law is to be found, and a number of additional duties were given to the computer after installation. These included valve checking for leaks in the diaphragms, which if allowed to persist result in unstable control. Automatic control of the packing process was undertaken with considerable success by using a modified weighing machine, in which the weight was digitized and presented to the computer. By means of the rapid servo action it was possible to control weight to 1 oz in 1 cwt.

Experience

The conclusions to which I.C.I. came can be summarized as follows:

(1) That d.d.c. was at least as good as analogue control, that the plant was more firmly and gently controlled and that it recovered more rapidly from plant disturbance.
(2) Due to centralized display of information and precision control, the work of the operator was speeded up.
(3) That initial nervousness, which led to plant shut-down for what are now seen to be trivial reasons, was not justified.
(4) That the requisite reliability could be achieved. (An availability of 99·6% was achieved over 2 years, and of the 0·4% down time, roughly half was due to avoidable user errors and the remainder to electronic circuit faults. This availability, although not as high as would be wished for, was sufficiently encouraging to justify further d.d.c. systems).
(5) That although the economics of such a pilot scheme could not be used as a basis for future systems, nevertheless d.d.c. had arrived. (The company ordered a further six systems, five of which are now installed and working at various plants).

Conclusion

In December 1964, the Fleetwood plant was closed and the equipment was returned to Ferranti's works for modification and incorporation of improved features which experience had shown to be necessary. The equipment was re-installed in May 1965 at a large mid-Cheshire plant which produces a variety of products, including soda-ash. The computer has enabled the whole plant to be operated from a fully-centralized control room and will, in addition to its control tasks, be employed in the optimization of feed-stocks and heat-mass balances, as well as other work of an experimental nature.

Reference

Thompson, A. 'Operating Experience with Direct Digital Control'. *Proc. I.F.A.C./I.F.I.P. Conference*, Stockholm, 1964.

TOUCH-BUTTON SWITCHES

SWITCHES in industrial environments are often required to withstand rough treatment. The contacts of conventional mechanical switches can become damaged, corroded and coated with dirt during continual usage and the switch lever and housing can also be broken.

Contactless switches, with no moving parts whatsoever, which can be totally enclosed would reduce the chances of damage and would eliminate the problems of dirt and corrosion.

Such switches include photosensitive types and inductive and capacitive proximity switches. Another type which is finding application in industry is the 'electronic touch button' where all that is required to switch it on is that an operator should place his finger on or near a plate.

The touch button is based on a gas-filled discharge tube. A metal plate is fixed to the outside of the glass envelope in the vicinity of the discharge gap. When the tube fires, a red discharge glow is formed indicating that the tube is on.

The principle of operation can be described with reference to Fig. 1, supplied by Cerberus Ltd. of Switzerland. The d.c. voltage, V_{ht}, applied to the anode and cathode of the tube (in this example a Cerberus type GK11 tube) is about 200 V. An a.c. voltage generator, producing a voltage V_{st}, which is between 140 and 220 V, is connected between the cathode and earth. The anode-to-cathode voltage must be less than the firing voltage of the tube. Normally the tube does not conduct and the switch is off.

When the plate on the tube is touched, a capacitance, C, is introduced between the plate and earth. This provides a path for the alternating current introduced by V_{st}. This current will flow through the tube to produce sufficient ionization of the gas to cause the tube to 'fire' and conduct. The tube will continue to conduct when C has been removed from the plate.

To extinguish the tube and to turn the switch off, the anode voltage must be momentarily reduced to a value below that of the maintaining voltage (the voltage required to sustain conduction). Fig. 2 shows a simple experimental circuit where the tube is switched off merely by the supply voltage being removed by a push-button switch. The potentiometer, R_v, can be used to adjust V_{st} and vary the sensitivity of the unit.

The value of V_{st} required will be governed by the value of C which will be used to fire the tube. The graph in Fig. 3 illustrates this. From this graph it can be seen that a value for C equal to or greater than 5 pF is the most convenient. Practical experience has shown that the capacitances most frequently met are in excess of 5 pF even when the operator is wearing gloves.

The anode current produced is of the order of 10 mA which is adequate for the operation of relays and other devices.

A more practical circuit is that shown in Fig. 4. Here the tube will only conduct while the plate is touched. Rectified but unsmoothed half cycles of a.c. voltage are applied to the anode. With C connected to the plate, the tube will be fired and extinguished during each half cycle. Once C is removed, the tube will no longer be fired.

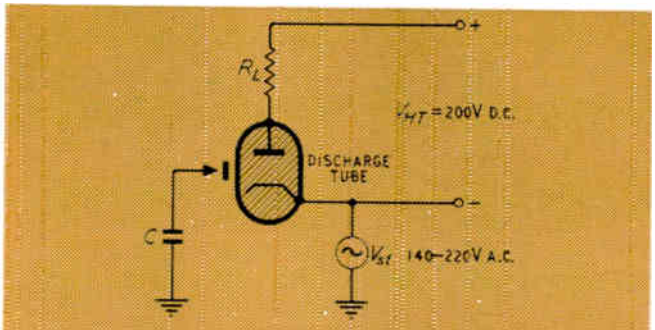


Fig. 1. Diagram depicting the operation of the electronic touch-button

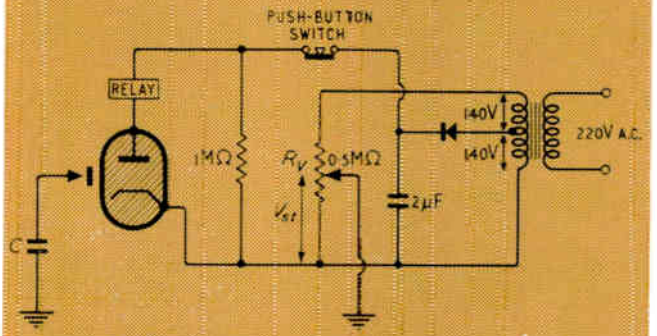


Fig. 2. A simple experimental on-off switch using an electronic touch-button

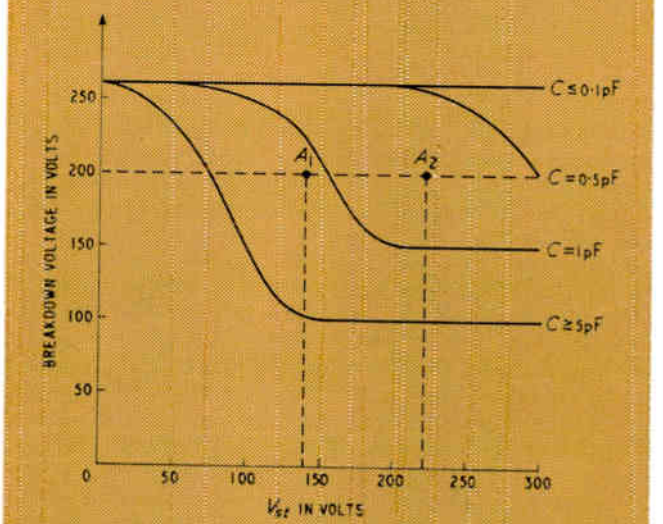
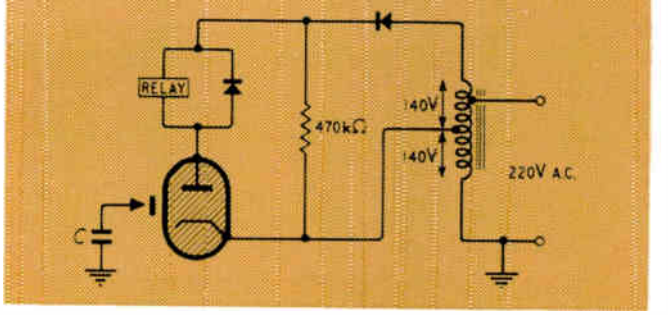


Fig. 3. This shows a family of curves for the GK11 touch-button. A_1 and A_2 are the minimum and maximum values of V_{st}. From this it can be seen that the breakdown voltage is less for higher values of C and that for these higher values a lower V_{st} can be used

Fig. 4. The circuit diagram of a touch-button unit where the switch remains on only while the button is being touched



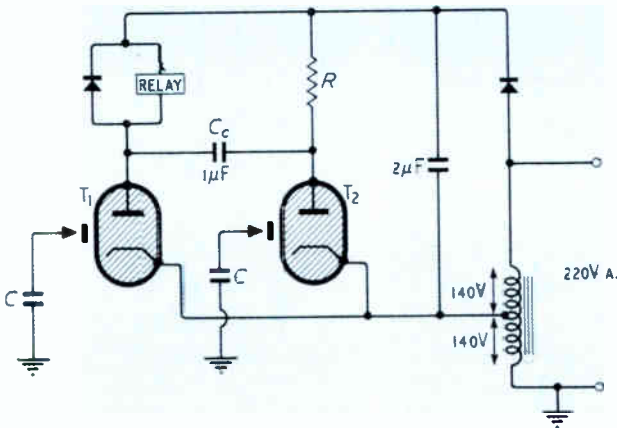


Fig. 5. (Left) A flip-flop type of circuit using two touch-buttons

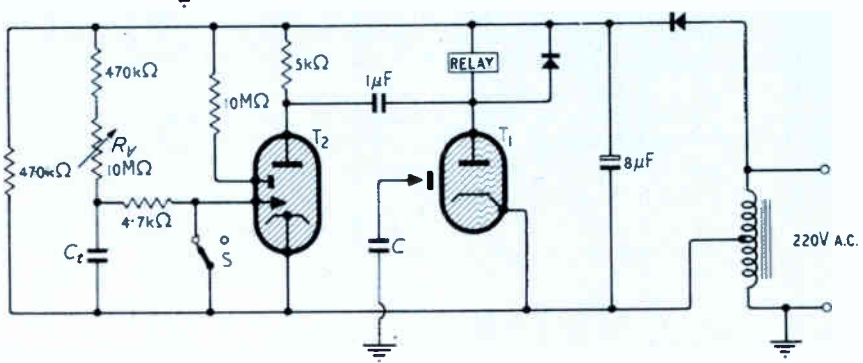


Fig. 6. (Right) A time delay relay circuit using one touch-button and one cold-cathode discharge tube

A flip-flop type of circuit utilizing two tubes, one to turn the switch on and the other to turn it off, is shown in Fig. 5. In its initial state neither of the tubes conduct and coupling capacitor, C_c, is uncharged. If the plate on T_2 is touched, this tube will fire and a current will be drawn through R and through C_c and the relay. C_c will be charged up with the left-hand plate (on the T_1 side) positive. Initially the current through the relay will be high but as the charging time constant of C_c is small the duration of the current through the relay will be too short to operate it. The relay current will cease when C_c is fully charged. When the plate on T_1 is touched, the tube will fire and conduct via C_c and R in series and via the relay. C_c will now start to discharge via R. This will increase the voltage drop across R, reducing the anode voltage of T_2 to turn it off. Eventually the discharge current falls so that the current drawn by T_1 will flow only through the relay and operate it. C_c will by then be charged up with its right-hand plate positive. When T_2 is touched and fired, current will be drawn through C_c and the relay and through R. C_c will discharge and the voltage drop across the relay will be increased. The anode potential of T_1 will fall to cut the tube off.

Time-Delayed Switching

A further example of a circuit incorporating the electronic touch-button switch is shown in Fig. 6. This is a time delay relay circuit using a cold-cathode relay tube, T_2. When T_2 is conducting, T_1, the touch button, is cut off. T_1 is touched and fired and T_2 is cut off in a manner similar to the operation of the circuit in Fig. 5. The capacitor C_t is charged up until the potential at the starting electrode of T_2 has risen to a value sufficient for it to fire the tube. As T_2 goes into conduction, T_1 is cut off. The time taken for the capacitor to charge up to the required value is determined by the value of C_t and the total value of resistance in the charging circuit of C_t. As T_1 comes on, the relay contact marked S closes to form a discharge path for C_t. In this circuit, R_v can be adjusted to vary the charging resistance, and therefore the time constant, of C_t. A delay range of 1 :10 is provided by this adjustment.

Modern Methods for Machining Metal

The latest ways of machining metal will be shown in a series of five programmes for engineers, 'Clean Cut', which starts on BBC-1 on Sunday morning, October 2 (repeated the following evening). The aim is to show how old techniques and new ideas can be used to produce greater efficiency and to save money.

The final programme will show various money saving ways of short circuiting the traditional way of using cutting tools. The following week the subject will be cutting holes and will include advice on improving the performance of the conventional drill. On Sunday, October 16, the programme will be about numerical control and will show how savings of 80% or more can be produced by the use of automatic sequencing machines and tape controlled machines. The final programme will show various techniques of cutting without contact and how they are being used and developed in industry today. The series is produced by Michael Garrod.

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For further information circle 253 on Service Card

Designed particularly for use in amplifiers where linearity must be maintained down to low current levels, these five Mullard '1 amp' n-p-n double-diffused silicon planar transistors have linear gain/current characteristics and high collector/base voltage ratings (75V for the 2N1613 and 2N1711). High cut-off frequency and low collector/base capacitance also make them suitable for industrial high current switching applications.
All five transistors, together with the Mullard BFY50 series, provide extensive performance coverage in applications where 1 amp current ratings are required. They are available for quick delivery at very competitive prices. Encapsulation is TO-5.
Here are brief specifications.

	2N696	2N697	2N1420	2N1613	2N1711
V_{CBO}	60V	60V	60V	75V	75V
P_{tot}	600mW	600mW	600mW	800mW	800mW
$T_j$max	175 C	175 C	175 C	200 C	200 C
h_{FE} (150mA)	20–60	40–120	100–300	40–120	100–300
f_T	40Mc/s	50Mc/s	50Mc/s	60Mc/s	60Mc/s
C_{ob}max	35pF	35pF	35pF	25pF	25pF

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

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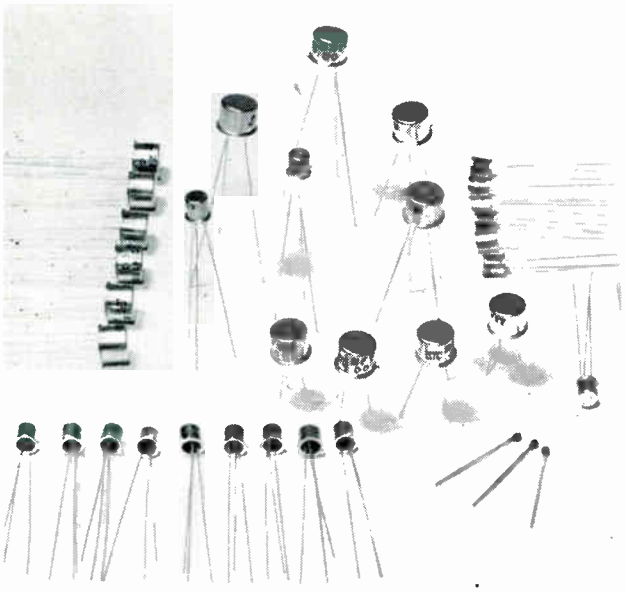
MD 56

For further information circle 255 on Service Card

STC SEMICONDUCTOR REVIEW

SEPTEMBER, 1966



Low power transistors

Low Frequency General Purpose Amplifiers
The BSY78 is a high voltage general purpose amplifier and switch having a maximum collector dissipation rating of 230mW. It is well suited for use in D-C amplifiers and the isolated case facilitates the mounting of BSY78 pairs in a common heat sink.
For low-noise amplifiers the 2N929 and 2N930 are recommended.

General Purpose Amplifiers/Low Speed Switches
For medium level amplification at frequencies up to tens of MHz the BCY42 and BCY43 transistors are particularly recommended. These transistors can also be used in most chopper applications. Of special note here is the low (2:1) gain spread at 1mA.

Switching Transistors
The BSY95A has earned itself the reputation of a well-designed reliable, general purpose medium to high speed switching transistor. It heads a long list of switching transistors which are now available from S.T.C. Semiconductors, including the popular 2N708. A recent addition to the range is the 2N2369 which is a high gain, very high speed switch.

High Current and High Voltage Transistors
The BSY79 is a high voltage device particularly suitable as a driver for numerical indicator tubes.
For relay switching, recommended types are BSY83 to BSY86. Of the JEDEC types the 2N1613, 2N1711 and 2N1893 are ideal high voltage amplifiers.
The BSX22/23 are intended for high current amplification and switching, i.e. to more than 1·5A; in addition the BSX23 has a V_{CE} rating of 65V and is often used in waveform generator output circuits.

High power transistors

The STC range of silicon semiconductors covers frequencies up to at least 400MHz. They are suitable for medium and high power amplification of all types of signals including A.M. and S.S.B. C.W. Power outputs range from 1W to 50W; in the extreme, 20W output can be achieved typically at 400MHz with the 3TE440.
The range of devices includes JEDEC and Pro-Electron types and the standard range of "3TE" types. Encapulations include TO-3, TO-39 and TO-5, strip-line and stud-mounted packages.
Strip-line packages are used on the higher frequency devices, providing greatest bandwidth, power gain and lower output. Most types have the emitter connected to the case thereby minimizing internal lead inductances to give very high power gain and maximum bandwidth, and to facilitate the mounting of the heat sink. Supply voltages of up to 40V can be used with many types; certain types have been designed to operate at 18V and below, e.g. 3TE350.
The highest power transistors within the range employ resistor stabilisation which results in increased output power, increased power gain, and lower intermodulation products in single side band operation. They can be biased in class AB without an external emitter resistor.

For full details of all STC Semiconductor products write, phone or telex

S.T.C. Semiconductors Limited

Footscray, Sidcup, Kent.
Telephone: FOOtscray 3333. Telex: 21836.

STC SEMICONDUCTORS

For further information circle 256 on Service Card

Applications and Techniques

Metal-Sealing Process

A new sealing process, developed by Impco Inc. and available through Huco Engineering Industries Ltd., has been introduced for the impregnation of porous castings with both ferrous and non-ferrous metals.

The technique employs a solvent-free impregnant (contact-cured by immersion in hot oil) which gives a 100% fill and eliminates the 'bleed-out' or exudation that is common during oven-type curing. After curing, there is no visible trace of the impregnant, which is resistant to operating temperatures ranging from −54 to +175 °C; the impregnant is also unaffected by fuels, oils, alcohols, glycols, solvents, salts and mild acids.

The process is equally suitable for sintered products, both as a corrosion preventative in ferrous sinterings and as a pre-plating treatment for all materials; one particular application of it is in the prevention of corrosion and blistering of electro-plated components.

For further information circle 49 on Service Card

Automatic Bank-Note Dispensing

An automatic machine for the payment of bank notes has been developed by Telefunken in co-operation with Ostertag Werke A.G. in W. Germany.

An identification token and a punched card (similar to the kind used for feeding information into a computer) are all that a bank customer requires to draw a 100-mark note from the machine, which is 'open' twenty-four hours a day.

Electronic equipment first of all compares the punched card with the identification token, checking both for validity, and then delivers the note. Only one note per customer may be drawn each day, and the machine cannot be defrauded.

The customer's identification token and his punched card are inserted into the appropriate openings, whereupon the machine delivers a 100-mark note

Turbine-Blade Testing

A new technique for measuring stress, strain and vibration in power turbine blades—it may also be used in jet aircraft engines—has been developed at the Central Electricity Research Laboratories in Leatherhead, Surrey. The system uses transducers attached to turbine blades rotating at 3,000 r.p.m., their signals being transmitted by radio frequencies. Receivers are used to pick up the transmitted signals and recorders record a second-by-second account detailing exactly how the blades perform under operating conditions.

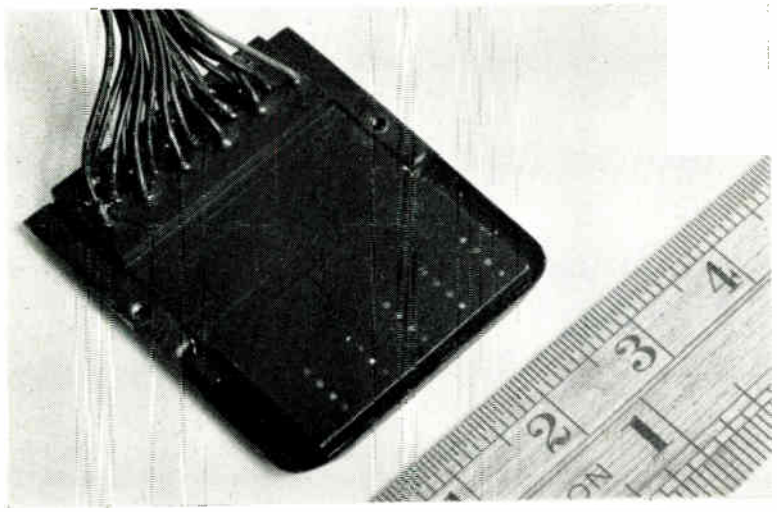
With other systems in use up till now, it has been necessary to drill holes in the turbine blades to accommodate signal leads, but this has had the disadvantage of modifying the blade behaviour so that it was impossible to obtain a completely clear picture of what happened under normal working conditions. Furthermore, these older methods employed slip-rings and brushes to make the electrical connections, such arrangements functioning unsatisfactorily at very high speeds and under the severe environmental conditions obtaining inside a turbine.

The biggest problem which has been overcome was to make the components capable of working under a continuous centrifugal pull of 7,000 *g* and at temperatures up to 150 °C. A prototype system has shown that at least 2,300 hours' successful operation is possible.

Coded Film Marking

In industrial photography, it is often necessary to record additional information on the film during exposure. Such information can be digitally encoded and then marked on the edge of the film by an array of small lamps, neon lamps or cathode-ray tubes normally being used for this purpose. But these operate from a relatively high voltage (the former having a limited operating speed) and both require complex optical systems to produce an image on the film.

To overcome these disadvantages, Ferranti have introduced a range of gallium-phosphide (GaP) lamps, which are more reliable and are physically small enough to be used in contact with the film. The film is marked with 1-msec pulses to maintain record legibility, and films of a wide range of speeds may be marked with an adequate density for visual or mechanical readout. Also, due to the greater packaging density possible with GaP lamps, a greater



A typical film-marking array, using 20 gallium-phosphide lamps manufactured by Ferranti Ltd. Using conventional mounting techniques, a packaging density of 900 lamps/sq. in. is possible

amount of information may be put on the film either by circular, rectangular or bar-code marking.

In GaP lamps, light emission is obtained from a p-n junction prepared in the crystal by diffusion or alloying techniques. When a p-n junction is biased in the forward direction, electrons cross from the n-region into the p-region, where they combine with holes; the reverse also happens, since holes are able to cross into the n-region and combine with electrons. This re-combination energy is given up as light and heat in the case of the GaP lamp, which has the advantage that visible light of various wavelengths may be obtained from the crystal by doping with various selected impurities.

For further information circle 50 on Service Card

Dye Kettle Rate-of-Boil Control

Of particular interest in atmospheric dyeing applications, a measurement and control system for maintaining a constant and repeatable rate-of-boil in closed dye kettles has been developed by Foxboro-Yoxall Ltd. Precise control (sensitive to temperature changes as low as 0·01 °F) prevents boiling over and, since it is no longer necessary to observe the boil, dye-kettle doors and exhaust dampers may be closed during the boiling period.

Boiling rate is a function of both temperature and atmospheric pressure, and the Foxboro system uses a differential measuring instrument which takes both variables into account. One side of a differential-pressure transmitter is connected to a sensing bulb filled with a material having a vapour-pressure curve similar to the contents of the vessel in which the bulb is immersed; the other side is left open to kettle pressure at a point above the liquor. The differential transmitter compares the vapour pressure in the sensing bulb (produced by the dye-liquor temperature) with that of the liquor, the end result being a measure of the rate of boiling.

Once the boiling temperature is reached, the measurement signal is transmitted to a pneumatic controller, which balances the signal against its set-point signal for the desired boil rate. The controller's output then throttles a control valve in the steam line to maintain precisely the set rate of boil.

For further information circle 51 on Service Card

Electronic Type Composition

An electronic type-composition system (the Videocomp, model 70/820), which is capable of setting the entire text for a newspaper page in two minutes through the use of video and computer techniques, has been introduced by the Radio Corporation of America.

Employing electronic character generation, the 'metal-less' typesetter uses a computer memory to store up to four different type fonts, ranging in size from 5 to 24 pts. Original copy is fed into the computer, which hyphenates and justifies the text and produces an output tape; this is then read electronically by the Videocomp, which calls from the memory the characters of the desired font and size.

Under program control, it generates text at rates of up to 600 characters per sec, writing it with an electron beam on to the face of a high-resolution cathode-ray tube. The characters on the tube are exposed (through a precision lens) directly on to sensitized film or paper for subsequent printing by offset litho, letterpress or gravure processes.

For further information circle 52 on Service Card

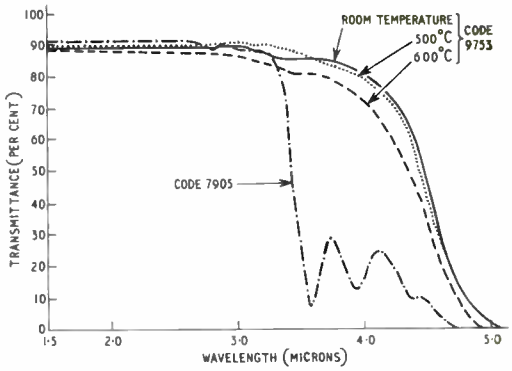
Infrared-Transmitting Glass

A new glass (Cortran Code 9753) that has a wide range of infrared transmittance has recently been introduced by Corning Glass.

Most glasses transmit infrared light up to a wavelength of about 2·7 microns, but the Code 9753 will transmit 82% of infrared energy at 4 microns (see graph). Transmittance at shorter wavelengths is essentially the same down to about 400 millimicrons, and sharp cut-offs occur at each end of the transmission band.

The material, which has good corrosion resistance and mechanical strength, is expected to find many applications as infrared-transmitting filters and in optical instrumentation.

For further information circle 53 on Service Card



These infrared-transmittance curves for Cortran Code 9753 indicate the small effect of elevated temperatures in the long infrared region. The Code-7905 curve shows how previous infrared glasses compare with the new material

Datum-Centre Locator

A battery-powered instrument for locating datum centres with absolute accuracy has been developed for use on jig borers by Watton Electronics Ltd. Known as the OB Centre Locator, it incorporates a non-contact method of transferring an electrical signal from a rotating gauge to a stationary meter.

The 2½-lb OB Centre Locator which, when mounted by its ½-in. diameter paralleled shank in a drill chuck or collett, will gauge internal and external diameters ranging from $\frac{3}{32}$ to 6 in.

A continuous reading of out-of-true position is indicated on a forward facing meter (see picture), which remains stationary as the jig borer spindle rotates. The stylus of the adjustable-radius instrument rotates around the workpiece to sense out-of-true, and the signal from this is amplified and passed to a meter where it causes the pointer to deflect in a pendulum movement. By adjusting the traverse and cross-traverse controls to bring this movement to a minimum, the operator knows that he has found the best average centre between the machine spindle and the diameter being located.

Errors arising from spindle drive torque, oil-film build-up and operator hand pressure are eliminated, and friction-free gauge suspension, the absence of slip rings and leads and a clutch-protected stylus ensure complete reliability.

For further information circle 54 on Service Card

Automatic Control of Acid Concentration

The efficient operation of continuous-coil pickle lines necessitates a constant and accurate knowledge of acid concentration. Optimum efficiency is difficult to achieve by periodic manual analysis, but Honeywell Controls Ltd. have now introduced a system for controlling acid concentration automatically. Developed and applied in collaboration with a leading U.S. steel manufacturer, the system continuously monitors the density and iron concentration of pickle liquor, from which parameters the acid concentration is continuously computed.

The control system is equally applicable to sulphuric-acid and hydrochloric-acid pickling, and operates by continually sampling acid from the final pickling tank and passing it through a colorimeter and a Honeywell density transmitter.

The colorimeter measures the iron concentration, which is kept at the required level by regulating the water addition with an electronic recorder/controller. A two-pen recorder, with control of one pen, records the density and acid concentration by regulating the flow of acid to the tank; this flow is then recorded and integrated.

For further information circle 55 on Service Card

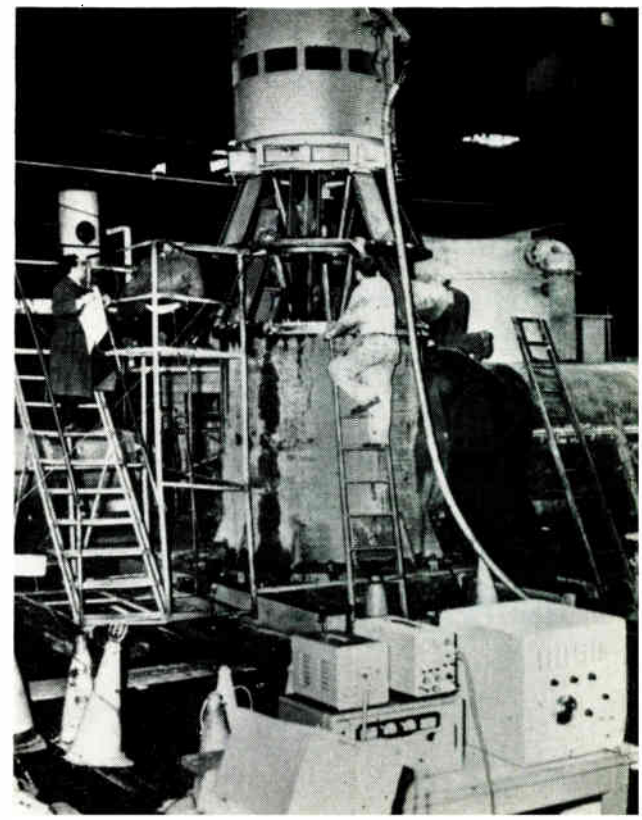
Speed-Reducer Efficiency Measurement

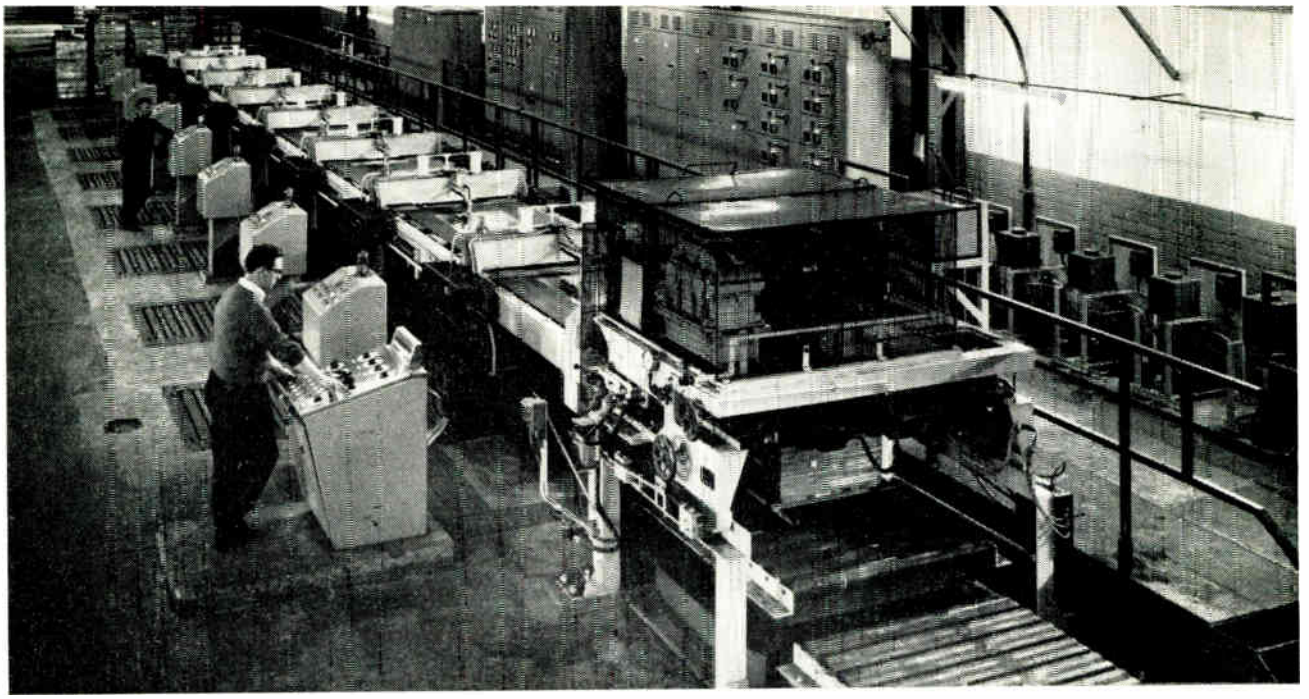
The problem of how to measure the efficiency of gear-train speed reducers operating between a high-speed power source (such as an electric motor) and a low-speed load (such as a ball-crushing mill) is yet another which can profitably be solved using radio-telemetry techniques.

The Philadelphia Gear Corp., employing equipment supplied by Industrial Electronetics Corp., of Florida, has been applying the method in assessing the efficiency of their speed reducers. Radio telemetry transmitters, operating from strain gauges on the input shaft and output shaft, simultaneously transmit torque readings to stationary indicators. A tachometer on the input shaft gives the r.p.m. of both input and output shafts, and from these readings horsepower is readily calculated.

For further information circle 56 on Service Card

Radio telemetry being used by the Philadelphia Gear Corp. to measure the efficiency of their speed reducers. The telemetry transmitters are easily installed and removed, and may be used in areas with dirty and corrosive environments



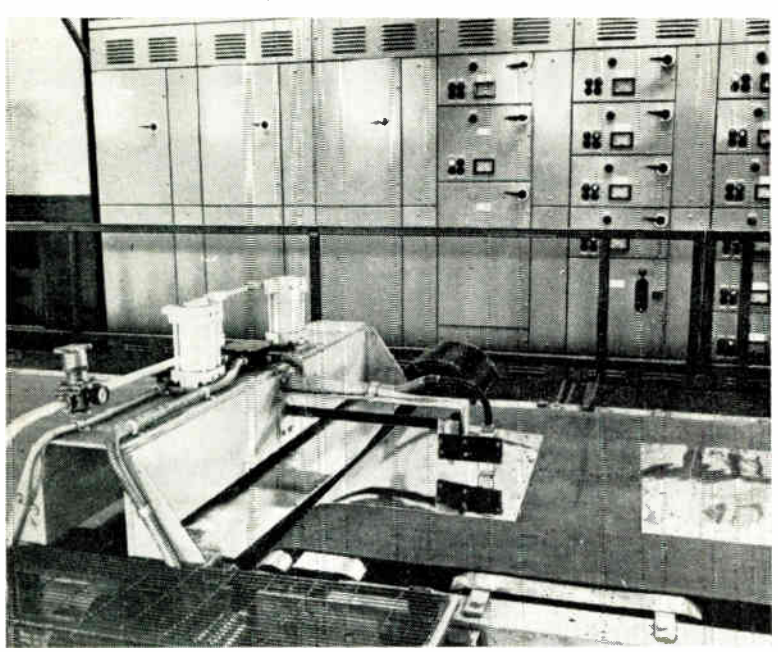


Static-Switching Equipment for Sheet-Steel Classification

THE G.E.C. Engineering Group has supplied the Steel Company of Wales Ltd. with an automatic static-switching system for sorting tinplate of mixed gauges into piles of pre-selected thickness ranges.

The sheets are loaded on to a conveyor line in batches of approximately one ton, and on entering the line the thickness of each sheet is measured by a β-ray gauge. This gauge feeds signals into the static-switching system, which operates selection gates so that the sheets are sorted into eight piles. When the pile at any of the eight grading points is complete, the line is stopped automatically and an alarm is given so that the sorted pile can be removed.

Part of the sheet-steel classifying line at S.C.O.W's R.T. Mills Works in Llanelli, Carmarthenshire. The line functions automatically at speeds of up to 400 ft per min, and here a sheet is shown entering one of the selection gates



The system uses logic elements for controlling the various gate-solenoid and pile-counter operations, and a display system indicates the passage of the sheets along the line and the operation of the gate solenoids. Further displays show the states of all the relevant logic elements.

The output signal from the β-ray gauge is linearized and then amplified by gauge-selection amplifiers whose gain is controlled by set-up switches; these are calibrated in units of sheet thickness over the range 0·003 to 0·03 in.

The time when the sheet is positioned correctly under the β-ray gauge (i.e., the 'read' time for the logic store system) is determined by logic NOR elements operated from photocell detectors. After passing under the gauge head, the spaced sheets are transported along a number of conveyor belts; each of these is equipped with a gate that diverts a sheet on to a pile in one section or passes it on to the next one, according to the coded information of sheet gauge previously determined on the first unit.

As each sheet is fed into a conveyor section, the code information of the gauge for that sheet is fed into a store which is updated according to the number of sheets fed into its particular section. A proximity-detector unit signals when the first sheet reaches the end of the conveyor section and selects the highest updated code. Logic units then determine the operating conditions for the gate to accept or pass the sheet, and once this information is obtained the code store down-dates for the next sheet.

Logic signals are programmed to ensure that the gates operate only for a change of information. Successive sheets of the same gauge are therefore diverted by the gate for only one initial gate operation, thus minimizing wear and tear on the gate-linkage system. Each sheet passing down the gate to a pile must, however, produce a signal for the pile counter, and this signal is obtained from the logic equipment without the need for extra detectors. When a pile is complete, the line is automatically stopped and an alarm is signalled to the operator; after removal of the sorted pile, the line-run speed controls are reset and the classification continues.

A SOLID STATE SWITCHING MODULE

By D. S. NICHOLLS*

This article is written as an introduction to solid-state switching. Although it deals briefly with most of the basic switching and logic circuits which are now being used in control systems in industry, its main object is to stress the simplicity of one widely used principle of switching. The article shows that complex control of switching systems can be built up by interconnecting a number of standard switching modules. Examples of a number of systems are given.

SOLID-STATE switching techniques are now firmly established in most industrial control situations and are rapidly becoming commonplace in several large manufacturing organizations.

Many of the switching elements used incorporate semiconductor devices such as transistors, diodes and thyristors and as a result there is evidence that some potential users are deterred by a belief that this necessitates highly-specialized electronic staff for designing, installing and maintaining such systems.

There is obviously no substitute for a properly-trained specialist for dealing with the most complex problems which can arise in any control scheme, but these situations are relatively rare and in general the majority of industrial control problems can be confidently handled by the technician who has an appreciation of the principles involved for any particular control method.

This article is an attempt to stress the basic simplicity of at least one widely used principle of solid-state or so called static-control systems now finding favour in many modern plants. While the elementary approach used may require tolerance by some, it is hoped this may still be of value to those readers who are perhaps themselves faced with the task of imparting similar knowledge to other engineers who at present have a predominantly electrical background.

Control-System Requirements

It is reasonable to divide any control system broadly into three sections, namely, command information or input—decision routing or logic—action or output.

The command or information sources usually necessitate some form of mechanical/electrical converter between the operation and logic system and typically consist of such items as push buttons, selector switches or transducers of various types depending on the operating medium required.

Similarly, action depends on some form of output conversion device such as a solenoid, a heater, or a motor.

The part of a control system linking these two extremes represents the major portion of any scheme to which solid-state logic components can be readily applied.

Industrial controls frequently require complex sequences and actions to be performed by commands initiated from very simple actuators suitably arranged with interlocks and proofs so that malfunction due to wrong selection is virtually eliminated. This has resulted in the need for large numbers of electromechanical devices to achieve the required programme, determined by the system logic. With present trends to maximum 'automation' of machines and processes a vast number of switching operations become necessary and can be performed by relays, uniselectors or similar units.

Justification for Static Switching

Present day electromagnetic devices have reached a high state of perfection and a life expectancy is commonly predicted as in excess of 10 million operations. The failure rate with such switching units tends, however, to increase with operating frequency and there is in any case a limit to the maximum practical speed of operation due to mechanical inertia and similar factors.

With maximum output mass-production lines or machines, the failure of control elements becomes a very serious cost factor in terms of system down time. This situation can frequently be equally true for both a large or small system. As an example, a section of an integrated production line for motor vehicles could fail and result in an effective loss of output in the order of one finished engine for every minute this section was inoperative.

There are many small industries which rely on a limited number of high-production automatic-injection moulding machines for making small plastic component parts. If two such machines are producing one particular item at a rate of thousands per hour, failure obviously results in a 50% reduction of output with cost implications which can be very significant.

Another case where cost is not so evident but the service factor is of prime importance, is the modern automatic high speed passenger lift control systems. These are increasingly commonplace in hotels, offices and multi-storey buildings of many kinds.

In each of these cases it is evident that a most important factor is that of consistent reliability and it is this which may be considered a particular virtue of solid-state switching devices.

Non-moving (i.e., static) switching elements have been used in various different forms in the past, but it is availability of the semiconductor transistor and diode at low cost which has now resulted in an upsurge in the use of these devices for present industrial switching control.

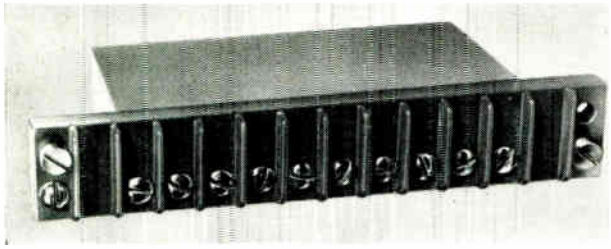
These components have now been packaged by a variety of different manufacturers into small enclosed modules, each of which is internally connected to produce certain well established control switching functions.

The logic section of a control system exploits several clearly defined functions of which probably the most commonly recognized are defined AND-OR-NOT-MEMORY. These are of course just literal statements of various logic conditions, for example: An apparatus may operate when power is available, 'AND' a starting command has been given, 'OR' continue to operate if the running condition is 'MEMORIZED' but must be inhibited or 'NOT' operate if stopping command is present.

Many people are familiar with the way these situations are satisfied by series and parallel contact arrangements using electromagnetic relays and some solid-state devices are available which each separately perform any of these individual logic operations.

An extremely versatile and basically simple module is now very widely used by many systems manufacturers and exploits the NOT OR or as it is more generally termed the NOR switching principle.

* MTE Control Gear Ltd.



This illustrates one of the standard NOR switching modules

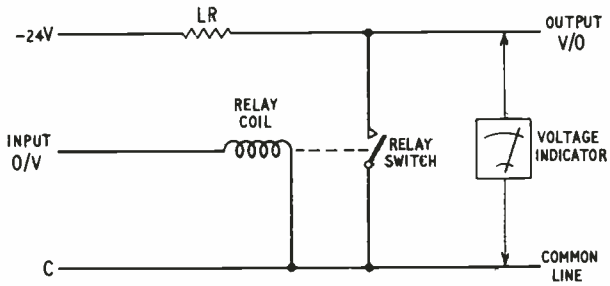


Fig. 1. Here an electrical analogy shows the function of a NOR switch. With zero input, between the input socket and common line, there is full voltage at the output terminals. With an input voltage sufficiently high to energize the relay the output is shorted and there is zero output

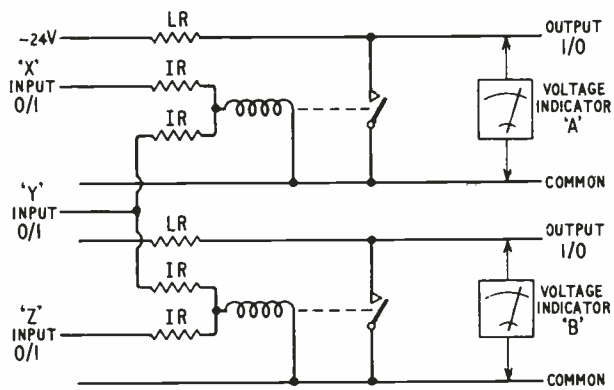
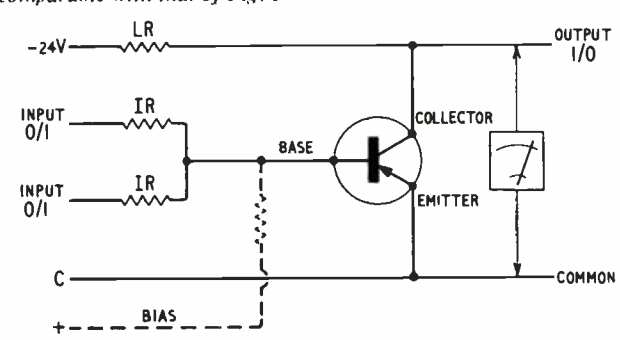


Fig. 2. This shows two circuits of Fig. 1 with modifications. There are three inputs, X, Y and Z. By selecting the value of resistors IR, an input signal at X will change only the output condition at 'A', and an input signal at Z will change only the output condition at 'B', whereas an input signal at 'Y' will change the output conditions at both 'A' and 'B'

Fig. 3. This circuit is the same as that in Fig. 1, but the relay has been replaced by a switching transistor. The operation is comparable with that of Fig. 1



Physically these are presented in a variety of different forms and one example is shown in the illustration. The particular advantages of this assembly are small size coupled with the facility to perform all of the logic functions noted with the one transistor resistor circuit arrangement which results in an extremely economic device.

The NOR Switching Principle

Electrical analogies may be used to emphasize the operating features of this type of unit and if reference is now made to Fig. 1, it will be apparent that components arranged as shown will result in a voltage being indicated by the instrument between the point designated 'output' and 'common line'. This condition can be designated 'V' while the input as shown can be designated '0'.

If the input connection to the relay is now connected to a voltage source, and this can conveniently be the −24 V point, it will result in energization of the relay causing the switch contact to shunt or by-pass the output point. The result is no significant instrument deflection; that is, the output has been taken to a '0' condition. It may be noted in fact that the output condition is an electrical inversion of the input condition.

Proceeding to Fig. 2 it can be seen that this is a duplication of the first diagram with minor changes added. In particular these changes are the addition of input resistors IR and a change in the symbols used for input and output conditions; i.e., the digits 0/1–1/0 have been substituted for 0/V–V/0. This latter can be justified since in general the magnitude of voltage 'V' is not important for logical considerations as we are only concerned with a definite two-state change; i.e., on/off, output/no output. If input resistors are selected which just permit energization of the relay when *one only* is in series with the coil, it will be seen that input marked 'X' taken to −24 V line will cause an output change only at position A. (Relay coil B will not be energized since three resistors are in series with input 'X'.)

In a similar manner input marked 'Z' connected to −24 V while input marked 'X' is left open, will cause an output change only at position B.

If both inputs 'X' and 'Z' are left open and input 'Y' is instead taken to −24 this will cause both 'A' and 'B' outputs to change since obviously in each case one series resistor only is again involved in the coil connection to −24 V. This analogy should indicate how individual inputs can be effectively isolated from each other on a current-proportioning basis and this principle can be used to avoid the risk of feedback operation through commonly intercoupled circuits.

If consideration is now given to Fig. 3 where the relay is now replaced by a transistor, it will be apparent that this circuit will function in a manner comparable with the relay arrangement in Fig. 1. Since the p-n-p type resistor illustrated is basically a current amplifier, a relatively high current will flow between the emitter–collector connections when the base is held negative relative to the common or emitter line. With suitably selected components negligible voltage drop will be observed across output of the device when either input is connected to the −24-V line. This, of course, results from the apparent very low-impedance condition which exists between the output collector connection) and common (emitter connection) when the device is bottomed or effectively is passing the maximum amount of current permitted by the resistor LR.

As this same type of transistor with the base held positive will present an apparent high impedance between collector and emitter due to conduction being cut off, these two states may be compared with the shunt or open circuit conditions

already considered in Fig. 1. In practice it is necessary to ensure the base is in a positive condition when no significant negative potential is applied to any input by means of the additional bias resistor connection shown dotted and coupled to a positive 24-V potential.

Examination now of Fig. 4 shows the complete internal circuit of the six input NOR TR/R logic elements shown in an illustration. In practice the number of actual input isolating resistors used is generally dependant on the mechanical considerations of the method of housing various components involved, six being a fairly common upper limit. Also illustrated in this diagram is a typical symbol that is used to represent the NOR logic function, where the lines terminating with an arrow are the input connections and the single line without the arrow head at periphery of circle is the output connection. In practice it is not normal to show the + — and common power connections since these are always assumed to be present unless otherwise specifically noted. The characteristic operation of a NOR unit may be summarized as follows: A voltage will appear on the output lead only when there is no voltage applied to any input; i.e., 'V' output when there is neither voltage on input 1 NOR input 2 NOR input 3, etc. Conversely if there is a voltage present on any input there will be no voltage at the output, all conditions being relative to common line.

Consideration of Fig. 5 indicates how these single NOR devices may be coupled to produce the equivalent of OR AND and MEMORY functions. Although the inverter function is also included, since this is the effect of using one input and output connection only, in practice such units become redundant in a comprehensive control diagram. Inspection of the OR AND groups show that if two such groups follow one another, this results in sequential connection of two units which perform only an inverting function. Clearly a double inversion of any condition is unnecessary and introduction of such items can be avoided if the following rules are borne in mind.

1. Inputs and outputs of NOR devices designated OR and AND respectively are complementary.
2. A single NOR element designated OR is in a 'GO' condition when the output is '0', alternatively any input is '1'.
3. A single NOR element designated AND is in a 'GO' condition when output is '1' or all inputs are '0'.

The memory function illustrates the obsolescence of inverters and also indicates how a NOT function is introduced on the last element to provide a master inhibiting action (a '1' must hold the output in a '0' condition).

Fig. 6 shows a small section of a typical circuit and emphasizes the elimination of inverters in normal interconnected functions. In practice a comprehensive modern control system employs a considerable variety of different combinations of these logic functions and necessitates large numbers of such blocks in some form of dust protecting enclosure. An illustration indicates the panel layout of the system used for controlling an automatic machine tool. Comprehensive control also necessitates the use of subsidiary devices to convert the logic power levels to a magnitude suitable for handling external power requirements. A variety of accessories are available which are fully compatible with the NOR switching levels and permit loads either a.c. or d.c. in the range of 3 W to 3½ kW to be comfortably handled. Technically any specified load can be switched but above about 5 kVA there is usually a significant economic limiting factor.

Various types of input switching device may be used such as any of the standard range of industrial contact type pushbuttons, limit switches, selector switches, etc., providing a suitable filter converter is employed to permit external

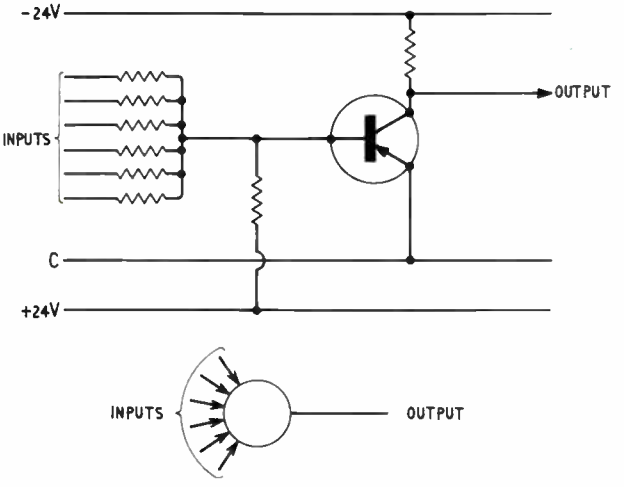


Fig. 4. The complete circuit diagram and schematic symbol of a six-input NOR logic element are given here

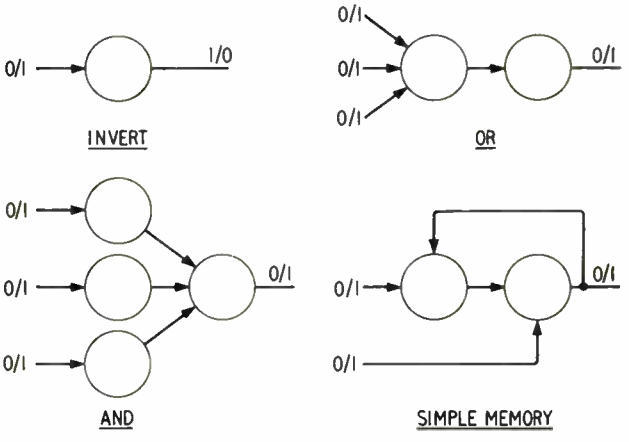
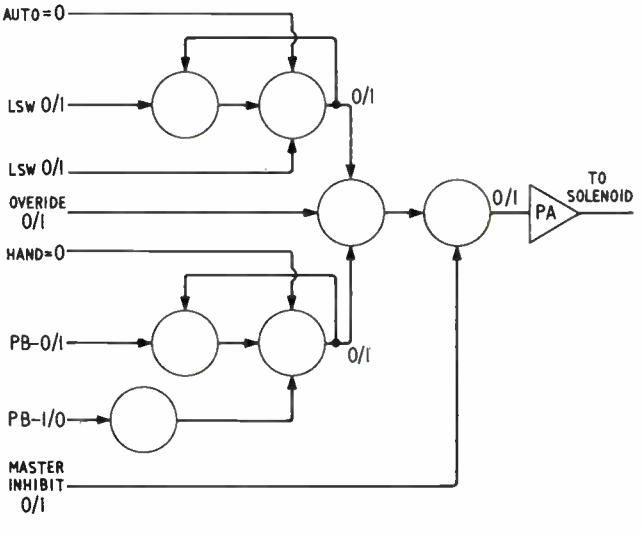
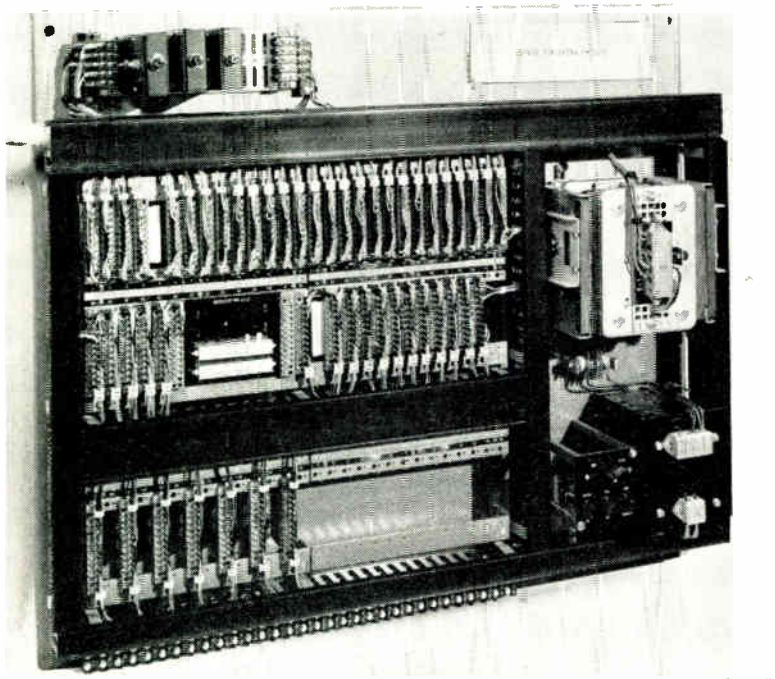


Fig. 5. By interconnecting two or more NOR elements other logic functions can be obtained. These four diagrams show examples of this technique

Fig. 6. Shown here is a small section of a typical circuit for the control of automatic machine tools





This picture illustrates the layout of a control system for an automatic machine tool using a number of standard modules

switching at about 100 V and eliminate the risk of oxide films causing contact unreliability. Equally suitable are the long-life sealed contact devices such as vacuum switches, mercury switches, reed switches, etc. The latter now offers an attractively-priced long-life assembly compatible with the overall system reliability.

If solid-state input devices are required, a large variety of proximity switches are now available and permit the construction of an all static switching system. These proximity switches vary considerably in price depending on: features required; i.e., if sensed material is ferrous, non-ferrous, non-metallic, or sensing accuracy, repeat accuracy, etc.

Various methods of construction can be employed and the modules are very tolerant in respect of mounting attitude and most environmental situations. The principle precautions necessary in assembly are due to the high switching speed of individual units making it necessary to ensure that unwanted signals such as electrical interference are not accidentally introduced into the system.

Although every system is designed to suit the specific requirements of the control problem, many differing situations have comparable features, with the result that a number of semi-standard circuit patterns tend to emerge and appear in many schemes.

Examples are: counting circuits using either ring counter arrangements or binary stages; sequential system based on either a counting system or series of programming proofs; oscillating or pulse generating circuits based on the use of *CR* time delays and capacitive coupling; scanning and coincidence circuits based on interrogation and comparison of simultaneous information.

All of the foregoing and similar techniques in addition to normal AND/OR logic are readily achieved using the standard 'NOR' logic element with an absolute minimum of additional accessories.

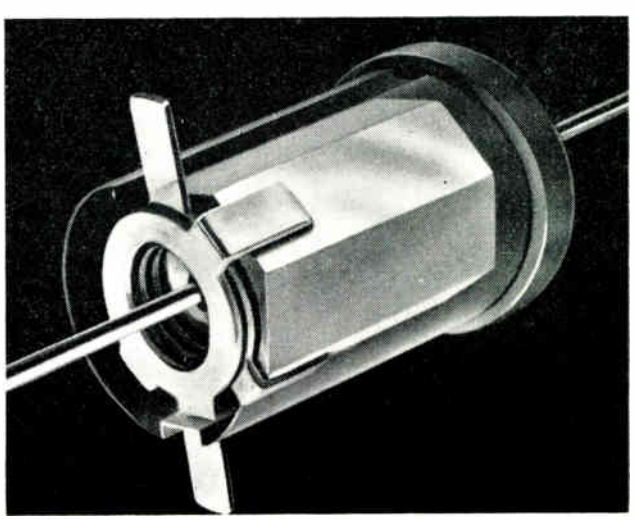
Temperature-Compensated Reference Diodes

A range of temperature-compensated reference diodes, offering improved temperature coefficients and spanning a voltage range far wider than has previously been available, has been announced by Texas Instruments Inc.

The new device comprises a glass-encapsulated hermetically-sealed diode within a self-regulating polycrystalline semiconductor 'oven', a non-conductive outer jacket of compression-moulded high-temperature nylon providing protection against moisture and physical damage. Available in fourteen standard ratings from 3·3 to 12 V (and up to 33 V on special order), the new TIXD746-759 series offers increased design flexibility in circuits requiring temperature-compensated diodes, which hitherto have largely been limited to 6 and 9-V devices.

Current to the self-regulating oven varies inversely with temperature to provide stability over a wide temperature range. Maximum temperature-coefficient ratings are 0·005% per °C, from −55 to +100 °C, and 0·003% per °C from 0 to 75 °C: temperature coefficients as low as 0·001% per °C are available depending upon the voltage range. The diode also provides temperature stability over a wide current range, and is relatively immune to voltage fluctuations; (temperature is maintained within 1 °C over a 10% voltage change).

Typical applications include voltage-regulated power supplies, digital voltmeters, high-frequency crystals, differential amplifiers, and instrumentation requiring voltage reference.



The diode 'oven' is 0·531 in. long and has a diameter of only 0·352 in. Virtually noise-free, it operates at 24 V a.c. or d.c. and will maintain diode-junction temperatures to within 2% in the range −10 to +50 °C, or 8% from −55 to +100 °C

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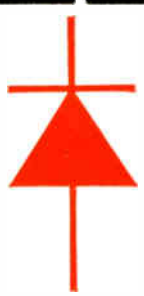

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AAY30	50	400	500
AAY42	70	400	400
AAZ17	75 (Surge)	150	900
AAZ15	115	250	1800

Point Contact Diodes

Type No.	Max P.I.V. (V)	IFM (mA)	Max Operating Frequency (Mc/s)
AAY11	90	150	—
OA70	22.5	150	100
OA73	30	150	100
*OA79	45	100	60
OA81	115	150	10
OA85	115	150	10
OA90	30	45	100
OA91	115	150	10
OA95	115	150	10
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Industrial Measurement System for Lathes

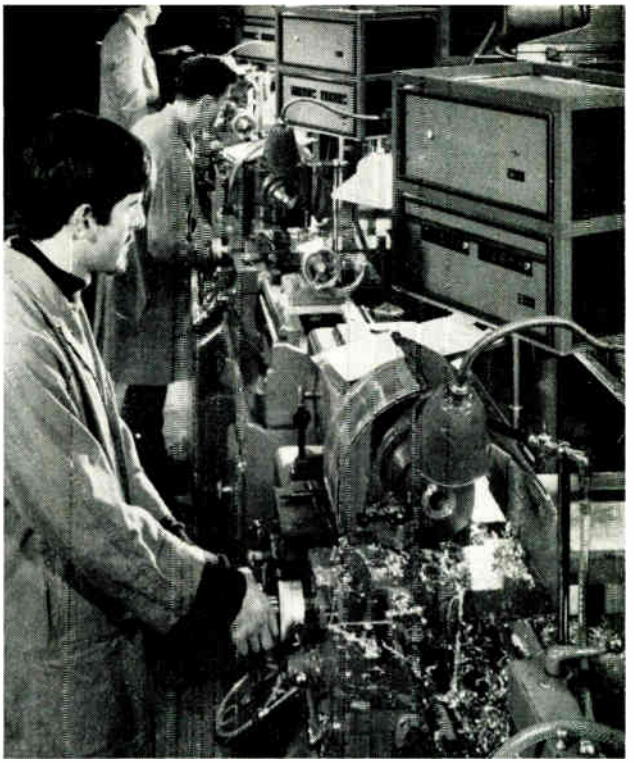
Investigations into the operation of lathes in the light engineering industry have shown that only about 20% of the total production time is spent cutting metal. The rest of the time is taken up by tool grinding and setting, interpretation of drawings, and continual measurement and correction, all of which call for highly-skilled labour.

Ferranti have developed a system known as 'Digiturn' which eliminates the gauging and, if pre-set tooling is used, reduces the manipulation time. This reduction of the indirect work elements increases productivity. The system also enables less-experienced operators, than are normally required, to produce high-class work.

The equipment incorporates sealed measuring units and a combined two-axis digital read-out which displays the dimensions of the workpiece as it is being cut. The read-out and power unit can be easily mounted in a suitable position on the lathe to allow the operator access to the datum-set push buttons and also to the dial-set switches. These switches are used to set-in to the in-feed counter the datum cutting dimension of the tool.

The workpiece dimensions are measured by two transducers, which are an integrated version of the Ferranti optical block and grating measuring system, and are presented numerically on two displays. The X axis (traverse) has a maximum read-out of 9·999 in. and the Y axis (in-feed) has a read-out up to 9·9998 in. of workpiece diameter.

All measurements refer to pre-set data and, once established at any suitable location on the lathe, are retained until the system is switched off. The direction of carriage travel is shown by an arrow on the numerical display indicator.



This shows the Digiturn in use. It has been designed to increase the machining accuracy and speed of lathes and can reduce floor-to-floor times in a workshop by as much as 7%

The Y axis has an overall accuracy over the range 0·10 in. of ±0·0005 in. and an accuracy of 0·0003 in. on small diameter changes. The repetitive accuracy in each case is ±0·0002 in.

The X axis system accuracy is ±0·00015 in. over 0·10 in. of travel with a repetitive accuracy of ±0·001 in.

For further information circle 57 on Service Card

Manufacturers' Literature

Radio, Television and Electronic Components. This twelfth edition of Pye's catalogue contains in its 116 illustrated pages (plus a 36-page professional electronic components supplement) full details of the manufacturer's complete range of electrolytics, condensers, resistors, transistors, silicon rectifiers, capacitors, printed-circuit amplifiers, power packs etc. for industrial use.
Radio and Television Services Ltd., P.O. Box 11, Gloucester Street, Cambridge.
For further information circle 58 on Service Card

Glass Sealing Alloys. Telcon Metals Ltd. recently issued their publication No. TP24/366, a 9-page illustrated brochure describing their glass-to-metal sealing alloys for applications including valves, semiconductors, cathode-ray tubes, capacitors, transformers and hypodermic syringes. Tables and graphs are included giving specifications, compositions, magnetic properties and typical thermal-expansion characteristics of the alloys.
Telcon Metals Ltd., Manor Royal, Crawley, Sussex.
For further information circle 59 on Service Card

A Computing Service for Engineers. This 23-page computer publication (No. 5058) will serve as a useful introduction for engineers to the techniques of programming and the services offered to them by I.C.T. Programs for a whole range of engineering problems already exist in standard form, and the main body of the text details a number of these for the solution of problems in linear structural analysis, mechanical engineering and chemical engineering.
I.C.T. Ltd., 68 Newman Street, London, W.1.
For further information circle 60 on Service Card

Electrical Connectors. Ether Ltd. have issued their new 76-page catalogue of electrical connectors designed for compact multi-circuit connections. Sections on miniature, sub-miniature, high-voltage, printed-circuit and industrial plug and socket connectors include illustrations, outline drawings, electrical data and specifications.
Ether Ltd., Electrical Connector Division, Hitchin Street, Biggleswade, Beds.
For further information circle 61 on Service Card

Industrial Components; Industrial Semiconductors; Industrial Valves and Tubes. Three new 35-page quick-reference guides from Mullard are now available, giving outline drawings, illustrations, encapsulation details, full technical data and abbreviated product information. Also available is a 94-page industrial valves and tubes equivalents guide for 1966.
Mullard Ltd., Industrial Markets Division, Mullard House, Torrington Place, London, W.C.1.
For further information circle 62 on Service Card

Materials Handling Systems. This 14-page illustrated brochure from E.M.I. describes the many different types of electronic equipment that have been developed for use with materials-handling systems. New modes of operation (involving the integration of materials-handling equipment with production processes and control systems) are introduced, and the ways in which systems for weighing, proportioning conveying and warehousing can be improved are discussed.
E.M.I. Electronics Ltd., Hayes, Middlesex.
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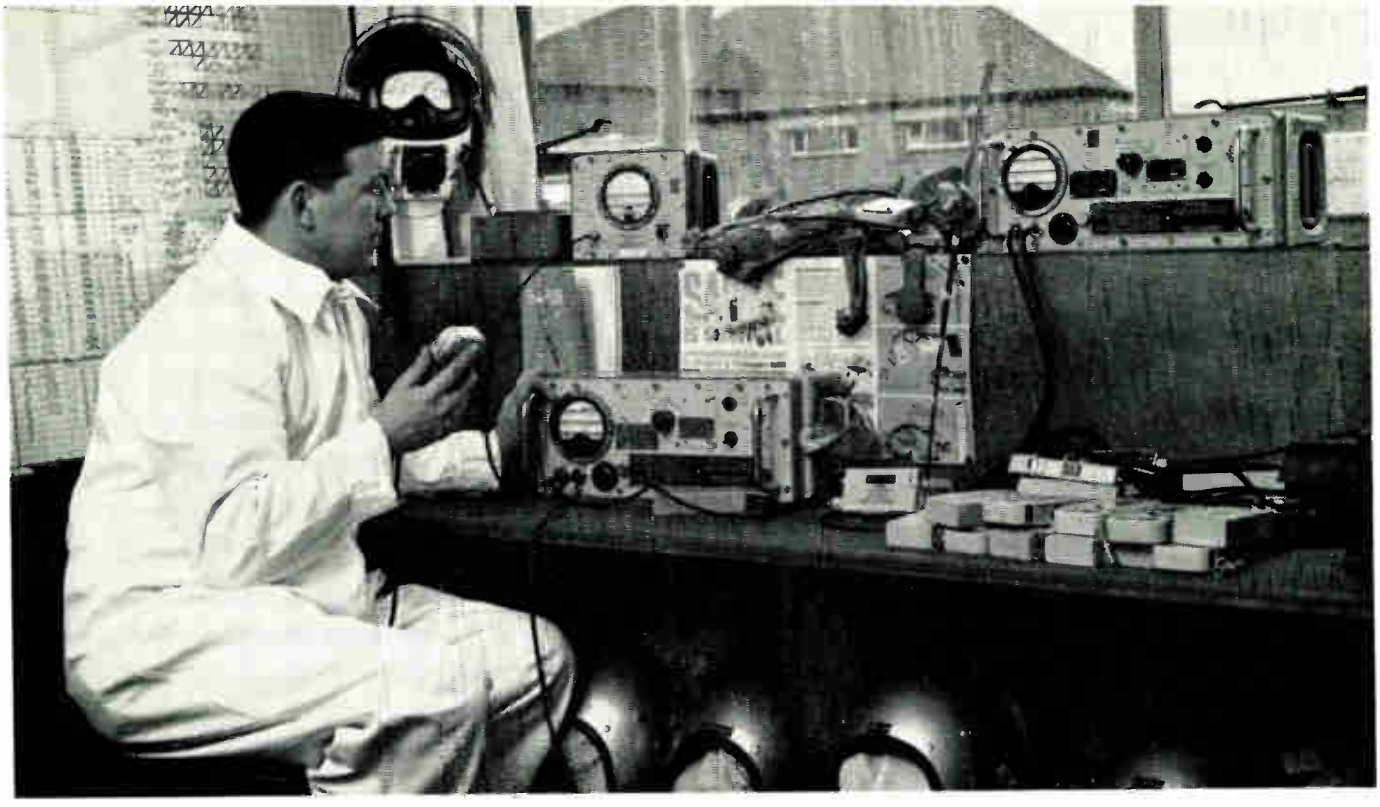
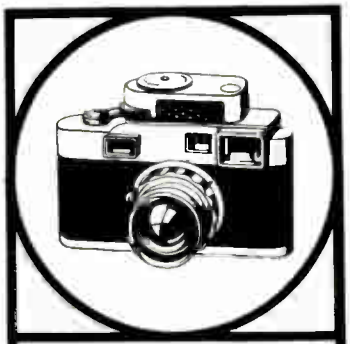


Pocket rescue beacons, manufactured by Burndept Electronics Ltd. and in use by B.A.C. flight-test crews at Warton in Lancashire, are shown here undergoing routine maintenance checks (ten minutes on a 'go/no-go' performance tester) for operational efficiency. About the size of an electric razor, the Burndept-Sarbe beacons can send bleep signals up to a distance of 250 miles to give immediate identification and location of crash survivors



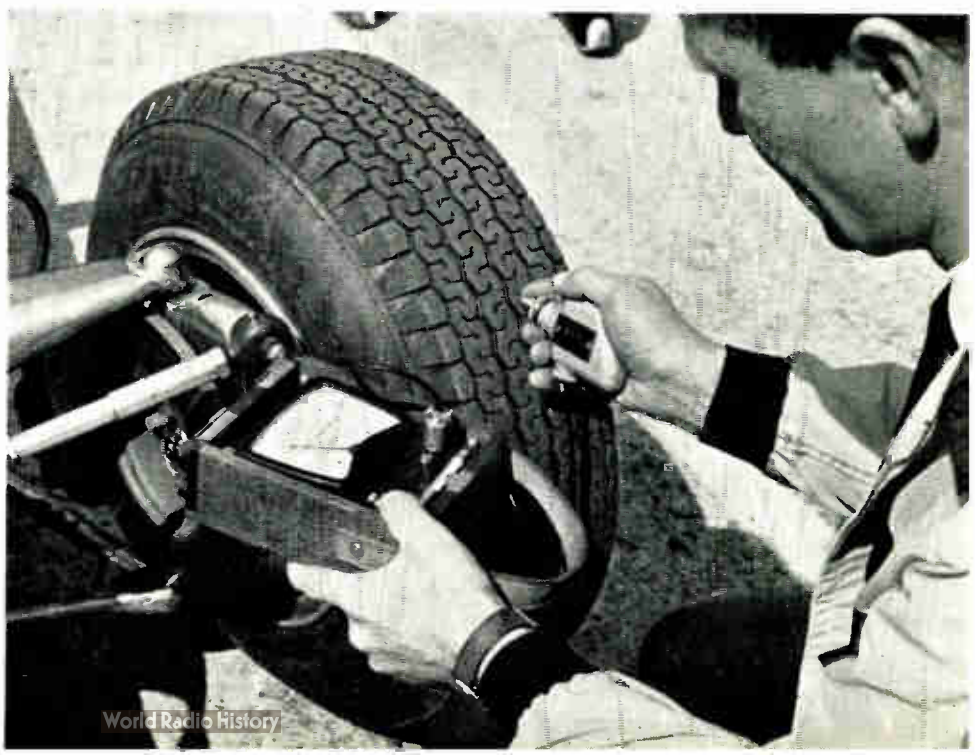
ILLUSTRATED REPORTS

Weighing ten tons, and measuring some 50 ft in diameter, this radio-link dish—supplied by Telefunken and shown here being hoisted on to a lattice-steel tower erected on the Torfhausberg in the Harz area of W. Germany—is to be used to improve telephone and television services. Together with its opposite number (a similar parabolic dish, to be erected soon in Berlin on Shäferberg) it will help to supplement automatic trunk dialling and television transmissions between the Federal Republic and Berlin

A 760-mile submarine-cable system linking the U.S.A.F. Eastern Test Range base at Cape Kennedy with Grand Turk Island in the Bahamas, is being supplied by STC Ltd. The cable system will be capable of carrying 270 simultaneous telephone conversations (or the high-speed data equivalent) and will be used to support U.S.A.F. and N.A.S.A. test programmes by handling administrative, record and data communications. The picture shows part of STC's $\frac{1}{4}$-mile long production facility at their Southampton factory. The 1-in. diameter cable has an inner steel-wire strength member, which is enclosed with a welded copper tape to form the centre conductor; then follows a process in which polyethylene dielectric is extruded over the inner member and shaved (by the three-bladed rotary cutter on the extreme right) to a precise diameter of $1 \pm 0{\cdot}001$ in. In the foreground, the dielectric diameter is being continuously monitored before the final stages of production, when a coaxial outer copper conductor and final layer of protective polyethylene are applied

Quartz crystals are now in full production at STC's plant in Harlow, Essex. Quartz crystal units are used extensively as reference devices to keep radio and telecommunications equipment on frequency, and at present the Harlow plant produces some $1\frac{1}{4}$ million such devices a year—well over half the U.K. output. The photograph shows some of the 'home-grown' quartz being removed from a thick-walled steel cylinder, in which it had been growing for 21 days in conditions of high temperature and pressure—up to 24,000 p.s.i. and 400 °C

Measurement of the tread temperature of racing-car tyres immediately after track testing or actual races is a vital part of the research and development programme carried out by the Dunlop Rubber Co. Ltd. Here, an engineer is shown using a portable pyrometer specially produced for the purpose by Sifam Electrical Instrument Co. Ltd., of Torquay. A needle-type thermocouple, carefully inserted into the tyre tread without puncturing the tyre, gives a rapid and accurate temperature reading within seconds



The need for a more thorough appreciation of and education in computer techniques is becoming urgent as highly sophisticated equipment becomes available.

This article discusses the sort of approach industry should be adopting, if it is to make full use of present-day computing facilities, and stresses the role of the computer as a tool for use in a variety of applications.

INDUSTRY'S ROLE IN COMPUTER EXPLOITATION

*By J. W. GALE**

TOWARDS the end of last year Elliott-Automation ran a three-day computer programming course for parliamentarians in the House of Commons (see Fig. 1), an event which got a fair share of publicity in the press and on radio and television; public interest in computers was stirred, even if not actively roused. But the economic and political importance of computers are not my subject here. What I want to point out now is the significance of the MP's course as a measure of the development of computing technology in three vital respects.

First, in respect of the hardware. It is a tribute to the toughness and reliability of the modern electronic computer that anyone could contemplate borrowing four £40,000 machines from their routine jobs, breaking them down and taking them to London, assembling and installing them in the unfamiliar (and uncontrolled) environment of House of Commons committee rooms, reversing the process after three days, and expecting them to work well throughout the whole procedure.

Secondly, in respect of software—the programming languages which are used to give instructions to a computer. 'Algol' was the language taught to the MPs and its features are typical. Its purpose is to enable the computer user to apply his mind to the problem to be solved, and to ignore almost entirely the quite incidental details of the computer's electronic circuitry. Algol is, in the ugly jargon of the trade, a problem-orientated language. It happens also to have been widely adopted internationally, so that it becomes the means of exchanging programs between computers of quite different types and origins.

Thirdly, the MP's course indicates the progress made in techniques of teaching programming to large numbers of people on very short courses. One is frequently asked what is the basic educational qualification of a potential computer programmer. I used to answer: 'O-level in algebra', but nowadays I prevaricate and simply say that anyone with the intelligence to understand his own problem can be taught to use a computer to solve it.

Fig. 1 (title picture). Dr. Jeremy Bray, MP, and Miss Pamela Ewington (an Elliott instructress) at an electronic computer in the House of Commons

The Computer as a Tool

A computer then is a tool to be used by anyone who has a computable problem. It happens to be electronic, but this is usually of negligible importance to the user—who cares only that it will respond predictably to instructions expressed in a particular way. The computer's ability was defined most accurately by the remarkable Lady Lovelace in 1842[1]:

> 'The analytical engine has no pretensions whatever to originate anything It can do whatever we *know how to order* it to perform'

The remarkable situation is that, after more than 120 years, the truth and significance of this dictum are understood by so few in industry. The 'black box' image of the computer persists and even thrives.

For this the computer manufacturers must accept a measure of blame. It is easy to sell a miracle (though harder to deliver one) and the general awe of the electronic brain was possibly an aid to sales in the early days. To a degree at least, the early initiates encouraged the view

* NCR Elliott Computer Workshops Ltd.

that the computer possessed powers not capable of comprehension by the many.

Now we have to change all that, and the signs are that we are getting somewhere. The popular press is beginning to understand computers and treat them seriously in print —the Thomson organization is even using them to produce a daily evening paper (see Fig. 2)—and BBC 2 has tried very hard to spread some real knowledge of computers among the serious-minded viewers.

Computer Appreciation

The Royal Liberty School, at Romford, is the first school in Britain to install a computer (see Fig. 3) and the technical colleges and CATs have a fine empirical approach to the use of computers by students. Sadly, however, the universities, though much better equipped with computers, often hide them from their students, and it is quite possible to graduate in mathematics without using your department's computer.

All this, oddly enough, has a great deal to do with the significance of the computer in industry. The impact of the computer to date has not been great and will only become significant when computers are used in industry in much larger numbers. Before this can happen enormous numbers of engineers, accountants, managers and directors must be sufficiently educated in computer techniques.

Each and every computer installation and computer application must be preceded by investigation, costing, specification, coding, program testing, recoding and so on. But the present (and probable future) resources of all the computer manufacturers and consultants put together will not be sufficient to provide for more than a small fraction of the computer jobs which abound in every works or office.

The solution is not to recruit a new army of professional computer experts to sally forth and conquer industry on behalf of the computer makers. It is to ensure that every man or woman with responsibility in industry knows enough to recognize a problem which lends itself to automation, and to specify the method of tackling it. One well-known firm, which owns no computer yet, has had over one hundred of its staff trained in computer programming in the last two years—at a cost of about £1,000 and 400 man-days of time. This is the right approach.

The Role of Computers

Having thus attempted to cut the computer down to size —to represent it as a commonplace tool for us all—it becomes necessary to restore it to its proper place, for the power it gives us is far from commonplace.

Professor Gill recently pointed out[2] the effect, in the field of communications, of the million-fold increase in the speed of printing presses and the hundred-million-fold increase in the speed of telegraphy. Such differences of degree amount to a difference in kind. Just put into the hands of intelligent men the power to do a million calculations a second—and then step back to watch what develops.

It is fair to ask what, in 10 years or so, has in fact developed. The payrolls calculated by computer are by now well known and numerous (though that is not to say

Fig. 2. The Elliott/Thompson 'Computerset' system in the composing room of the Reading Evening Post. *Up to twelve operators simultaneously type at keyboards connected to a computer, which automatically justifies the copy and punches out a tape for the typesetting machine*

Fig. 3. The Royal Liberty Grammar School, at Romford, is the first in Europe to order its own computer. Here pupils are shown receiving instruction on an Elliott 903

that each new one is not troublesome at its birth). Stock control is on the brink of becoming routine—though there is scope for the continuing development of more subtle means of stock forecasting.

On the technical side, some engineers—aeronautical and structural, for example—would scarcely build a thing nowadays without using the computer's power of calculation at some stage of the design. Again, almost all optical manufacturers use computers to trace the paths of light rays through lenses and thus design more complex systems faster and cheaper.

Fig. 4. Customers preparing tapes and running programs at the NCR Elliott 'Computer Workshop' at Greenford

On-line to industrial processes, computer applications are progressing step-by-step through data logging to closed-loop control—of, for example, paper-making machinery.

Computers are growing up in their vital management role, too. Many firms, especially in the construction industries, habitually use the new 'network' methods of project planning to analyse progress in detail at short intervals with the computer's aid. Linear programming techniques enable some management strategies to be optimized with certainty, and a farming syndicate has recently used this method to choose the best combination of crops and animals.

Set against these successes, however, are some bright hopes not yet fully realized. Automatic language translation and the detailed production control of manufacturing processes still await the breakthrough (or the necessary accumulation of experience) which will one day make them entirely economic.

What is clear, above all, is that at present we know less about the potential of the electronic computer than we know about the surface of Mars. We can gaze into the future and discern quite clearly that computers will continue to grow faster, cheaper, even more reliable and much more numerous. But what subtle things their users will do with them cannot (and need not) be guessed at.

Note especially that I look to the computer users to apply the machines in clever ways. Nearly all of the striking new computer applications of the last decade have originated with computer users rather than with the manufacturers. It will always be the man who has lived with a problem for an important part of his working life who is most likely to solve it. It is necessary, however, that he should well acquaint himself with the use of the tools most likely to help him.

'Computer Workshop'

It is one of the computer manufacturer's major duties to make this knowledge easily available. My own company's contribution here is its 'Computer Workshop' service. For £9 anyone can attend a three-day course, during which he will write and run a program of his own; three weeks later he can come back with another program to be tested and run with our help.

Thereafter we turn him loose to see what he can do with a computer. At any of four centres in London (see Fig. 4), and two soon to be opened in Manchester and Birmingham, he can hire time by the quarter-hour at £20 an hour on a powerful machine (and down to £4 an hour, off-peak, on a smaller one).

Several hundred firms have used this service and some have already progressed to computer ownership. Some never will—but will continue happily to save money or make money by using the service.

Every firm with an eye to the future would like to know all about electronic computers. There is only one place to learn how to swim—in the water.

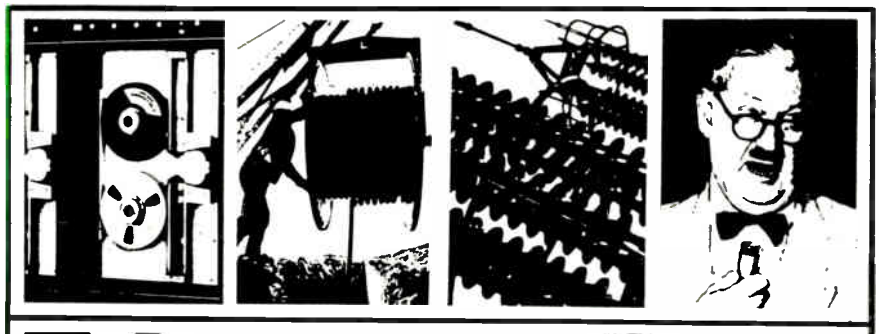
References

[1] Editorial notes to an article on Babbage's Analytical Engine in Taylor's 'Scientific Memoirs', Vol. 3, 1842, by Ada Augusta, the Countess of Lovelace. Reproduced in Faster than Thought, edited by B. V. Bowden, Pitman, 1953.

[2] Professor Stanley Gill, inaugural lecture at Imperial College, London, 26th January, 1965. *Computer Journal*, Vol. 8, No. 3, Page 177.

Acknowledgement

The author thanks Elliott-Automation Ltd. for permission to publish this article. The opinions expressed are, of course, his own and not necessarily those of the company.



TALKABOUT

By NEXUS

The exhibition scene this year was enriched by Ships' Gear International '66. This was the first of its kind and for the electronics engineer with a nautical bent there was much to see and admire. The electronics content was spread evenly over the three major fields of communications, navigation and ships' automation.

One of the centre pieces was a full-scale fully engineered ship's bridge shown by Kelvin-Hughes in association with S. G. Brown Ltd. and Chadburns (Liverpool) Ltd. This featured the new KH series of modular radars on public show for the first time. Within short hailing distance were Sperry with a big new range of marine electronics including Seatrac, the radar recently mentioned in this column. Marconi International Marine, as might be expected, had a lavish display and Decca Radar, with over 20,000 marine radars already sold were still busy booking orders.

Seafaring is nothing if not a very international affair and those engaged in the supply of marine equipment have a broad international outlook. And, like many shipowners who, for various reasons, prefer to sail under flags of convenience, so, I found, do many equipment manufacturers.

Ships' Gear International '66 was an up-to-date and fascinating exercise in the study of who owns whom and who makes what. And, on the whole, British industry acquitted itself well in matters of honesty and deportment where the interlocking of industrial, economic and even political considerations inevitably causes some difficulty in presentation.

'Publish and be damned', say most companies. A wise policy, and so we all know that Kelvin Hughes is a division of Smiths Industries. That S. G. Brown is a Hawker Siddeley company in association with American Bosch Arma Corporation. That Arkas automatic pilots and Simrad echo sounders, both shown by Decca, are made respectively in Denmark and Norway.

By the same token we also know that Sperry, an international company, labels equipment Sperry/TKS when it is made by the associated Tokyo Precision Instrument Company (TKS) in Japan. And that the International Marine Radio Co. Ltd. are tied to Standard Telephones and Cables Ltd. and have strong links with Standard Radio and Telefon A/B, Sweden, and Standard Telefon og Kabelfabrik A/S, Norway, and that the whole lot is part of the giant American I.T.T. group. We also know that the new range of closed-circuit television equipment marketed by A.E.I. is made by Grundig—it says so quite clearly in the sales literature.

Unfortunately it was not quite such plain sailing everywhere. One international organization flying the flag of a famous British firm was showing a large range of equipment not previously associated with this company. The star exhibit was billed in hastily prepared literature bearing the British company's name. But, alas, it turned out to be another Japanese import. Which made me wonder if the British end of the organization does any original work at all. In short, this was a psychological blunder. How much more effective this display could have been if it was staged openly in its true colours under the name of the foreign parent and demonstrated the group's international total capability. And, not least, the capability of the British based company who, in fact, do valuable R. and D. as well as production though not extensively, if at all, in the marine sphere.

Incidentally, the Nexus Award for Attention to Detail went to Germany. With true Teutonic thoroughness the tradition of dipping the flag in salute has now been fully automated by A.E.G. No longer is an expensive deckhand or signaller required. Gone are the days of trudging out in oilskins on a gale-swept deck to struggle with messy ropes and pulleys. Today the captain can stay in the comfort of his air-conditioned bridge and personally salute by merely pressing a button. Furthermore, the system operates equally well under whatever flag the ship is sailing.

The Farnborough Air Show this month will be even more confusing than Ships' Gear. This will be the first international Farnborough and since the last show two years ago our aircraft industry has moved solidly into Europe with a whole range of joint ventures.

Although there is little doubt that the show will be as festive as usual it will be overshadowed by the gloom spread by an unsympathetic Government. True, political moves to kill off Concord and ELDO have failed and the Minister of Aviation, or his successor looking after aviation (the Ministry is being disbanded as I write) will make encouraging noises. But the hard fact will remain that despite all the fanfares and the ballyhoo the industry's biggest customer has opted to buy American—and to the tune of over £100,000,000. This odd fact will not escape the many overseas visitors who will be wondering if they can afford to buy British when we don't do so ourselves.

Fortunately for the electronics industry the Electronic Engineering Association has exerted pressure to get a reasonable percentage of avionics into the more ancient designs of the American aircraft we are buying. E.M.I's sideways-looking radar, for example, will be in the reconnaissance pods of the Phantoms, Cossor will supply i.f.f., Elliott Flight Automation the navigation computer and autopilot, Plessey u.h.f./v.h.f. communications, Marconi h.f. communications and so on. Much of this equipment was originally intended for the British TSR2.

It is a sobering thought that on the F 111's there will be little or no British avionics other than communications. But it is pleasing that the variable geometry concept of the F 111 is British and that even on the older

Phantoms which have been extensively altered in design for the Royal Navy, the Americans now admit that with Rolls-Royce Spey engines and airframe modifications the R.N. Phantom F-4K is far superior to the all-American F-4J. In fact the Americans are tickled pink, so much so that the U.S. Navy's F-4Js are now being modified in the airframe to bring them into line with the F-4K. This seems to indicate that off-the-shelf U.S. products are not always as efficient as they could be.

It will be interesting to see how the E.E.A. Press Conference, normally held on the Wednesday of the Farnborough Show, fares this year. Two years ago it was not very impressive. E.E.A., despite having a press officer plus a retained public relations company to put over the British electronics message, have been fairly silent for some months. They put out a statement recently deploring the effect of the Selective Employment Tax, but little else. In contrast, the Society of British Aerospace Companies produces a lively weekly newsletter and makes sure that the texts of aides-memoire to the Government get wide publicity.

One thing the E.E.A. Publicity Committee could usefully do is to look into the situation at the new British Trade Centre in New York where, incidentally we have been refused permission to fly the Union Jack except on very special occasions. John Lord, New York correspondent of the *Financial Times*, reporting the opening of what is described as the biggest permanent trade centre in the world, said '. . . while Britain has been trumpeting to Americans its advanced industrial techniques, the most obvious piece of automated equipment at the Centre—a question and answer machine to help visitors—was made in the U.S.'

I congratulate Elliott Automation on their Mobile Computer Classroom. Fitted with an Elliott 903 it is currently touring the country, initially to teach schoolteachers the art of programming and computer use and, later, the pupils of technical colleges, grammar schools and secondary schools.

The scheme is in collaboration with the Department of Education and Science but schools will have to pay a hire charge of £35 per half day. Already, say Elliott's Directorate of Information Services, the mobile classroom is booked for 70% of its time.

In a flush of enthusiasm E-A Information Services point out that many pupils 'who have no particular scholastic distinction are fully capable of achieving great competence in the use of a computer. This opens up a whole new career structure for children who otherwise might be condemned to a dull and uninteresting life of routine work and its attendant frustration'.

Developing this exciting theme the press handout quotes the case of Mr. R. I. Moseley who is the driver and supervisor of the classroom. At the age of 15 he joined Elliott as an industrial trainee in the machine shop. At 19 he decided to learn computing and now, at the age of 21, he has qualified. The tremendous climax of this story is that he now earns, with overtime, £1,000 a year. In short, as a fully qualified driver, computer programmer, and teacher in charge of £20,000 of equipment, he has just about got level with the labourer, dustman, or long-distance lorry driver.

This may seem low until one looks at rewards offered elsewhere for diligence in learning, initiative, application and achievement.

The Medical Research Council technician rate (G.C.E. A level passes in scientific subjects) is in the range £427–£1,021. The University of St. Andrews, looking for a computer programmer offers a salary scale of £1,000–£1,350. But here you must be a graduate with a degree in mathematics. For the real clever guy who is an honours graduate in science or technology, what could be better than British Railways Board? Here you can not only belong to a swinging organization and work in laboratories in with-it spots like Crewe, Derby or Glasgow, but they pay you as well. The salary scale is £925–£1,370 plus, of course, the usual travel concessions just as if you were important like a guard or a porter.

On balance, then, Mr. Moseley without a degree is doing quite nicely and is keeping ahead of A-level types and not far behind graduate rates (provided he gets in enough overtime). But are any of these salaries ever likely to catch up with the rewards of the real elite, such as the dockers?

My recent mention of Honeywell Controls' 'fine literary flourish' in using Shakespearean quotations brought an immediate and agonized response from the parent Honeywell Inc., of Minneapolis. And signed by no less than George M. Muschamp, Vice-President—Engineering, International Operations, who says he is appalled at being up-staged by the Service Department.

For Mr. Muschamp, mentioning his Norman-French ancestry and countless British generations behind him since 1066 and all that, reminds me that he was in the field quoting Shakespeare at a much earlier date. Mr. Muschamp used his quotation on June 8, 1964, when speaking at the Systems Engineering Conference in New York City. His subject, 'The Emerging Philosophy of Systems Management'.

Asked for a definition, Mr. Muschamp said he found a 'real message' for the conference while attending a performance of Henry the Fourth at Stratford-on-Avon, England.

'England', said Muschamp, 'even in those days was itself a complex system. The Earl of Northumberland, allied against the King, thought the manager of the system should be changed and, furthermore, that the system be redesigned. His ideas were voiced by Lord Bardolph by these Shakespearean words':

> When we mean to build
> We first survey the plot, then draw
> the model;
> And when we see the figure of the
> house,
> Then must we rate the cost of the
> erection;
> Which if we find outweighs ability,
> What do we then but draw anew
> the model
> In fewer offices, or at least desist
> To build at all? Much more, in
> this great work,—
> Which is almost to pluck a Kingdom down,
> And set another up,—should we
> survey
> The plot of situation, and the
> model,
> Consent upon a sure foundation,
> Question surveyors, know our own
> estate,
> How able such a work to undergo,
> To weight against his opposite, or
> else,
> We fortify in paper, and in figures,
> Using the names of men, instead of
> men:
> Like one that draws the model of a
> house
> Beyond his power to build it; who,
> half through,
> Gives o'er and leaves his part-created cost
> A naked subject to the weeping
> clouds,
> And waste, for churlish winter's
> tyranny.
>
> Part II, Act I, Scene III

I have to agree with Mr. Muschamp who says of Honeywell 'we have a fine Shakespearean company'. They are certainly on the ball with the Bard.

NEW APPARATUS

ELECTRONICS COMMUNICATIONS INSTRUMENTATION CONTROL

1. Safety Switch

A safety switch for use on machine guards has been introduced by Austin S. Beech and Co. Ltd. under the trade name of the 'Sentrigard'. This consists of an encapsulated magnetic switch which is fitted to the machine being used. A plunger holding a small magnet is fitted to the guard of the machine so that when the guard is closed the plunger is inserted into a hole in the switch casing. The switch will only be operated, to operate the machine, if the plunger is correctly located. The switch is waterproof, oil proof and dirt proof.—*Austin S. Beech and Co. Ltd., Energy Works, Leighton Buzzard, Beds.*

For further information circle 1 on Service Card

2. Heating Tape

Hotfoil Ltd. have introduced a waterproof electrical heating tape, the type GW, for use on pipes carrying high-viscosity oils, bitumen, food products and similar substances. It is capable of heating the pipes up to 200 °C. It can be used to maintain liquids at elevated temperatures or to raise liquids to high temperatures while they are static or being pumped in the pipe. Standard tapes are manufactured in lengths from 12–70 ft, with power ratings from 5–70 W per ft and for operation from 240-V single-phase supplies. Tapes for other voltages and in longer lengths can be supplied.—*Hotfoil Ltd., Heath Mill Road, Wombourne, Wolverhampton.*

For further information circle 2 on Service Card

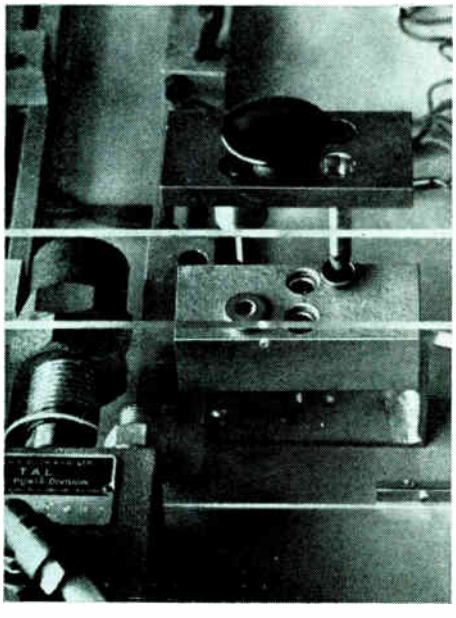
3. Burglar Alarm Unit

A photoelectric burglar detector unit has been introduced by Photain Controls. This will operate over distances between the light projector and receiver of 100, 500 and 1,000 ft. An infra-red light beam is used and this is electronically modulated. The control circuitry connected to the receiver is tuned to respond only to the modulated light from the projector. It will not respond to light from other sources. When the light beam is broken, a relay is de-energized and remains in that condition until the equipment is manually reset.—*Photain Controls Ltd., Randalls Road, Leatherhead, Surrey.*

For further information circle 3 on Service Card

4. Electronic Security Unit

An electronic security unit for use on motor vehicles has been developed by Glendor Research and Distribution Co. It consists of a 5-gate logic unit controlled by a 24-way rotary switch and a microswitch. A lettered dial is fitted to the vehicle instrument panel. With the vehicle ignition switched on, the operator selects a code of five letters on the dial, the microswitch being pressed for each letter. This causes the five gates to be opened which will operate an internal relay. The ignition circuit and the starter solenoid can then be operated. An optional bonnet lock can also be



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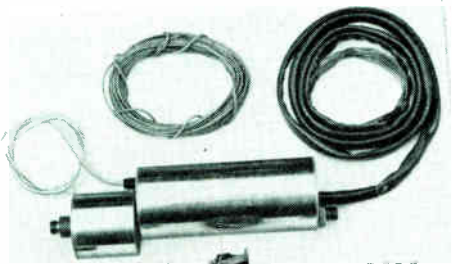

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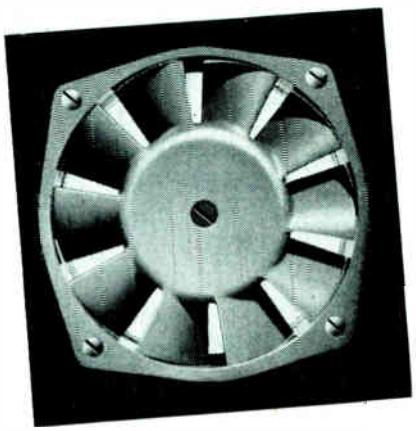

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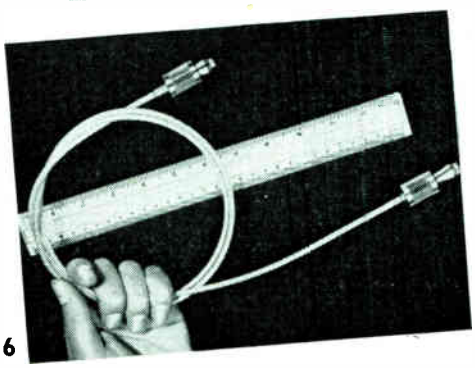

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obtained and, when fitted with this, the unit can also be used for protection of doors, safes, etc., where maximum security is required. A unit for diesel vehicles is also available. This operates a fuel valve so that the fuel line is only open when the correct sequence has been selected on the dial.—*Glendor Research and Distribution Co. Ltd., 25 Watford Field Road, Watford, Herts.*

For further information circle 4 on Service Card

5. Lightweight Fan

A lightweight fan for cooling computers and electronic equipment has been developed by Plannair. It is 3½ in. in diameter, less than 2-in. deep, weighs 1¼ lb and will move 25 cu ft of air per min. This fan is powered by an enclosed 12-W motor operating on either 230 or 115 V, 50/60 c/s. No starting capacitor is required. Satisfactory operation is achieved to 95% relative humidity within a temperature range of −40 to +70 °C.—*Plannair Ltd., Windfield House, Leatherhead, Surrey.*

For further information circle 5 on Service Card

6. High-Pressure Hoses

The high-pressure flexible hoses developed by EMI Electronics provide a safe and reliable means of making connections between parts of pneumatic equipment which move independently of each other during operation. Flexibility is maintained when the hoses are pressurized. The hose consists of a bundle of twelve small-diameter stainless-steel tubes in a nylon protective sheath. It is suitable for use with high-purity gases where it is essential that the pipe-work does not liberate adsorbed contaminants.—*EMI Electronics Ltd., Hayes, Middlesex.*

For further information circle 6 on Service Card

7. Pressure Switches

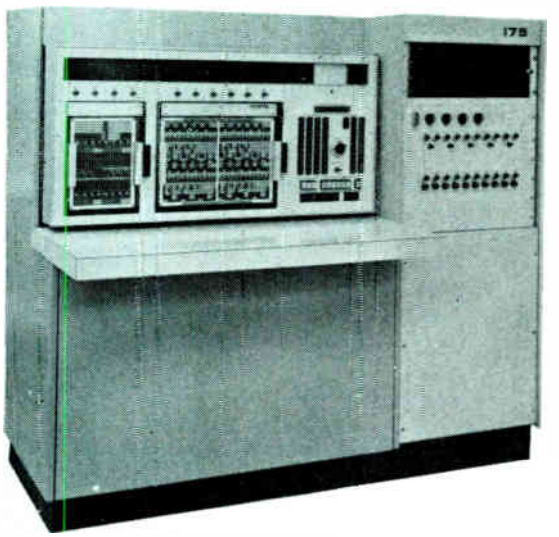
Bradbury Controls have extended the range of 'LucySwitches' which are marketed by Browell's Partnership Ltd. Adjustable indicating pressure switches in this range are now available for pressures of up to 7,000 lbf per sq in. These can be preset and locked to avoid accidental alteration of the setting. Other types which can be easily adjusted during use are available. Low-pressure types for use with pressures below 10 lbf per sq in. are also included. Other units include pressure gauges, valves and miniature cylinder actuators.—*Browell's Partnership Ltd., 5/9 Beadon Road, Hammersmith, London.*

For further information circle 7 on Service Card

ELECTRONICS

8. Analogue/Hybrid Computer

Redifon-Astrodata Ltd. have added the Ci-175 analogue/hybrid computer to their range of scientific computing equipment. This medium-capacity machine provides up to seventy-five 100-V solid-state operational amplifiers and incorporates solid-state control; a comprehensive range of analogue modules terminates at a central removable patchboard, individual integrator control lines and digital-logic modules terminating at a separate logic patch-



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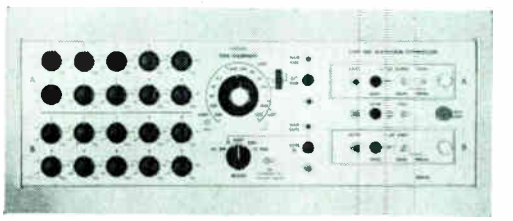

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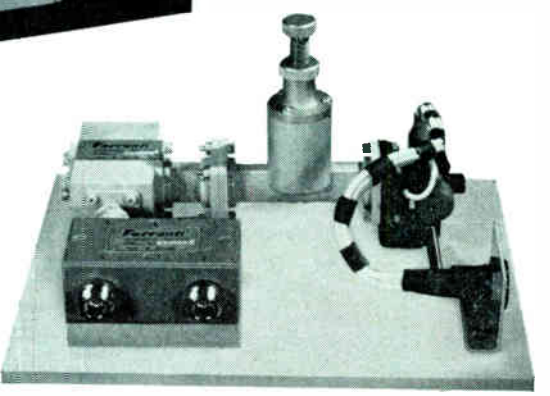

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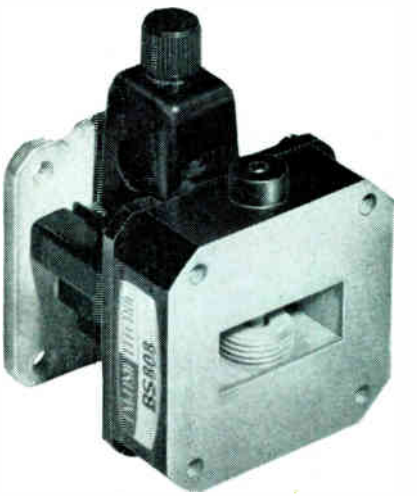

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board, also removable. Overall power consumption is less than 1 kW, and where a greater capacity is needed several machines can be operated together, the 'slave' mode being a standard feature. The Ci-175 has been designed for use in industrial research laboratories and computation centres, being particularly suitable for solving problems in servo-system design, process dynamics, optimizing control and hybrid simulation.—*Redifon-Astrodata Ltd., Brookside Avenue, Rustington, Littlehampton, Sussex.*

For further information circle 8 on Service Card

9. Parametric Amplifier

Now available from the electronics department of Ferranti is the type VCA/C12 parametric amplifier, a low-noise non-degenerate unit operating in the frequency range 4·0 to 5·0 Gc/s. The balanced idler circuit employs two variable-capacitance diodes, which are mounted in a single encapsulation and operate in push-pull at 13 Gc/s, such a configuration eliminating filters in the idler circuit. The combined noise figure for the amplifier and ferrite circulator is less than 2·3 dB, and for a gain of 20 dB the 3-dB bandwidth is a maximum of 40 Mc/s.—*Ferranti Ltd., Gem Mill, Oldham, Lancs.*

For further information circle 9 on Service Card

10. Waveform Synthesizer

Exact Electronics Inc. have introduced their solid-state high-speed waveform synthesizer (model 400), whose internal clock rate of 3 c/s to 10 Mc/s is ideal for shock vibration testing and telemetry pulse code modulation. Basically, the unit comprises two ring counters that sequentially switch twin channels of ten independent current sources (controllable in amplitude and slope) into a common load; combinations of the output may be varied by selecting various plug-in units. The internal clock is calibrated in steps from 0·33 sec to 100 nsec, with a variable potentiometer increasing the range to 1·3 sec. Two trigger outputs are available, which coincide with the end of each 10-increment cycle; one is a fast pulse with an 80-nsec rise/fall time, the other being 250 nsec.—*Livingston Laboratories Ltd., Greycaines Rd., North Watford, Herts.*

For further information circle 10 on Service Card

11. TR/Limiter Cell

The English Electric Valve Co. have introduced an X-band TR/limiter cell combination (type BS808) with peak operating powers of up to 200 kW. Requiring no external trigger, it is designed for use in radar equipment that uses very sensitive crystals or tunnel-diode amplifiers. The unit, which is electrically and mechanically interchangeable with a standard X-band TR cell, consists of a gas-discharge TR cell and a solid-state limiter fitted together. Its main features are a very low spike leakage (less than 0·01 erg/pulse, measured at 40 kW peak power with 1·0-μsec pulses and at 1,000 p.p.s.); full passive protection; and elimination of crystal burn-out.—*English Electric Valve Co. Ltd., Chelmsford, Essex.*

For further information circle 11 on Service Card

NEW ELECTRONICS COMMUNICATIONS INSTRUMENTATION CONTROL

12. Portable Gas Laser

A portable d.c. gas laser (the B17/S), which may be plugged into a 110–120 V or 200–240 V a.c. source, is now available from Scientifica. Completely self contained, the 10-lb unit, which measures approximately 17 × 5 × 3½ in., may be tripod mounted and has a regulating circuit to compensate for supply-voltage variations. Its beam wavelength is 6,328 Å, power outputs for a multiphase wavefront being 1 mW in visible and 3 mW in infra-red light; with a uniphase wavefront, the power output is ½ mW in visible light.—*Scientifica, 148 St. Dunstan's Avenue, Acton, London, W.3.*

For further information circle 12 on Service Card

13. Digital Typewriters

Electrically-operated digital typewriters, with or without programming facilities, have been introduced by Hilger & Watts for use with automatic data-processing systems. The basic typewriter (FD 574) has a 17-in. carriage and is designed for remote operation under external electronic control; up to twenty-six character and function keys (adapted for solenoid operation) are available, together with a 'space' function. A commutator bar and patchboard unit (FD 576) can be fitted to the basic machine, so that variations in layout can be selected by interchanging plug-in programming units. This 'combar' acts as a serializer, ensuring that the print-out remains synchronized with the source of the information, and allows the typewriter to run at its optimum speed of 8 to 10 characters per sec; its capacity is 190 columns, the typewriter accepting a maximum of 50 input lines.—*Hilger & Watts Ltd., 98 St. Pancras Way, London, N.W.1.*

For further information circle 13 on Service Card

14. Gc/s 'Jumping Bean' Switch

The De Mornay-Bonardi DB 858 'jumping bean' switches are designed for comparison of Gc/s signals from alternate sources. Five models cover the operating frequency range from 26·5 to 140 Gc/s. In operation, the units switch continuously from one position to another in less than 2·5 msec and remain in each position approximately 25 msec. They provide channel-to-channel isolation of 35 dB, v.s.w.r. of 1·25: 1 and an insertion loss of 1 dB. Distributed in the U.K. by *C.T. (London) Ltd., 27 Ashley Place, London, W.1.*

For further information circle 14 on Service Card

COMMUNICATIONS

15. Man-Pack Radio

A high-performance transistorized transmitter-receiver which can be carried by one man has been developed by the British Communications Corporation Ltd. Although this compact unit weighs only 36 lb, it can cover ranges of up to 25 miles when used as a man-pack and 500 miles or more when used as a fixed ground station. Designated the BCC 30, the unit operates in the high-frequency band. It was designed to a military specification and is to enter Naval service in two versions, one with a maximum output power of 30 W and the other with a 3-W maximum output.—*British Communications Corporation Ltd., South Way, Exhibition Grounds, Wembley, Middx.*

For further information circle 15 on Service Card

16. Portable Telephone

F. W. Reynolds Ltd. have developed a version of the 'Stanofone' line telephone which clips to the operator's head thus leaving his hands free. The complete head piece weighs only a few ounces and is connected to a control box by a 4-ft cable. This control box contains the batteries, calling key and line connections and clips to the operator's clothing. Each telephone is connected directly to a second extension or via a simple exchange to more than one extension.—*F. W. Reynolds Ltd., 170 Chiltern Drive, Berrylands, Surbiton, Surrey.*

For further information circle 16 on Service Card

17. Intercom

The Reliance Telephone Co. has produced an internal telephone system known as the 'Loudspeakercall'. It consists of a master unit and a number of substations and the master unit can be connected to between six and 48 lines. Speech between the master unit and each substation is made over loudspeaker microphones. Incoming calls to the master unit are indicated by lamps and audible signals. The units can be arranged so that the lamps indicating the incoming calls remain on until successive calls have been answered.—*The Reliance Telephone Co. Ltd., Turnells Mill Lane, Wellingborough, Northants.*

For further information circle 17 on Service Card

18. Pocket Paging System

Multitone Electric announce a range of selective paging receivers. In addition to radio versions the receiver range includes ultrasonic frequency induction receivers. These receivers used with the Multitone match-box size v.h.f. talk-back transmitter allow selective call plus two way speech with total pocket equipment weighing under 6 oz. For very large hospitals and industrial establishments the range includes systems capable of 200 calls per minute. In addition to individual calls, group alert calls can be sent out to call emergency teams in hospitals or industrial plants.—*Multitone Electric Co. Ltd., 12 Underwood St., London, N.1.*

For further information circle 18 on Service Card

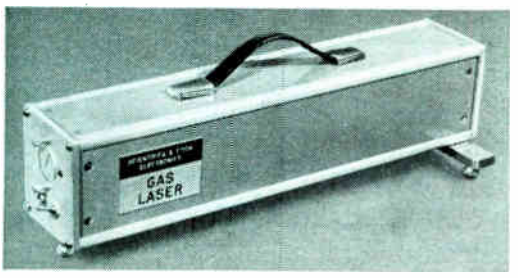
19. Unattended Facsimile Reception

A system comprising a Muirhead facsimile receiver and a Sontranic telephone answering machine allows an unattended receiver to answer a call and receive transmissions automatically, over the public telephone network. A recorded message instructs the caller on transmission procedure. This system adds greatly to the convenience of facsimile transmission. For example, in one shipping firm, loading records are received automatically from the docks and are dealt with when convenient by the staff. The records continue to arrive throughout the weekend, to be dealt with on Monday. —*Muirhead & Co. Ltd., Beckenham, Kent.*

For further information circle 19 on Service Card

20. Open Circuit Locator

A portable instrument, which enables a technician to determine the location of an open circuit in paired communications cable up to 30 kilometres in length, has entered production at the Delcon Division of Hewlett-Packard. Known as the model 4910C open fault locator, it is battery-operated and weighs 2½ kgms. The device may be set to compensate for variations in cable capacitance caused by line usage and low capacitance carrier circuits. It also determines whether stray voltage or leakage resistance on the conductor would



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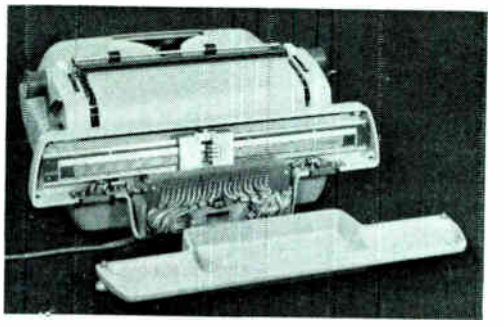

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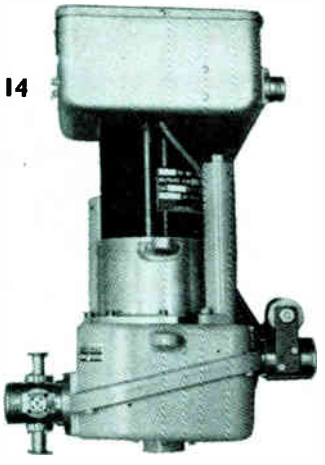

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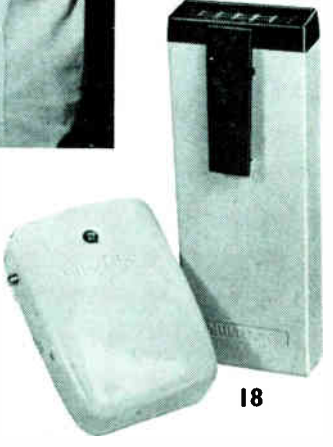

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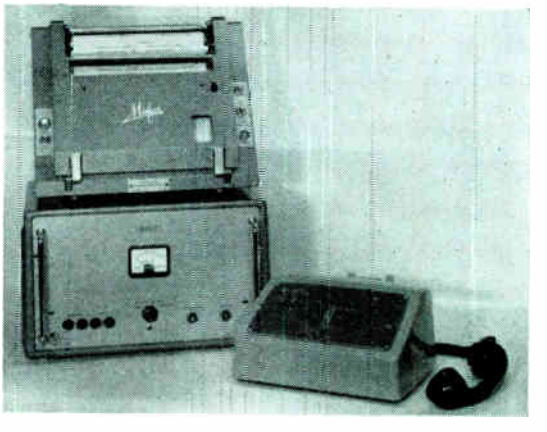

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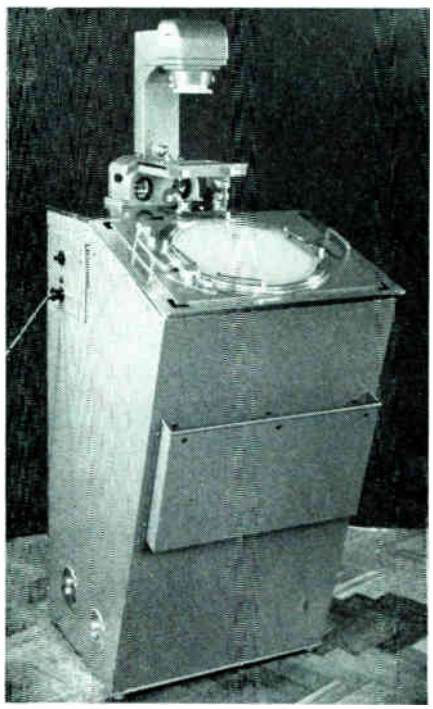

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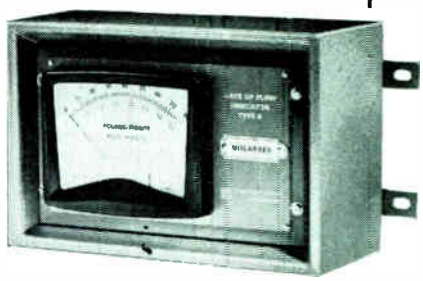

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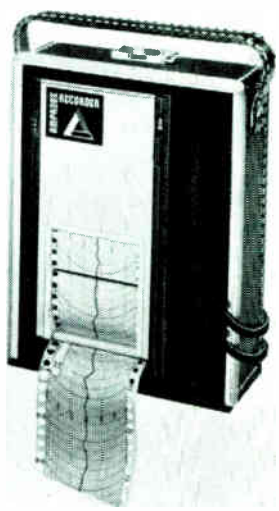

23

NEW ELECTRONICS COMMUNICATIONS INSTRUMENTATION CONTROL

preclude its use. Utilizing a taut-band meter, the 4910C has seven linear-reading distance scales: 30 m; 100 m; 300 m; 1,000 m; 3,000 m; 10,000 m; and 30,000 m.—*Hewlett-Packard Company, Delcon Division, 943 Industrial Avenue, Palo Alto, California, U.S.A.*

For further information circle 20 on Service Card

INSTRUMENTATION

21. Inspection Enlarger

An inspection enlarger, type TT 1066, for use in engineering workshops, assembly and inspection departments, has been announced by Hilger & Watts. This floor-standing enlarger can be used for profile and surface inspection and has a magnification range of ×10 to ×500 utilizing interchangeable lenses. A co-ordinate measuring stage available for the enlarger has a measuring capacity of 4 in. longitudinal movement by 3 in. traverse movement. Both movements are individually controlled by 2-in. diameter micrometer drums reading direct to 0·0001 in. The size of the viewing screen is 20 × 16 in. A full range of accessories is available.—*Hilger & Watts Ltd., 98 St. Pancras Way, London, N.W.1.*

For further information circle 21 on Service Card

22. Rate-of-Flow Indicator

A recent development by Parkinson Cowan is the type S rate-of-flow indicator. When used in conjunction with a rate-of-flow meter-generator, this will give accurate and reliable indication of continuously-variable liquid flow conditions. The indicator, which requires no mains supply, consists of a moving coil d.c. microammeter with a measuring circuit for calibration and damping purposes. These facilities enable the indicator to be calibrated to suit the requirements of each particular meter-generator to which it is coupled. It may be calibrated in volumetric or gravimetric units and imperial or metric scales are available.—*Parkinson Cowan Ltd., Terminal House, Grosvenor Gardens, London, S.W.1.*

For further information circle 22 on Service Card

23. Voltage Recorders

Amprobe Instrument, a division of Soss Manufacturing Co. of the U.S.A., have announced a range of four a.c. voltage recorders. These are the model LAV2X with ranges of 95–130 and 190–260 V; the model LAV3X with ranges of 95–130, 190–260 and 380–520 V; the model LAV4X with ranges of 165–245 and 330–490 V; and the model LAV8600 having ranges covering 0–150, 0–300 and 0–600 V. The voltage levels are recorded on pressure-sensitive strip charts which obviate the need for ink pens.—*Amprobe Instrument, Division of Soss Manufacturing Co., 630 Merrick Road, Lynbrook, New York 11563, U.S.A.*

For further information circle 23 on Service Card

24. Digital Clock

Alma Components Ltd. have announced a digital clock designed primarily as a master programme timer. A synchronous motor supplied from the mains drives a series of reed uniselectors in cascade to provide a digital read-out in hours

(continued on page 443)

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For further information circle 259 on Service Card

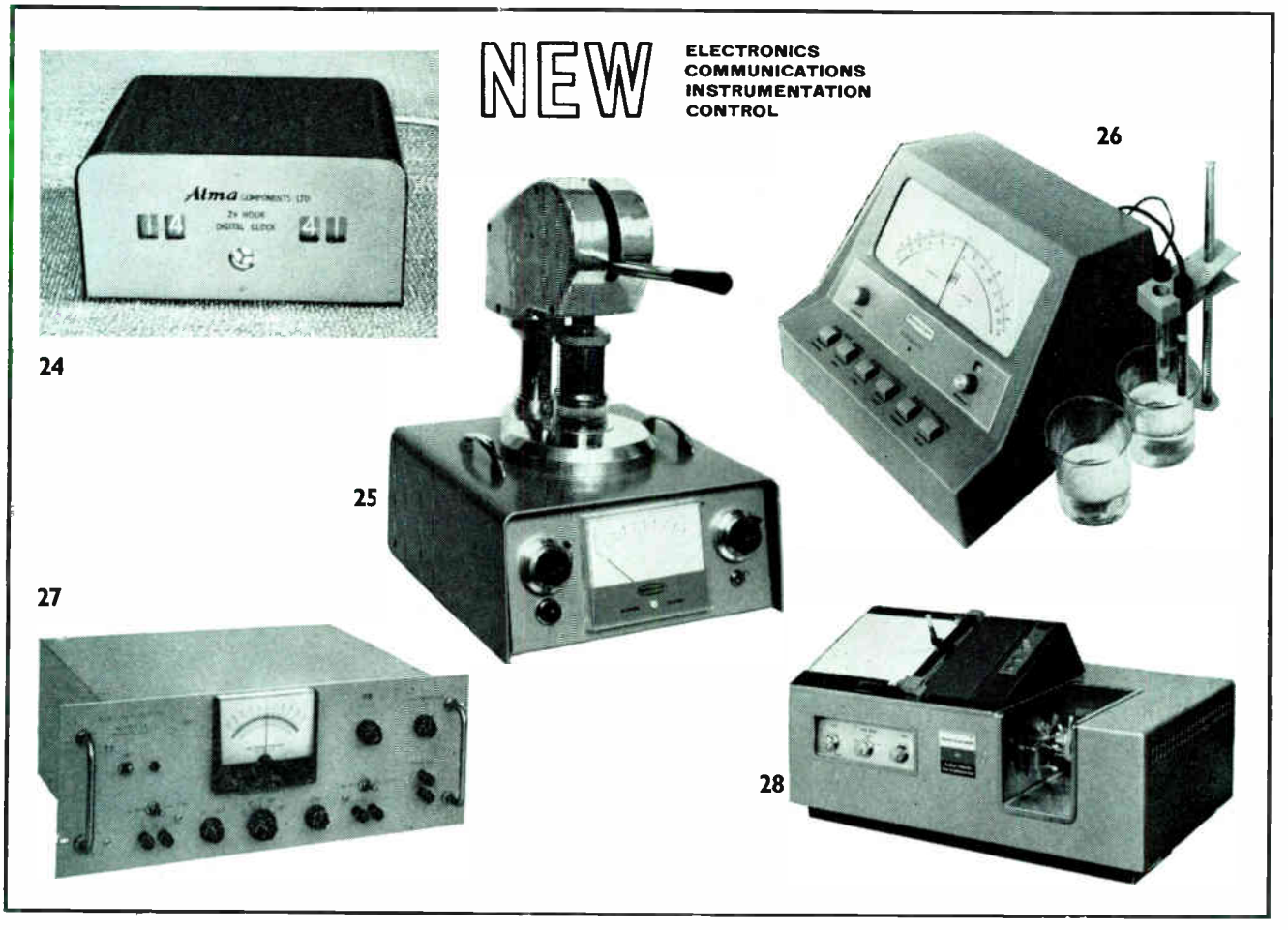
INDEX TO PRODUCTS

Please refer to appropriate pages to obtain code number for marking enquiry card

A—Advertising pages E—Editorial pages

MANUFACTURERS' LITERATURE

Page E429



and minutes. Initial setting to the correct time is carried out simply by four reed push-button switches at the back of the instrument. The uniselectors can be connected by the user to close or open an internal contact. The complete cycle is repeated every 24 hr or, by operating a switch, the clock can be converted for 12-hr operation. It can also be supplied having any desired time cycle (e.g., 48 hr, 60 hr, etc.) or to count in minutes and seconds. Special additional features can be incorporated to meet particular applications.—*Alma Components Ltd., Park Road, Diss, Norfolk.*

For further information circle 24 on Service Card

25. Moisture Meter

A moisture meter which ensures that the test sample is held at a constant pressure has been produced by Shaw Moisture Meters. A variation in the density of the sample, which would be caused by a pressure variation, will result in an inaccurate reading of moisture content. With the Shaw pressure-type moisture meter, pressures of 0–120 lb can be applied. Moisture readings accurate to 0·1% are directly given on a clear 5-in. scale. This accuracy is maintained throughout the operating range of the unit, this being ensured by the use of 10-turn precision potentiometers for the level and range controls.—*Shaw Moisture Meters Ltd., Rawson Road, Westgate, Bradford, Yorkshire.*

For further information circle 25 on Service Card

26. pH Meter

The 'Zeromatic II', a laboratory pH meter produced by Beckman Instruments, features push-button controls for ease of operation. The measurement ranges are 0–14 pH, 0–1,400 mV and −700 to 0 to +700 mV. The accuracy is ±0·05 pH or 5 mV and the stability is ±0·025 pH. An internal voltage compensator corrects for mains-supply fluctuations. Temperature compensation and a recorder output have been included. —*Beckman Instruments Ltd., Glenrothes, Fife, Scotland.*

For further information circle 26 on Service Card

27. Phasemeter

The model 350 phasemeter produced in the U.S.A. by the Wiltron Co. is now available in this country from Wessex Electronics. It operates in a frequency range of 10 c/s to 500 kc/s, a direct reading of phase being provided with a resolution of 0·1° at all angles. The accuracy does not fall below 0·5° for any angle. Input levels between 1 mV and 50 V can be accepted without the need for external attenuators or amplifiers and the input level can vary over a wide range without affecting the reading. A switch is included which allows the operator to take readings of 180° relationships with the needle at the centre-zero position. This eliminates the needle swinging from plus to minus 180°.—*Wessex Electronics Ltd., Royal London Buildings, Baldwin St., Bristol, 1.*

For further information circle 27 on Service Card

28. Spectrophotometer

The model 157 infra-red spectrophotometer introduced by Perkin-Elmer features automatic operation.

NEW

ELECTRONICS
COMMUNICATIONS
INSTRUMENTATION
CONTROL

A full quantitative spectrum from 2·5–15 microns can be recorded in 5 min and a qualitative run can be completed in less than one min. The spectrum is presented on the chart recorder as linear transmission against linear wavelength. After one spectrum has been completed, the wavelength is automatically reset to 2·5 micron and the paper is automatically advanced in the chart recorder. The next spectrum recording is initiated by operation of the start button. Various accessories, sample holders, etc., can be obtained.—*Perkin-Elmer Ltd., Beaconsfield, Bucks.*

For further information circle 28 on Service Card

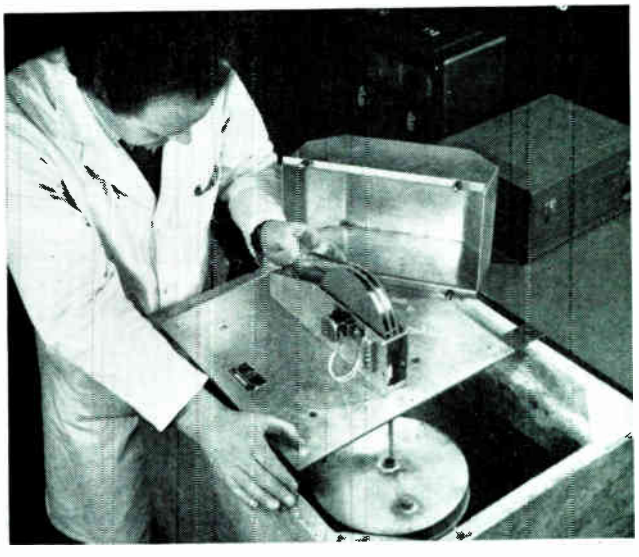
29. Small-Force Measurement

Schaevitz Engineering has developed a system, model A–FMS–3, for the accurate measurement of small tensile or compressive forces in the ranges of 0–1 oz up to 0–100 oz. The system consists of a dynamometer and a null-balance servo-driven indicator with an illuminated, moving tape, readout. The dynamometer frame supports a linear-variable differential transformer. The transformer core is suspended between two calibrated beams and a sensing probe. The deflection of the beams due to the applied force is transmitted to the transformer core, inducing an output voltage proportional to the force.—*Schaevitz Engineering, U.S. Route 130 and Schaevitz Boulevard, Pennsauken, New Jersey, U.S.A.*

For further information circle 29 on Service Card

29

31



30

CONTROL

30. Level Transducer

A float level transducer, for use on remote indication and control systems where an accurate feedback of the level of liquids is required, has been introduced by Scientific Systems. Two tapes, made of thin flexible stainless steel and wound in opposing directions (one is connected to the float, the other to a counterbalance weight) operate on a composite pulley to drive a hermetically-sealed potentiometer in proportion to the movement of the float; this enables a proportional electrical signal to be fed into the supervisory system. The unit, which requires no lubrication, is mainly for applications in the water, effluent and drainage industries, but may be used for other liquids by using the appropriate float material.—*Scientific Systems Ltd., Stover Trading Estate, Yate, Bristol.*

For further information circle 30 on Service Card

31. Direct-on-Line Starter

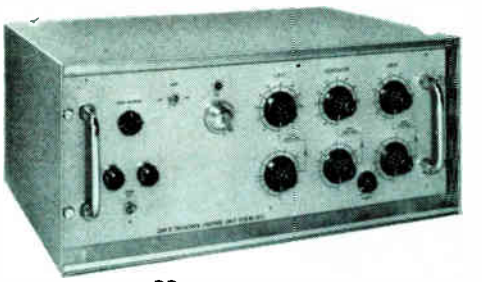
A new direct-on-line starter, mounted in a cast-metal case and suitable for use with 7½-h.p. motors, can now be supplied by B & R Relays. The starter (known as the KU12/S) comprises a type-K12 contactor and a type-U12 thermal overload unit, mounted in the metal case, which complies with BS578 Class 1A and has ¾-in. conduit entries at the top and bottom. The overload unit gives accurate tripping in overload conditions, with ambient-temperature compensation and single-phasing protection; tripping ranges are from 0·12–0·18 A up to 9–12 A.—*B & R Relays Ltd., Temple Field, Harlow, Essex.*

For further information circle 31 on Service Card

32. Speed Controllers

The speed of d.c. electric motors can be accurately controlled from rest to base speed with the 'Ergotrol' range of control units announced by The M.E.L. Equipment Co. The units enable speeds to be varied manually or by a control signal from a parent equipment or system, thyristors (s.c.rs) being used to control the motor-armature supply. Operating from a.c. mains, the range comprises seven models designed for use with d.c. shunt-wound motors from 1 to 40 h.p. to BS 2613. Regulation at the set speed is determined by feedback from the armature supply and is within 2½% of base speed, but a separate tachogenerator can be employed to provide the feedback signal, the regulation then being with-

32



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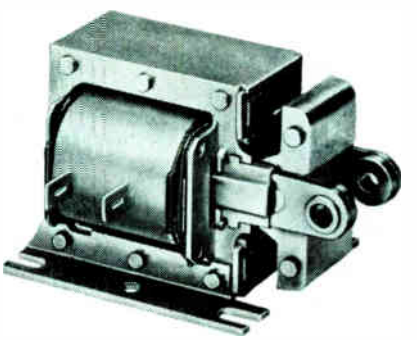

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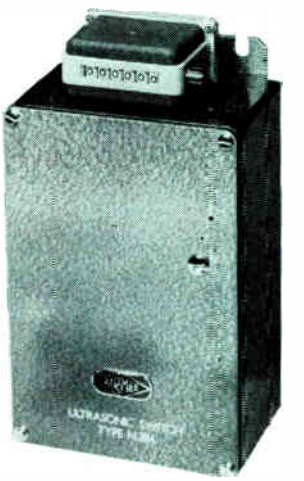


36

in 1% of base speed. A number of optional features are available, units up to 10 h.p. (shown here) being wall mounted, while those above 10 h.p. are console fitted.—*The M.E.L. Equipment Co. Ltd., Manor Royal, Crawley, Sussex.*

For further information circle 32 on Service Card

33. Impulse Generator Control Unit

P.C.D. have introduced a trigatron firing unit which will control high-voltage impulse generators, associated cathode-ray oscillograph transient recorders and chopping gaps or other devices. A chopping gap consists of two spheres connected in parallel with the transformer which is being tested by the impulse generator. The breakdown of the gap between the spheres can be controlled by the firing unit as part of the test procedure. The control unit produces a series of pulses which start the recorder, initiate the high-voltage surge and fire the chopping gap.—*P.C.D. Ltd., 4 Blackwater Station Estate, Camberley, Surrey.*

For further information circle 33 on Service Card

34. Dyebath Controller

A precision programme controller has been introduced by Fielden Electronics for controlling dyebath temperature conditions, which must be reproduced exactly to achieve accurate colour-shade matching. A plastic cam is cut to the desired temperature 'contour', and this is followed by a capacitive detecting head to give proportional control to a steam valve. This cam-follower unit transfers the control to a precision thermostat when the critical temperature value is being approached, a six or twenty-four hour chart recording of dyebath temperatures being provided.—*Fielden Electronics Ltd., Wythenshawe, Manchester 22.*

For further information circle 34 on Service Card

35. Control Solenoids

Plessey have started to produce three ranges of compact control solenoids (for a.c. or d.c. operation), which are being made under a licence agreement with Dormeyer Industries, of Chicago. The Super-C series is of folded-frame design, comes in three sizes and has holding forces of 0·8 to 2·5 lb at the rated a.c. or d.c. voltage. The Super-D series is box framed, has eight sizes and offers holding forces of 0·6 to 2·5 lb. Finally, the Super-T series (shown in the picture), which is for a.c. operation only, is of laminated design, comes in four sizes and has pulls up to 12 lb at 1-in. stroke.—*Plessey Wound Components Ltd., Abbey Works, Titchfield, Hants.*

For further information circle 35 on Service Card

36. Ultrasonic Switch

A non-contacting ultrasonic switch (type N384), for use under difficult conditions, has been designed by

Airmec Ltd. Normally housed in a robust modular case, the switch consists of a control unit, power unit and a pair of probes, between which an ultrasonic beam at approximately 40 kc/s is maintained. Interruption of the beam for as little as 2 msec causes relay contacts to change over, providing a switching action which may be utilized for control and/or counting. The beam may be interrupted by (or reflected from) products, including transparent objects, and can be piped into inaccessible places. The performance of the switch is unaffected by atmospheric pollution, probe contamination or ambient light. Operational selection is achieved by the use of small 14-pin function plugs, which are plugged into a socket on the front panel of the control unit.—*Airmec Ltd., High Wycombe, Bucks.*

For further information circle 36 on Service Card

COMPONENTS

37. Switches

Elremco have announced a range of push-buttons and switches designed to augment their SBIK range of motor starters and contactors. The units are constructed on a modular system so that the form or style of a

NEW

ELECTRONICS
COMMUNICATIONS
INSTRUMENTATION
CONTROL

unit can be changed by substituting other types of push-button in the range. The switch elements consist of one normally-open and one normally-closed contact rated at 6 A, 250 V a.c. inductive or 2·5 A, 550 V inductive. The elements may be stacked for six normally-open and six normally-closed contacts. Included in the range are illuminated push-buttons and lamp fittings, three-position push-button units, key switches, two- and three-way selector switches as well as other types.—*The Electrical Remote Control Co. Ltd., Bush Fair, Harlow, Essex.*

For further information circle 37 on Service Card

38. Reed Switch

Alma Components have introduced two reed-relay push-button switches. These have been designed to give a clean make and break with a minimum of bounce or spurious contact. The type RSA has a normally-open contact and the RSB is normally closed. Maximum ratings are 0·5 A at 200 V or 10 W into a resistive load. The life is better than 10^8 operations. —*Alma Components Ltd., Park Road, Diss, Norfolk.*

For further information circle 38 on Service Card

39. Battery Holders

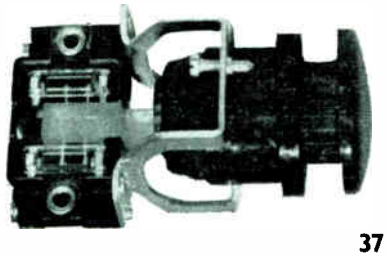
A group of panel-mounting battery holders has been introduced by Bulgin. These accept one, two or three U.11 or similar batteries. The bodies are all plastic and the screw-on front cap is clearly legended 'Battery' and also shows the correct way to load. The rear solder tags and all internal metal parts are produced from corrosion resisting material and the contacting spring helps to push the cells forward when refilling. All models fix through the panel and are provided with a rear lock-nut.—*A. F. Bulgin & Co. Ltd., Bye-Pass Road, Barking, Essex.*

For further information circle 39 on Service Card

40. Polystyrene Capacitors

Salford Electrical Instruments Ltd. are producing a range of polystyrene capacitors known as the type RPF. These have been designed for exacting professional applications where high reliability is required together with a high stability, a low power factor and a negative temperature coefficient. The components are manufactured in four ranges of capacitance and working voltage. These are: 63 V, d.c., 1,500–510,000 pF; 160 V, 5–510,000 pF; 630 V, 5–200,000 pF; and 2,500 V, 10–100,000 pF.—*Salford Electrical Instruments Ltd., Barton Lane, Eccles, Manchester.*

For further information circle 40 on Service Card



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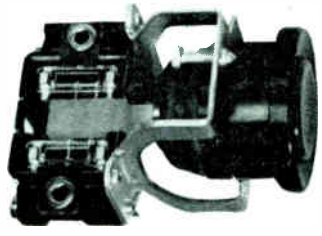

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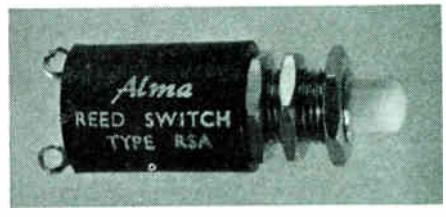

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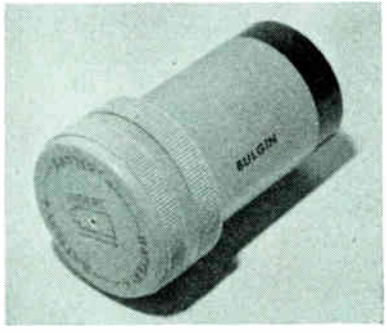

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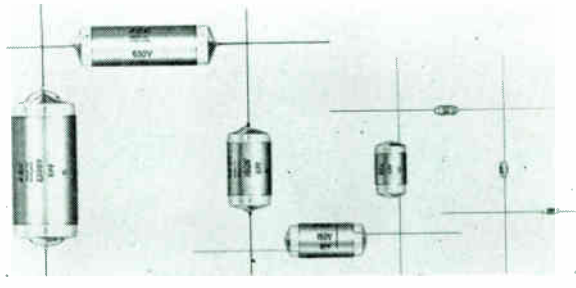

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1 in 3 computer controlled systems sold is by Ferranti

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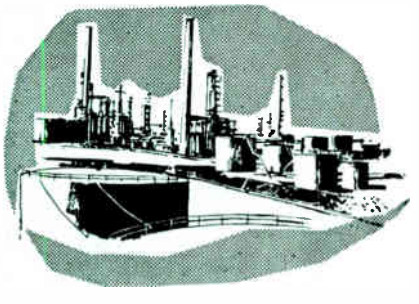


2 year evaluation by ICI leads to orders for 6 more

More than a third of all process controlled computer systems installed or ordered in the U.K. are by Ferranti—more than by any other manufacturer. Direct Digital Control or DDC is the name given to the computer control system pioneered by Ferranti. First installed in 1962 at ICI Soda Ash Plant at Fleetwood, it was the first, and still is the most advanced, installation of its type in the world. ICI alone have ordered six more—one of them a mobile installation that can be tried out at various plants to confirm automation feasibility. Five of these systems have been delivered.

What is DDC?

Direct Digital Control Systems are computer oriented, the computer being one of the Ferranti Argus range. The computer samples at high speed anywhere up to 1,000 or more plant variables, calculates the required control functions and directly operates the control valves to conform to the computer's instructions.

What types of plant can DDC automate?

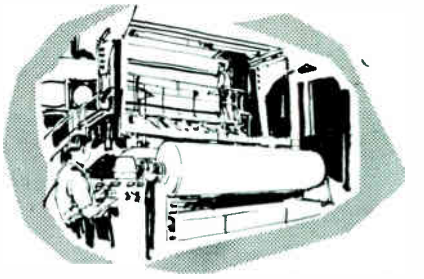
DDC systems can be used for the automatic control of both continuous and batch processes. Any industrial process in which a large number of parameters have to be kept under control or surveillance comes within the scope of DDC. DDC systems can be used to control new plant; or plant not fully automated, by replacing or supplementing analogue controllers; or they can operate in series or parallel with existing controllers.

What puts DDC in a class by itself?

The essence of DDC is that all operational data is converted to digital terms. Digital systems operate with more precision, and occupy considerably less space than analogue systems. Yet they cost less, and are more reliable. They are more flexible in use, offer a wider range of options. As better knowledge of the plant accumulates, DDC allows progressive improvement in the control schemes, which can be implemented merely by changes in the computer programme.
More than any other system, they simulate the thought processes used by plant management, with the additional facility of calculating optimum operational settings under any given set of circumstances. This facility of optimisation is built into all Ferranti DDC systems.

How DDC works

DDC standard systems comprise an Argus computer, appropriate items of Argus input and output equipment, and an operator's control desk. The system takes as input electrical analogue and/or digital signals from plant transducers. The computer compares this data with previously designated set points and limits held in its memory. It may make optimum decisions. It calculates the required control functions. This data is used to operate directly on valve actuators or similar devices.



What makes DDC universal in application?

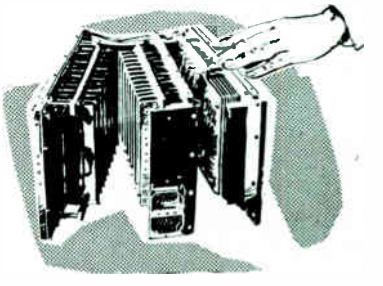
A fully modular range of input-output equipment, that can be tailored to suit the needs of virtually any present industrial process or plant; and a range of highly developed computers to handle the central control.

ARGUS 100
ARGUS 300

The Argus range is specially designed for process control, with a well proven order structure and extensive software packages. The 100 is a low cost serial machine. The 300 is a much more powerful parallel machine.

ARGUS 400

This is the first of a new compatible range of micro-miniaturised computers. It combines low cost with high reliability, and can be expanded by plugging in more modules.



For further information on DDC, write to Automation Systems Division, Ferranti Limited, Simonsway, Wythenshawe, Manchester 22.

FERRANTI

ARE BIG IN AUTOMATION NOW

FAS 11
For further information circle 263 on Service Card

One of these Kemet Capacitors never left the factory

—which one and why not?

Most people would find it difficult to say. In fact, it was the fourth from the top. And the reason? A flaw so small that it took special X-ray equipment to detect it. Now such a flaw does not affect normal operational performance, and this particular capacitor would have proved perfectly satisfactory in a conventional circuit. But Union Carbide scrapped it without hesitation because all Kemet capacitors must meet the criteria laid down in Aerospace and Defence specifications. How does Union Carbide impose this rule inflexibly, yet keep prices down? The answer is stringent quality control throughout the manufacturing process. By obtaining all raw materials from approved sources and by constant attention to detail throughout production, Union Carbide ensure that reliability is "built-in" not "tested-in". This means the scrap rate is negligible and prices remain among the most competitive on the market.

If you would like to know more about Kemet solid tantalum capacitors and the advanced manufacturing and test methods which ensure their operational reliability, contact Union Carbide now!

Kemet Capacitors

another practical product of

UNION CARBIDE

UNION CARBIDE LIMITED, KEMET DEPARTMENT, ENGINEERING PRODUCTS DIVISION, 8 GRAFTON STREET, LONDON W1. MAYFAIR 8100
Sales and Enquiries: Aycliffe Industrial Estate, Co. Durham. Aycliffe 2601.
UK Distributors for 'J' Series Capacitors: SASCO Gatwick Rd., Crawley, Sussex.

CHEMICALS · CRYOGENICS · DYNEL FIBRE · ELECTRIC WELDING · ELECTRONICS · FERRO-ALLOYS · FLAME PLATING · PRESTONE CAR POLISH · SILICONES · SUPERALLOYS · UCON LUBRICANTS

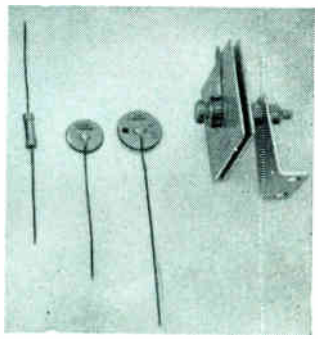
The terms Kemet, Dynel, Prestone, Ucon and Union Carbide are registered trade marks of Union Carbide Corporation

EC 90

For further information circle 264 on Service Card

NEW

ELECTRONICS
COMMUNICATIONS
INSTRUMENTATION
CONTROL



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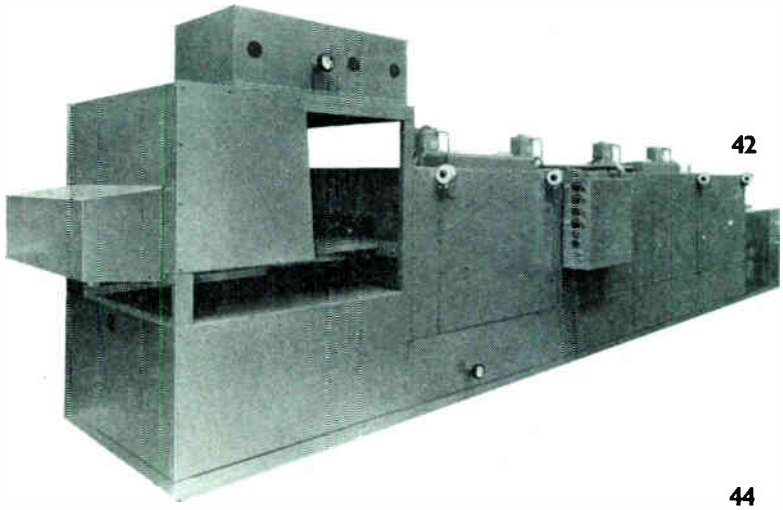

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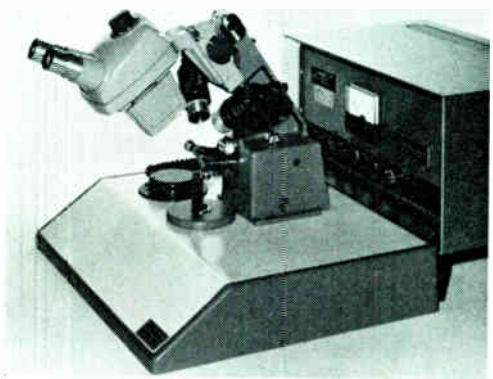


41. Varistors

A range of Sanken silicon carbide varistors known as the TVHS series can now be obtained from Photain Controls. The operating voltages of the units are between 150 and 840 V at d.c. currents of 1 mA. The resistance values at 1 mA d.c. are from 150–840 kΩ. For the complete range, the maximum permissible power is 1 W and the maximum operating temperature is 100 °C.—*Photain Controls Limited, Randalls Road, Leatherhead, Surrey.*

For further information circle 41 on Service Card

PRODUCTION AIDS

42. Conveyor Ovens

A.E.W. are offering a range of conveyor ovens which provide controlled heat treatment for mass-produced products. Two conveyor belts in each oven carry the products at variable speeds through a drying tunnel. Air is drawn from the working chamber, forced over heating elements and returned via slots at the base of the tunnel. An adjustable flue system controls the air exchange and the heaters automatically switch off in the event of a fan stoppage. Four thermometer regulators control the temperature for rapid and uniform heating throughout the length of the working chamber.—*A.E.W. Ltd., Imperial Works, High Street, Edgware, Middlesex.*

For further information circle 42 on Service Card

43. Conveyors

Gramac (Mechanical Handling) Ltd. have introduced the 'Miniway' conveyors for inter-machine and production-line conveying. Conveyors with belt widths from 2–48 in. are offered. The 'Miniway' is a precision-built conveyor with a box-section framework, crowned driving drums, sealed bearings, tensioning devices, a fractional horsepower motor, and with mounting plates for fixing to existing machinery. Being of unit construction, it may be built up into any required length.—*Gramac (Mechanical Handling) Ltd., Rye Road, Hoddesdon, Herts.*

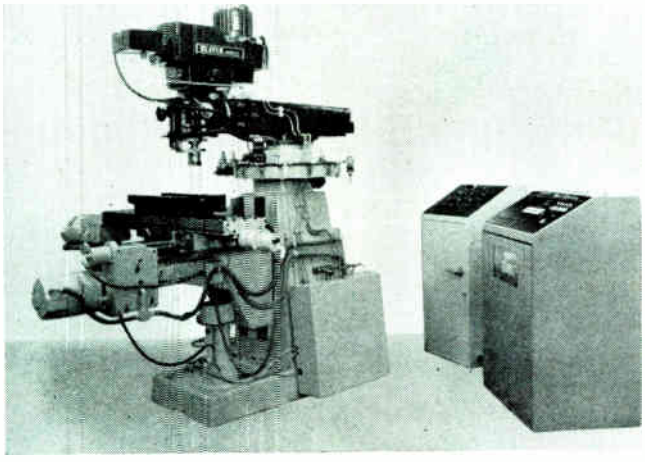
For further information circle 43 on Service Card

44. Ultrasonic Welder

Electrautom are distributing in the U.K. an ultrasonic welder for use in semiconductor manufacture where low heating is essential. Manufactured in America by Engineered Machine Builders, it is illustrated with an ultrasonic power source built by the Sonoband Corp. A rotatable chuck holds the workpiece which is viewed through a microscope. The operator positions it under the wire feed and welding tip using a hand control. A foot pedal is used to initiate the weld. The workpiece is then repositioned for the next weld, the wire being fed out automatically. After the second weld the wire is neatly severed at the joint. Alumin-

NEW

ELECTRONICS
COMMUNICATIONS
INSTRUMENTATION
CONTROL



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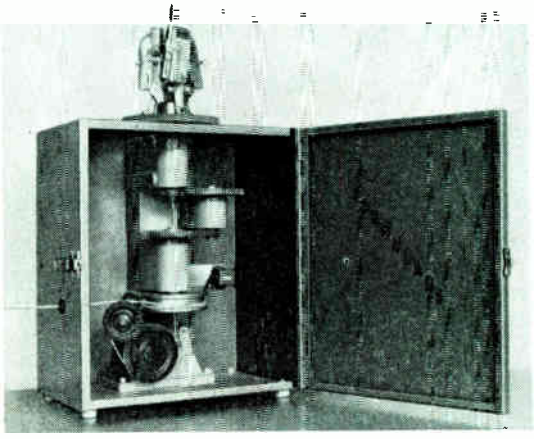

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ium, gold or other wires of diameters between 0·0005 and 0·002 in. can be used.—*Electrautom Ltd., 408 Finchley Road, London, N.W.2.*

For further information circle 44 on Service Card

45. Automatic Machining

The 'Beavermatic' recently introduced by Balding Engineering is an automatic drilling, milling, tapping, boring and machining equipment controlled by punched tape and hydraulics. Ten different spindle speeds can be automatically selected and automatic tool changing is featured. The movement of the table is controlled in both X and Y axes and it can be positioned in either axis with a resolution of $\pm$ 0·0005 in. Vertical movement of the machine knee can also be controlled with a positional accuracy of $\pm$0·001 in.—*Balding Engineering Ltd., Sweet Briar Road, Norwich.*

For further information circle 45 on Service Card

46. Colour Coding Wires

A method of colour-coding p.v.c. insulated wire which has been developed in the U.S.A. is now available on the European market. With the use of a machine produced by Formulabs Industrial Ltd., over 3,000 ft of wire per hr may be spirally-coded with one, two or three differently-coloured stripes applied simultaneously. Wire sizes from 3/64–7/32-in. in diameter are accommodated. The colour dries instantly, penetrates into the surface of the insulation and is abrasion and solvent resistant.—*Formulabs Industrial Ltd., Elstree Road, Elstree, Herts.*

For further information circle 46 on Service Card

47. Stud Welder

A portable stud welder, the 'Cromp-Arc 500', has been produced by Crompton Parkinson. It consists of a control unit, a handtool for application of the weld and associated cables and accessories. Studs and other attachments up to $\frac{1}{2}$ in. in diameter can be used and the system is suitable for use on mild steel and non-ferrous metals. Repetitive timing cycles accurate to $\pm$1% of setting are provided and the timer scale plate is calibrated in stud diameters in both British and metric sizes. The handtool incorporates an adjustable damping device for control of the speed of plunge of the stud.—*Crompton Parkinson Ltd., Crompton House, Aldwych, London, W.C 2.*

For further information circle 47 on Service Card

48. Sealant for Tubes

A special sealant for the bonding together of tubes of dissimilar metals has been added by Douglas Kane (Sealants) Ltd. to the range of 'Loctite' materials. Known as 'Tube Seal', it provides an inert and leak-proof bond having a minimum shear strength of 2,000 p.s.i. The material cures automatically at room temperature but a fast cure can be achieved by heating, for which a special heating device has been produced. The curing takes place only at the joint so that excess material can be wiped off. Considerable cost savings can be made if this method of bonding is used in preference to other methods such as brazing, welding or threading.—*Douglas Kane (Sealants) Ltd., Swallowfields, Welwyn Garden City, Herts.*

For further information circle 48 on Service Card

Industrial News

Personal News

Two sales appointments have been announced by Electrosil Ltd., of Sunderland. **John Campbell, B.Sc.,** is now marketing manager, and **John Booth** has moved to Slough as field sales manager.

N. F. Durrant, B.Sc., formerly with Semiconductors Ltd., has been appointed technical manager of the Glenrothes (Fife) plant of Hughes International (U.K.) Ltd.

Geoffrey J. Crask has now taken up the position of chief engineer (in charge of engineering, systems design and R. & D.) of Redifon-Astrodata Ltd., a member company of the Rediffusion Group. Also announced is the appointment of **David C. Seale** as export sales manager.

J. N. Aldington, B.Sc., Ph.D., M.I.E.E., F.R.I.C., F.Inst.P., a vice-chairman of A.E.I. Ltd., has been elected president of the Telecommunication Engineering and Manufacturing Association for the next two years.

H. N. Pemberton has been elected chairman of council of the Council of Engineering Institutions, and will take office next January.

Albert F. Holdaway, previously with Philips Industries Ltd., has joined the consultancy group of C-E-I-R Ltd., management-science consultants. The company's new assistant training manager is **Colin Tully,** formerly with English Electric-Leo-Marconi Computers Ltd.

G. Seear, M.I.E.E., has joined STC Ltd. as manager of the installation division in their transmission systems group. Based at Basildon, he is responsible for all group products and integrated systems involving landline and microwave equipment.

Colin N. E. Woodley has been appointed publicity manager of Marconi Instruments Ltd. (an English Electric Company); he will be in control of the publicity, photographic, technical-translation and printing departments.

Edward L. Falls, former director of industrial products, has been named the new director of international products for the communications division of Motorola Inc.

H. H. Harper, A.M.I.E.R.E., has been appointed sales manager of Scientific Systems Ltd., of Bristol, makers of electronic control systems.

Thomas A. Lee has been appointed to the newly-created position of field sales manager of Racal Instruments Ltd.

John Ware, F.R.I.B.A., has been elected chairman of council of the Television Society for the 1966-67 session. The new vice-chairman is **K. A. Russell, B.Sc., A.M.I.E.E., M.I.E.R.E.**

At the recent A.G.M. of The Institute of Physics and The Physical Society, the following were elected to honorary offices and as members of council: president, **Sir James Taylor;** vice-president, **Dr. J. V. Dunworth;** honorary treasurer, **Mr. P. T. Menzies;** honorary secretary, **Dr. R. Press;** new ordinary members of council, **Dr. P. F. Chester, Dr. B. R. Coles, Dr. J. W. Menter** and **Mr. L. A. A. Thomas.**

Company News

The Fairchild Camera and Instrument Corp., of the U.S.A., has registered a British Company — **Fairchild Instrumentation Ltd.**—to supply solid-state semiconductor test and measurement systems. The new manager is Joseph M. Dietz, and the company's address is Grove House, 551 London Road, Isleworth, Middlesex. (Phone: (01) 560 0838).

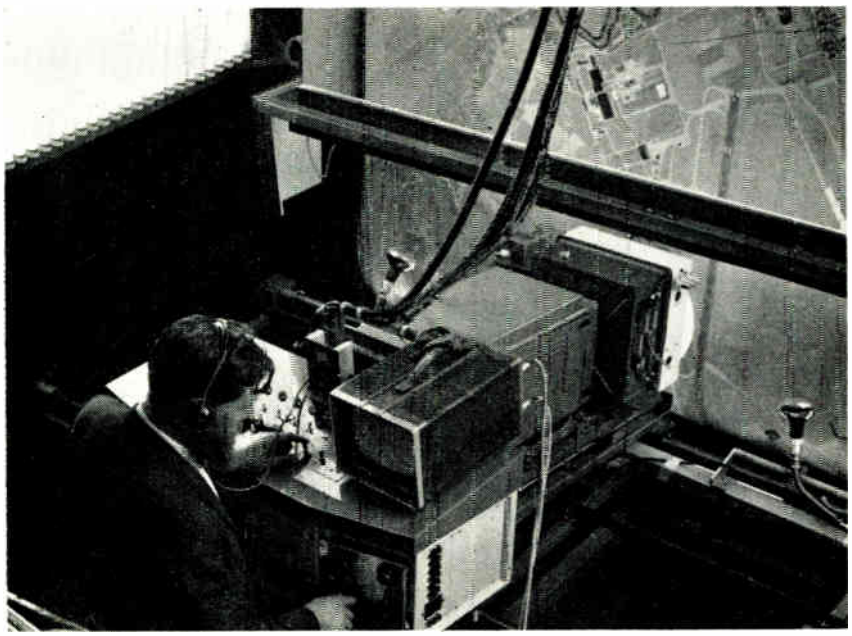
Kent Precision Electronics Ltd., manufacturers of solid-state industrial control instrumentation, have changed the name of their company to **KPE Controls Ltd.**

Vitality Bulbs Ltd., specialists in miniature indicator lamps, have moved to new premises at Beetons Way, Bury St. Edmunds, Suffolk. (Phone: Bury St. Edmunds 2071).

A new company, **Data Dynamics Ltd.** has been formed by two former G.E.C. men, Mike Tyndall and Dick Seal. Its products will consist of a range of tape-based equipment for feeding information into computers.

Impex Electrical Ltd. have been appointed sole U.K. agents for the products of the A. W. Haydon Co. of the U.S.A., manufacturer of precision timing motors, control devices and automation test equipment.

AN INTERLOCKING CONTROL SYSTEM, *installed at the Ferrybridge 'C' power station by STC Ltd., has allowed standardization of switchgear and centralization of plant interlocks to be accomplished, thus permitting considerable saving in costs at both the design and construction stages. The basis of the system—a control desk and panel of which are shown here—is a mechanical latch relay which is housed in a plug-in unit to form a 'building brick'; this can be easily fitted on to vertical frameworks and wired to suitable terminal blocks. The relay is fitted with numerous contact sets which can be connected into any wiring sequence chain by single-core wiring*



THIS COLOUR VISUAL FLIGHT ATTACHMENT (VFA), *which provides added realism for air-crew training in flight simulators, has been developed by General Precision Systems Ltd., of Aylesbury, for research on the supersonic Concorde airliner. Incorporating a closed-circuit colour television channel and an electronic computer, the system uses a special camera to scan a moving-terrain model from a position representing that of a pilot's eye*

English Electric Valve Co. Ltd., of Chelmsford, has entered into a technical-assistance and licence agreement with the electron tube division of **Litton Industries,** of California, U.S.A. This will allow an exchange of information and licences on tube development, production techniques and research concepts.

FieldTech Ltd. have been appointed by **M.E.L. Equipment Ltd.** as sales and service distributors (London and Southern England area) for the Philips range of mobile v.h.f. radio telephone equipment.

The **Electronic Engineering Association,** the **Scientific Instrument Manufacturers' Association** and the **British Electrical and Allied Manufacturers' Association** have formed a joint traffic engineering and instrumentation group, to be provided with secretarial services by SIMA, 20 Peel Street, London, W.8. (Phone: Park 2614).

The address of **SGS-Fairchild** is now Planar House, Walton Street, Aylesbury, Buckinghamshire. The telephone number is Aylesbury 5977.

Spembly Electronics have moved from their premises at Chatham to a recently-opened factory in Andover. The address is now Enham Arch, Newbury Road, Andover, Hants, telephone number Andover 5741.

A separate electronics division of **Union Carbide Ltd.** has been created to handle the company's growing range of electronic products. The division's factory is in Aycliffe, Co. Durham, where solid tantalum capacitors and barium getters are at present being manufactured.

Telcon Plastics Ltd. and **Industrial Reels Ltd.**—both in the British Insulated Callender's Cables group of companies—have been regrouped under control of a newly-formed industrial plastics division. The new director and general manager is D. Norman-Thomas, T.D., F.C.A.

A new fluidics division has been formed by **Techne (Cambridge) Ltd.** It will handle the development and marketing of the company's range of fluid-logic devices, which form the basis of the 'Technelog' pneumatic-control system.

Smith Industries Ltd. and the Sperry products division of **Automation Industries Inc.,** of Connecticut, have arranged to utilize each others patents in the field of ultrasonic non-destructive testing.

New National Technical Committee

The Council of the Society of Instrument Technology have decided to set up a single National Technical Committee to replace their previous four committees for automation, measurement technology, control and systems engineering. The new committee will be the focus of a re-organization within the Society, due to the changing emphasis of its technical activities; its first chairman will be Mr. R. E. Fischbacher (vice-president of S.I.T. and deputy director of B.S.I.R.A.).

P.C.M. for Telephone Service

The G.P.O. has placed orders for pulse code modulation (P.C.M.) terminal and line equipment with STC Ltd. and G.E.C. Ltd., to be installed towards the end of 1967. Invented in the laboratories of an associated STC Company, P.C.M. techniques will help to avoid congestion on links between telephone exchanges in London and the provinces by increasing the capacity of existing underground audio cables.

The new system will allow twelve conversations to be carried over only two pairs of wires, using existing

ACCURATELY DRILLING HOLES IN PRINTED-CIRCUIT BOARDS, *which have been designed for the range of A.E.I. CONPAC process computers, is here being achieved using a Possalux machine. Three standard sizes of holes can be produced by the machine, and altogether some 1,000 printed-circuit boards are built into each computer*

cables; speech is sampled 8,000 times per sec at the sending end, and is then converted into a sequence of pulses to be sent along the line at a rate of 1½ million per sec. Developed by the G.P.O. primarily for junction cables between 12 and 20 miles long, the system is highly resistant to cross-talk and noise disturbance, the terminal multiplex equipment making extensive use of modern micro-circuits.

Electronics Advisory Committee

A technical advisory committee on electronics has been set up by the Ministry of Technology under the chairmanship of Mr. I. Maddock, Deputy Controller (B) in the Ministry.

The Committee's terms of reference are:

(a) To identify within the field of electronics both research and development projects relating to systems, equipments, components and production technologies, the exploitation of which is important industrially and commercially.

(b) In relation to these projects to identify areas where effort and available facilities are considered to be too fragmented or on too small a scale.

(c) To make recommendations to Ministry of Technology and to review progress on electronics items in the Department's authorized programme.

The committee will have power to call on other bodies for advice and to co-opt members from industry and elsewhere if necessary.

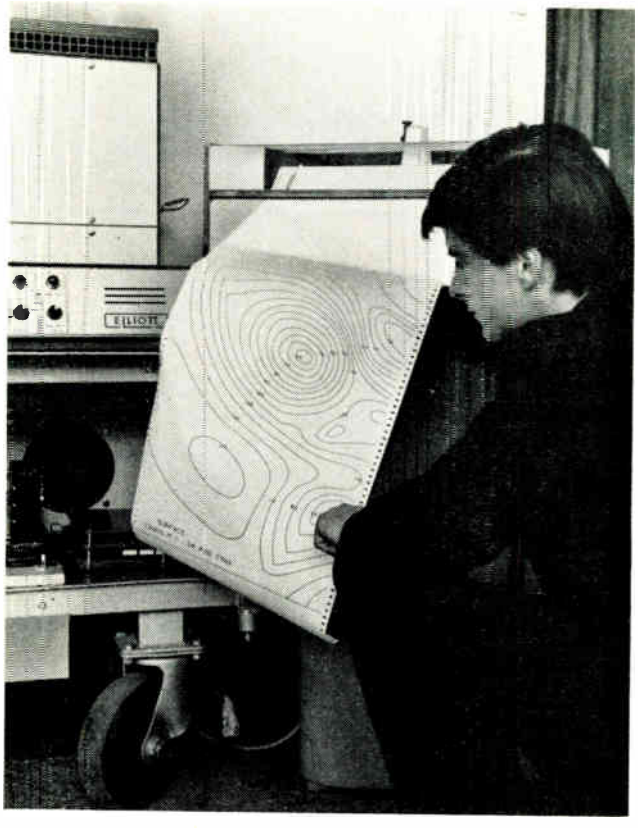
Members from industry have been appointed in their personal capacity, not as representatives of their companies or of the industries to which they belong.

BOAC Computer Programme

The recent announcement by BOAC of a £33½ million computer programme, to be completed over the next decade, represents a major step forward for the company into the 'era of scientific management'.

Following last year's announcement of the 'Boadicea' scheme, which was designed mainly for passenger seat reservations, passenger check-ins and weight-and-balance control, the new system to supersede it will eventually link nearly 100 BOAC stations throughout the world for six principal applications: planning and budgeting; current operations; engineering and maintenance; reservations, departure control and message switching; staff; and finance.

'Boadicea' was based on the use of two IBM computers, but the new system (which will be compatible with other airlines' computers) will necessitate yet another, which will not be available until late 1968. Before a final decision on the third machine is made, a complete evaluation of equivalent British equipment will be undertaken.



***AUTOMATIC PREPARATION OF WEATHER CHARTS** is here shown being accomplished by an Elliott-Automation 900-series computer, to which data on weather conditions is transmitted from meteorological stations dispersed over a wide area. The computer is used to prepare up-to-the-minute isobarometric and synoptic charts, thus allowing weathermen more time to concentrate on analysis and interpretation*

New Export Association Formed

Companies representing the bulk of the U.K. industry that provides postal machinery, equipment and supplies of all sorts (from post-office counter equipment to electronic letter and parcel sorting machines) have formed a new association to be known as the British Postal Equipment Engineering Association. The principal object of the association, which will have its headquarters in Locomotive House, 34 Buckingham Gate, London, S.W.1 (Phone: Victoria 1426), will be to promote exports to postal authorities throughout the world, and to provide a wide range of export marketing services to its members.

Machine-Tool Research

A three-year programme of research in gear cutting and finishing processes has started at Cambridge University. The research team, supported by a Science Research Council grant, will keep in close touch with both machine-tool manufacturers and users, as well as with design and engineering staff at Cambridge and with research workers elsewhere in this field.

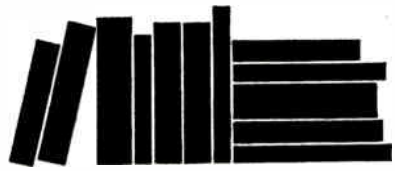
At first research will be concentrated on better designs for shaping, hobbing and shaving machines, concentrating in particular on the magnitude and directions of the cutting forces involved. More information about the optimization of the distribution of stiffness, inertia and damping in the kinematic train will also be sought.

VASCA and BVA Appointments

Mr. J. Bell (M-O Valve Company Ltd.) has been elected chairman of the Electronic Valve and Semi-Conductor Manufacturers' Association (VASCA) for the year beginning 1st July 1966, with Dr. F. E. Jones (Mullard Ltd.) as vice-chairman. Mr. A. Deutsch (Thorn-AEI Radio Valves and Tubes Ltd.) has been re-elected chairman of the British Radio Valve Manufacturers' Association (BVA) for a further year, with Mr. K. O. Rees (Mullard Ltd.) as vice-chairman.

Other VASCA appointments announced are Mr. J. Sharpe (E.M.I. Electronics Ltd.) as chairman, Group A. Management Committee, and Mr. E. Willis-Jones (Associated Electrical Industries Ltd.) as chairman, Group B Management Committee.

NEW BOOKS



Graphical Symbols for Electrical Power Telecommunications and Electronic Diagrams

B.S. 3939: Introduction: 1966, pp. 12 (price 5s.) and B.S. 3939: Sections 1 to 4, pp. 30 (price 15s.). British Standards Institution, 2 Park Street, London, W.1.

The publication of the first sections of B.S. 3939 begins the revision and amalgamation of B.S. 108 for general electrical symbols and B.S. 530 for telecommunication symbols.

To make the work available as early as possible the standard is being issued in groups of sections. The first two groups now available contain the general introduction and guidance on the use of symbols, and the following sections:—

Section 1: general qualifying and supplementary symbols. Section 2: unclassified symbols. Section 3: conductors and connecting devices, and Section 4: resistors. The symbols are intended for use in circuit, block and single-line diagrams.

The symbols in this Standard are identical with those internationally agreed within the International Electrotechnical Commission (IEC) except where established U.K. usage makes this impracticable at the present time. The lists of symbols and descriptions also give the general component reference (GCR) and show whether or not the symbol agrees with the IEC Recommendation.

Electrical Installations and Regulations

By J. F. WHITFIELD. Pp. 248 + xii. Pergamon Press, Headington Hill Hall, Oxford. Price 25s.

The purpose of this book is to provide the electrician with a clean and readily understandable explanation of the rules which apply to his work and to explain the reasons for them. It is based on the 'I.E.E. Regs'—*Regulations for the Electrical Equipment of Buildings: 13th Edition.*

A Guide to Supplier Quality Assurance in Engineering

Prepared by I.Prod.E.'s Quality and Reliability Committee. Pp. 30. The Institution of Production Engineers, 10 Chesterfield Street, London, W.1. Price 10s.

In producing this Guide, the Institution has recognized the need for guidance in, and dissemination of, the methods by which customers (i.e., manufacturing firms) may assure themselves that their potential suppliers possess the necessary skills, equipment and knowledge to enable them to meet the standards of quality required.

Instruments Electronics Automation Year Book and Buyers Guide : 1966. 2nd Edition

Edited by T. G. WILLIAMS, A.M.I.MECH.E., M.INST.F. Pp. 688. Morgan Brothers (Publishers) Ltd., 28 Essex Street, London, W.C.2. Price 60s.

In this latest edition the eight main sections have been completely revised and in many cases considerably expanded. Two new sections—'export information' and 'standard specifications'—have been introduced. Some 300 new firms have been added to the address section bringing the total to about 2,700 while the number of entries in the classified 'buyers guide' has been increased by approximately 10,000. The nineteen original equipment surveys have been brought up-to-date and the list has been expanded to twenty-two by the inclusion of surveys of digital computers, hygrometers, and pH meters and electrodes. This is the best and most up to date reference guide of its kind available in the U.K.

Electrical Who's Who 1966-1967

Compiled by *Electrical Review*. Pp. 549. Iliffe Books Ltd., Dorset House, Stamford Street, London, S.E.1. Price 65s.

Since this first appeared, in 1950, it has become established as the standard guide to leading men and women in the various branches of the electrical and electronics industries. Over 1,250 new names are included in the biographical section and after the deletion of those who have died or have left the electrical field the total number of entries has increased to 8,250. Inclusion in this section is at the Editor's invitation and no charge is made for entries.

Correlation Equations For Statistical Computations

Translated from the Russian by EDWIN S. SPIEGELTHAL. Consultants Bureau Enterprises, Inc., 227 W. 17th Street, New York, N.Y. 10011, U.S.A. Price $9.50.

Marine Radio Manual

By G. L. DANIELSON, M.SC.TECH., B.SC., A.M.I.E.E., and F. C. MAYOH, GRAD.I.E.R.E. Pp. 621. George Newnes Ltd., Tower House, Southampton Street, London, W.C.2. Price 80s.

This book has been written primarily for those preparing to become ships' radio officers; it covers P.M.G. 1st and 2nd class certificates.

Junction Transistors

By JOHN J. SPARKES, B.SC. Pp. 249 +viii. Pergamon Press, Headington Hill Hall, Oxford. Price 25s.

This is intended for students of engineering or physics. It should be fully comprehensible to second-year undergraduates.

Specification for an Artificial Mastoid for the Calibration of Bone Vibrators

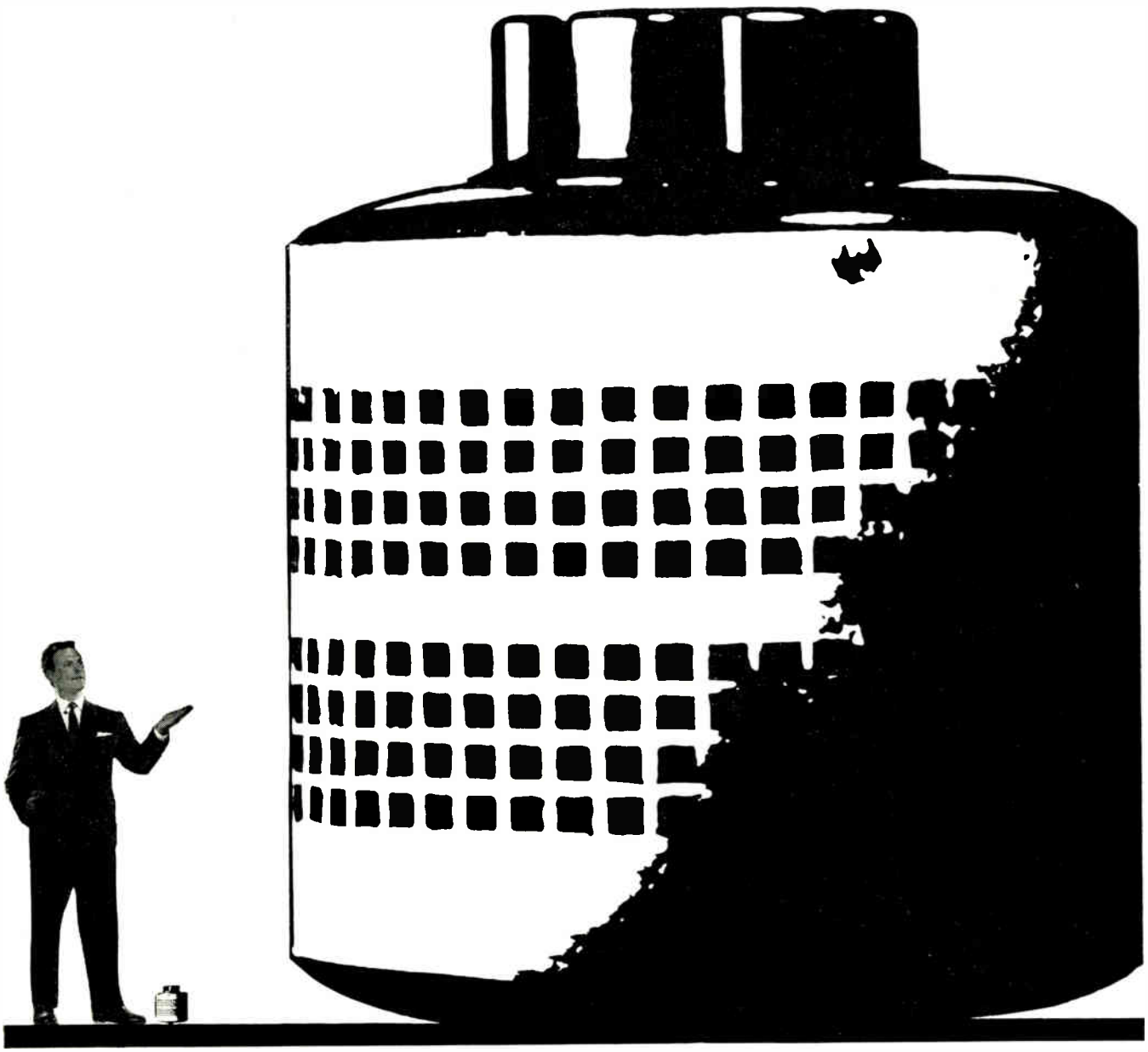
B.S. 4009 : 1966. Pp. 10. British Standards Institution, 2 Park Street, London, W.1. Price 4s. 6d.

Television Engineering, Volume 1

By S. W. AMOS, B.SC., A.M.I.E.E., and D. C. BIRKINSHAW, M.B.E., M.A., M.I.E.E. Pp. 301. Iliffe Books Ltd., Dorset House, Stamford Street, London, S.E.1. Price 45s.

Unsteady State Heat Transfer

By Y. V. KUDRYAVTSEV *et al.* Pp. 160. Iliffe Books Ltd., Dorset House, Stamford Street, London, S.E.1. Price 37s. 6d.



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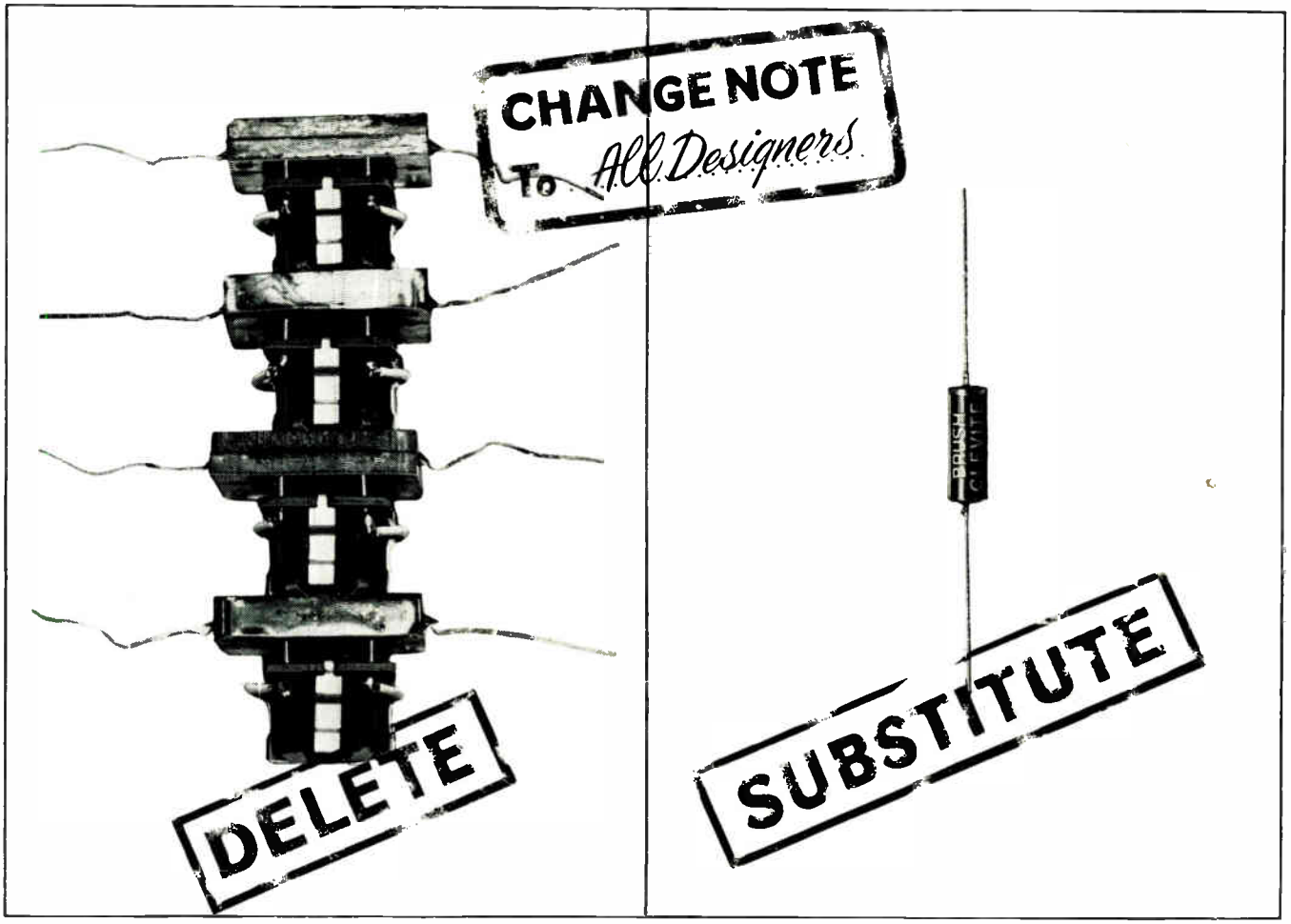

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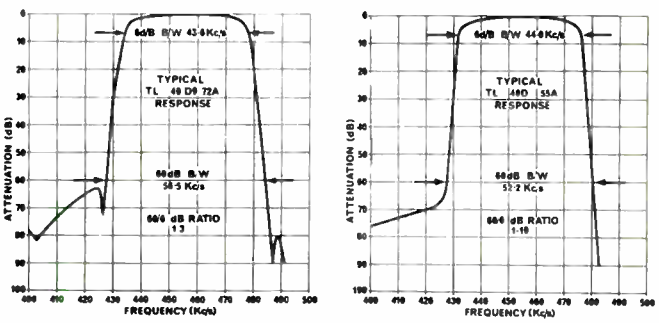

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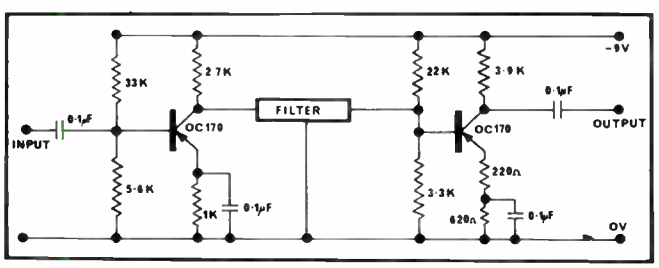

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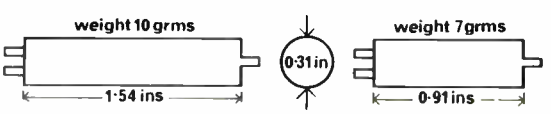

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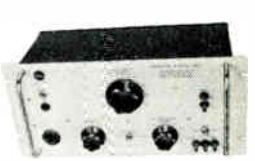

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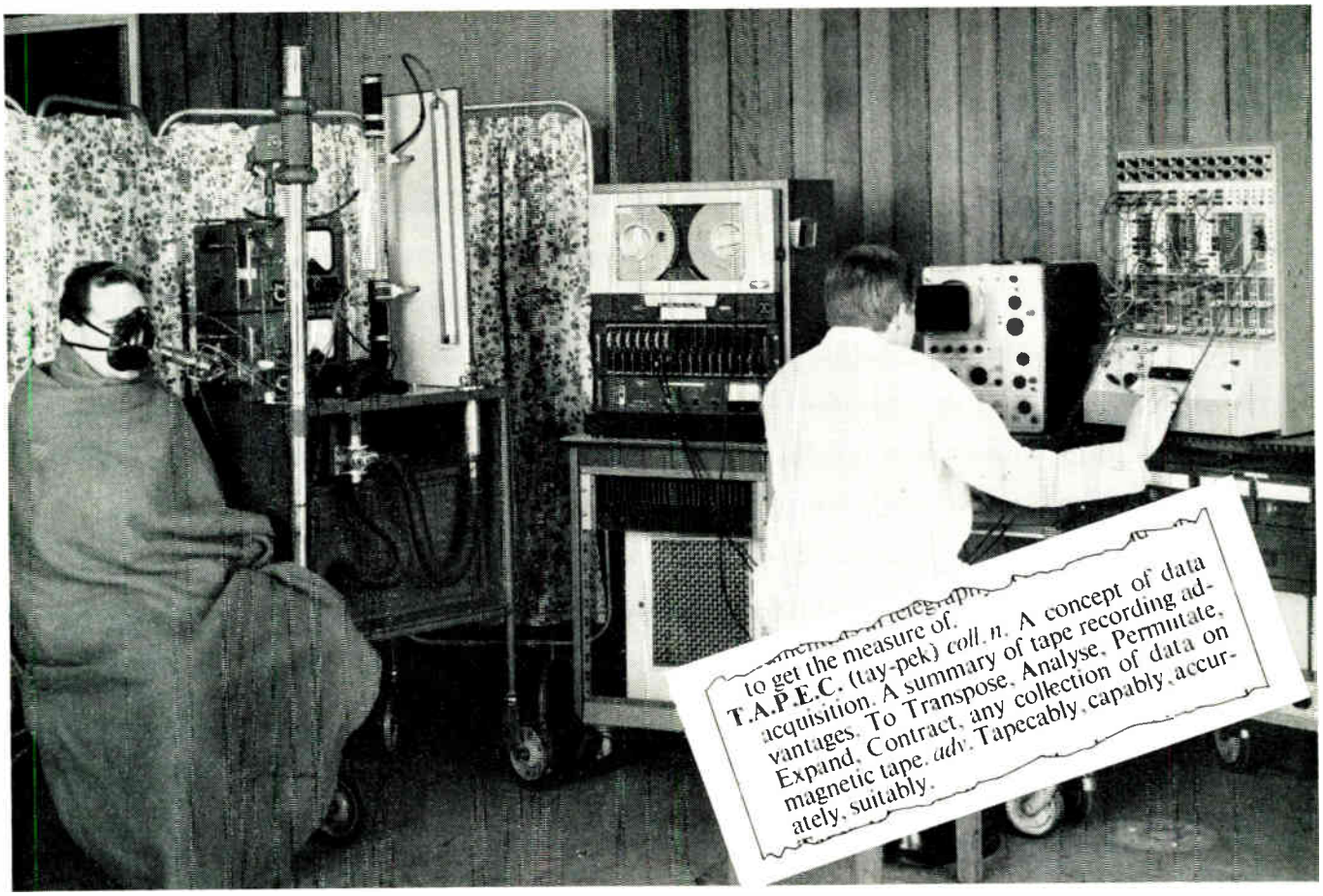

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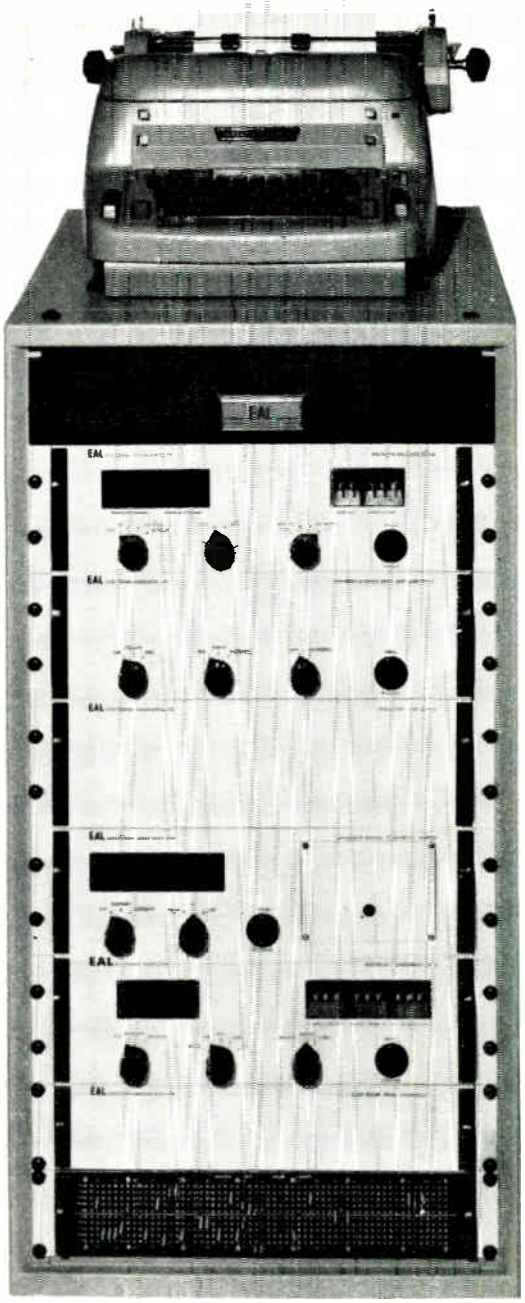

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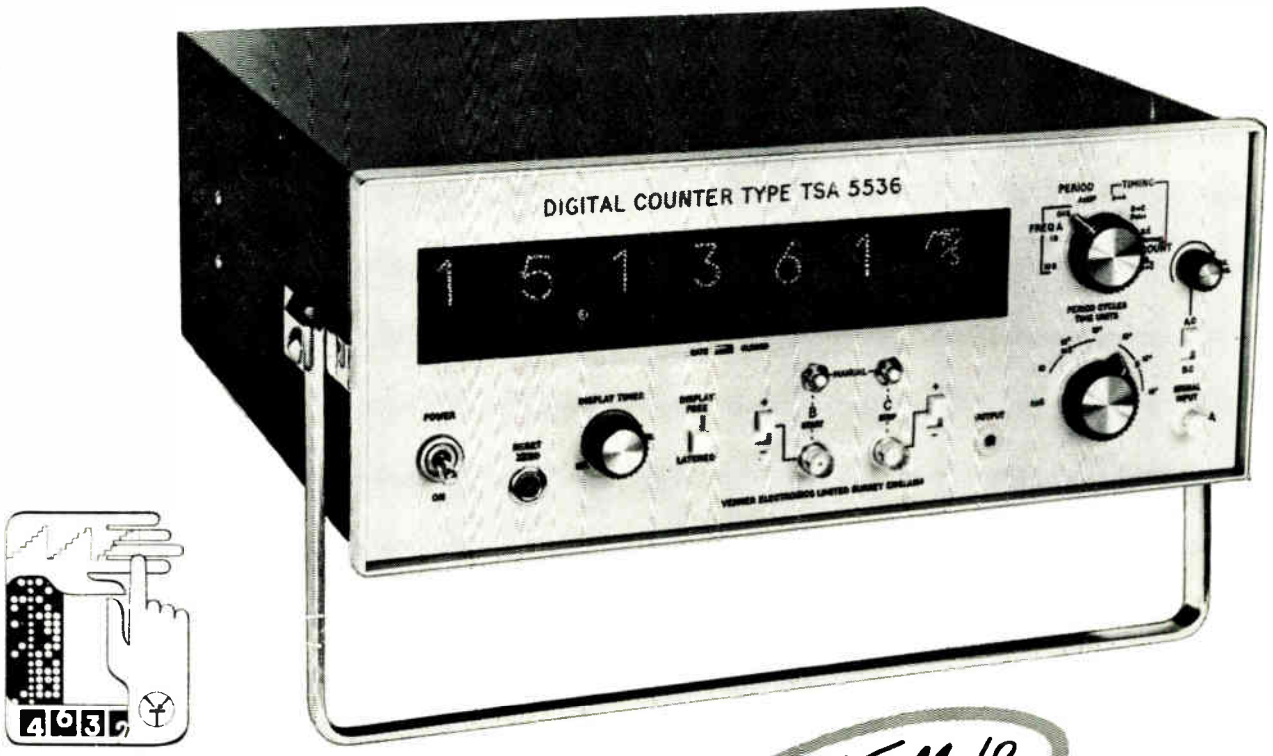

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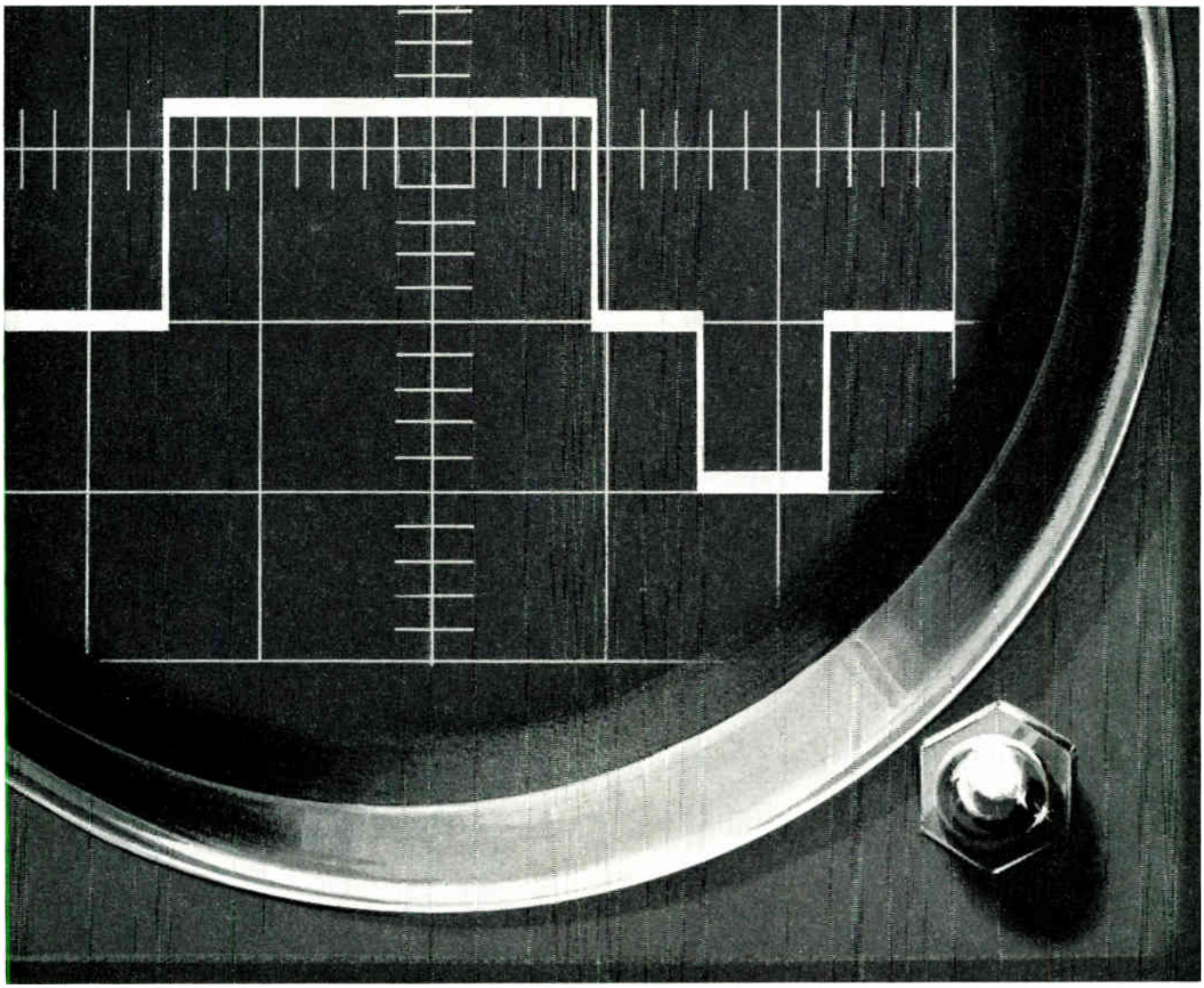

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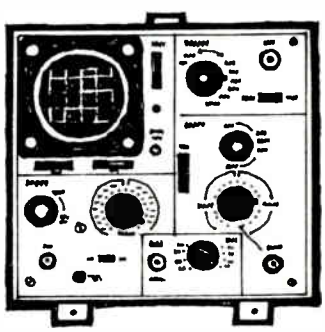

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INDEX TO ADVERTISERS

Meetings

Society of Electronic and Radio Technicians

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

23rd September. 7 p.m. Lecture on 'The Development of the Loud Speaker', supported by demonstrations. To be held at the Institution of Electrical Engineers, Savoy Place, London, W.C.2.

Conferences, Symposia and Colloquia

29th Aug.–2nd Sept. Symposium on Neutron Monitoring for Radiological Protection, to be held in Vienna. Further information from Mr. D. J. W. Dawes, Ministry of Technology, Millbank Tower, S.W.1. (Phone: Victoria 2255).

4th–8th September. Conference on 'Solid-State Devices', to be held at the University of Manchester Institute of Science and Technology. Organized jointly by the Institute of Physics and The Physical Society (47 Belgrave Square, London, S.W.1; Phone: Belgravia 6111) and the I.E.E., in collaboration with the I.E.R.E. and the I.E.E.E. U.K. and Eire section.

8th–10th September. Conference on 'Examinations'. To be held at the University of Sussex, Brighton. Organized by The Institution of Electrical Engineers, Savoy Place, London, W.C.2. (Phone: Covent Garden 1871).

12th–15th September. Conference on 'Electronic Engineering in Oceanography'. Organized by the Institution of Electronic and Radio Engineers (Phone: Museum 1901) and to be held at the University of Southampton.

12th–16th September. Conference on 'Radiation Methods in Nuclear Power', to be held at Berkeley, Glos. Further details from the Meetings Officer, The Institute of Physics and The Physical Society, 47 Belgrave Square, London, S.W.1. (Phone: Belgravia 6111).

12th–16th September. The Sixth International Conference on 'Microwave and Optical Generation and Amplification'. To be held at Cambridge University and organized by The Institution of Electrical Engineers, Savoy Place, London, W.C.1. (Phone: Covent Garden 1871).

12th–16th September. The Seventh International Machine-Tool Design and Research Conference, to be held at the University of Birmingham. Details from the Organizing Secretary, Department of Mechanical Engineering, Birmingham University.

13th–15th September. Conference on Electrical Network Theory and Design, to be held at the University of Newcastle-upon-Tyne. Further information from Dr. A. G. J. Holt, Electrical Engineering Dept., The University, Newcastle-upon-Tyne 1.

13th–15th September. National Audio-Visual Aids Conference and Exhibition. To be held at Whitelands College, Putney, London, S.W.15. Organized by the National Committee for Audio-Visual Aids in Education, 33 Queen Anne Street, London, W.1. (Phone: Museum 5791).

19th–21st September. Conference on 'Instrumental Optics and Optical Design'. To be held at the Chelsea College of Science and Technology, London. Organized by the Institute of Physics and The Physical Society, 47 Belgrave Square, London, S.W.1. (Phone: Belgravia 6111).

19th–23rd September. Symposium and Exhibition on 'Advanced Industrial Measurement and Control'. To be held at and organized by the Welsh College of Advanced Technology, Cathays Park, Cardiff. (Phone: Cardiff 37374).

19th–23rd September. Conference on High-Voltage D.C. Transmission. To be held at the Manchester College of Science and Technology, and organized by the Institution of Electrical Engineers, Savoy Place, London, W.C.2. (Phone: Covent Garden 1871).

20th–22nd September. Fifth International Symposium on 'Power Sources'. To be held at the Hotel Metropole, Brighton, Sussex. Organized by J.S.E.P.S.C. Symposium Committee, P.O. Box 136, 26 Wellesley Road, Croydon, Surrey.

21st–23rd September. Conference on the Physics of Semiconducting Compounds. To be held in London and organized by the Institute of Physics and The Physical Society, 47 Belgrave Square, S.W.1. (Phone: Belgravia 6111).

26th–29th September. Residential Conference on 'Integrated Process-Control Applications in Industry'. Organized by the Institution of Electrical Engineers, Savoy Place, London, W.C.2. (Phone: Covent Garden 1871).

26th–29th September. Sixth National Inspection Conference on Quality, Reliability and Marketing, to be held at New College, Oxford. Organized by the Institution of Engineering Inspection, 616 Grand Buildings, Trafalgar Square, London, W.C.2. (Phone: Whitehall 0818).

28th–30th September. Symposium on the industrial applications of isotopic power sources. Organized jointly by the European Nuclear Energy Agency and the U.K. Atomic Energy Authority, 11 Charles II Street, London, S.W.1. (Phone: Whitehall 6262).

28th–30th September. Conference on 'Energy Beams and their Uses', to be held at the University of York. Further details from the organizers, the Institute of Physics and The Physical Society, 47 Belgrave Square, London, S.W.1. (Phone: Belgravia 6111).

7th–12th October. 14th International Communications Congress, Genoa, Italy. Organized by The Secretariat,

WHAT'S ON AND WHERE

Continued

Instituto Internazionale delle Comunicazioni, Viale Brigate Partigiane 18, Genoa.

12th–13th October. International Design Congress—'Profit by Design'. To be held at Royal Garden Hotel, Kensington, London. Organized by Council of Industrial Design, The Design Centre, 28 Haymarket, London, S.W.1. (Phone: Trafalgar 8000).

13th–14th October. Fourth Canadian Symposium on Communications, to be held at the Queen Elizabeth Hotel, Montreal. Details from Prof. G. W. Farnel, McGill University, 805 Sherbrooke Street, W. Montreal, Canada.

18th–19th October. Symposium on 'Liquid Scintillation Counting'. To be held at the National Physical Laboratory, Teddington, Middlesex. Organized by The Institute of Physics and The Physical Society, 47 Belgravia Square, London, S.W.1. (Phone: Belgravia 6111).

18th–20th October. IMEKO Symposium on 'Microwave Measurement'. To be held in Budapest, Hungary. Organized by Committee of the IMEKO Symposium on Microwave Measurement, Budapest 5, P.O.B. 457.

24th–26th October. Second International Convention on 'Microelectronics', to be held in the Congress Hall of the Munich exhibition grounds during the Electronica 66 Exhibition. Organized by the International Electronics Association, Theresienhohe 15, 8 Munchen 12, W. Germany.

9th–11th November. International Conference on the Automatic Operation and Control of Broadcasting Equipment. To be held in London and organized by the Institution of Electrical Engineers, Savoy Place, London, W.C.2. (Phone: Covent Garden 1871).

Exhibitions

5th–11th September. Farnborough
The Annual S.B.A.C. Flying Display and Exhibition, to be held at Farnborough, Hants. Full details from the Society of British Aerospace Companies, 29 King Street, London, S.W.1. (Phone: Trafalgar 3231).

8th–14th September. Basel
First International Nuclear Industries Fair and Technical Meetings (Nuclex 66), to be held in Basel, Switzerland. Details from the Secretary, Nuclex 66, 4000 Basel 21, Switzerland.

12th–17th September. Manchester
Industrial Equipment and Services Exhibition. To be held in the City Hall, Manchester. Organized by Provincial Exhibitions Ltd., City Hall, Deansgate, Manchester, 3. (Phone: Deansgate 6363).

4th–9th October. Ljubljana
The Thirteenth International Exhibition of 'Modern Electronics', organized by the Yugoslav Committee for electronics, telecommunications, automation and nucleonics (ETAN). Details from Gospodarsko Razstavisce (Ljubljana Fair), Ljubljana, Titova 50, Yugoslavia.

4th–12th October. London
The 58th National Business Efficiency Exhibition. To be held at Olympia, London. Organized by the Business Equipment Trade Association, 109 Kingsway, London, W.C.2. (Phone: Holborn 6233).

10th–14th October. Amsterdam
Fairex '66, an exhibition of electronic components and testing equipment and professional electro-acoustic equipment. Further information from the Secretariat, Fairex Committee, Amsterdam, Minervalaan 82 hs.

11th–12th October. London
Exhibition and Conference on 'Ultrasonics for Industry', to be held at St. Ermin's Hotel, Caxton Street, London, S.W.1. Sponsored by the journal *Ultrasonics* and organized by Iliffe Exhibitions Ltd., Dorset House, Stamford Street, London, S.E.1. (Phone: Waterloo 3333).

17th–22nd October. Basel
Third International Exhibition and Congress of Laboratory, Measurement and Automation Techniques in Chemistry (ILMAC), to be held in the halls of the Swiss Industries Fair. Details from the Secretariat, Schweizer Mustermesse, 4000 Basel 21, Switzerland.

20th–26th October. Munich
Electronica 66, an international trade exhibition of electronic components and related measuring and production equipment. Details from Exhibition Consultants Ltd., 11 Manchester Square, London, W.1. (Phone: Hunter 1951).

24th–27th October. New York
Twenty-first Annual International I.S.A. Exhibition and Conference on Instrumentation, Systems and Automatic Control. To be held at the New York Coliseum, and organized by the Instrument Society of America, 500 William Penn Place, Pittsburg, Pennsylvania 15219, U.S.A.

24th–28th October. Antwerp
Exhibition and Congress on Instrumentation and Automation in the Paper, Rubber and Plastics Industries. Further information from P.R.P. Automation, Jan van Rijswijcklaan 58, Antwerp, Belgium.

13th–21st November. Paris
The Seventeenth International Packaging Exhibition, to be held at the Palais de la Défense in Paris. Further information from Salon de L'Emballage — Information, 40 rue du Colisée, 75 Paris 8, France.

PERA Exhibition and Conference Changed

The PERA Exhibition and Conference on 'Inspection and Testing Equipment', which was to have been held from 11th to 13th October, has been postponed and changed. The Conference will now be on 'Ensuring Product Quality', while the Exhibition will remain unaltered; both will now be held from 7th to 9th March, 1967, in Melton Mowbray.

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