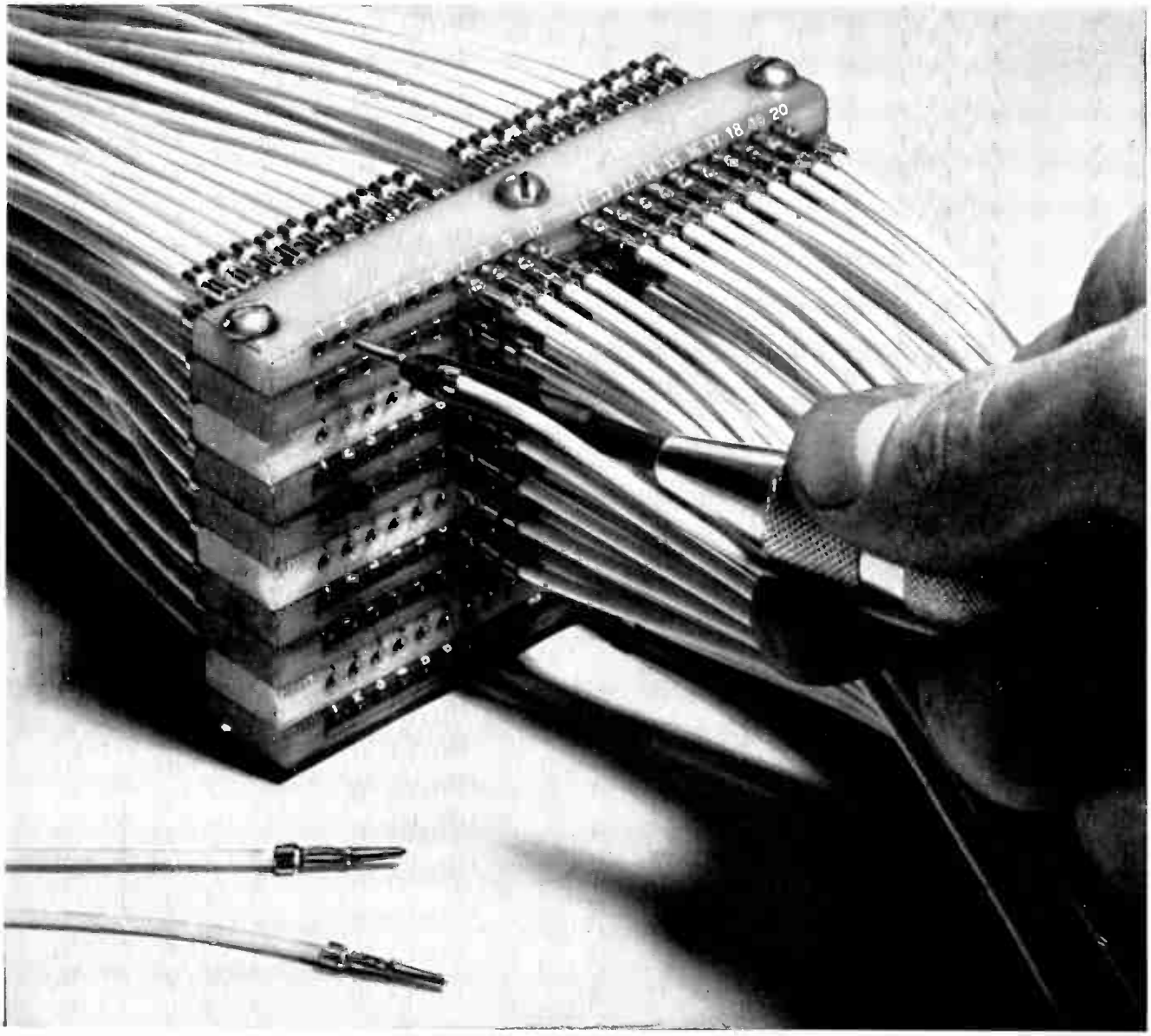
INDUSTRIAL ELECTRONICS

SEPTEMBER 1965 5s 0d



How small can a pin be?

Within a few thousandths of an inch of the diameter of the wire insulation—that's how we engineer **A-MP Taper Pins.** Anywhere the wire fits, our pins fit. This kind of density gives you extra design space.

With a nominal retention strength of 25 lb, A-MP taper pins ensure peak mechanical and electrical characteristics, even with temperature cycling of −85°F to +500°F, vibration at 150 c/s, and 20g acceleration.

AMP have the most comprehensive range of taper products in the industry—formed, insulation piercing, and screw machined types with optional insulation support.

A-MP Taper Pins

incorporating AMP controlled compression crimp for lowest applied cost.

Check these features:

- Pins are self-cleaning, self-locking.
- Matched crimping tools eliminate cold solder joints, burnt and brittle insulation.
- Automatic application gives lowest installed costs
- The widest range of matched taper pin blocks

AMP

AIRCRAFT-MARINE PRODUCTS
(GREAT BRITAIN) LIMITED

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AP 282

INDUSTRIAL ELECTRONICS

Incorporating **British Communications and Electronics**

Communications Automation Instrumentation Control

Contents September 1965

VOLUME 3 **NUMBER 9**

continued overleaf

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INDUSTRIAL ELECTRONICS

Incorporating ***British Communications and Electronics***

Communications Automation Instrumentation Control

OUR COVER

The welding together of small plastics parts is readily accomplished by the local heating set up at the joint by ultrasonic vibration. The front-cover picture shows ultrasonic welding equipment in use in a Max Factor factory. An article on p. 410 explains the method of welding in detail.

Contents *continued*

Features

Next Month

The October issue will contain an article dealing with an electronic method of sorting small objects by their colour. Other articles will include a description of a pulse compression system for radar.

For further information
circle 203 on Service Card

WELWYN
VITREOUS ENAMELLED WIRE WOUND RESISTORS
"W" RANGE TO DEF 5115

TYPE	DEF 5115 STYLE	DEF 5115 RATING at 70 C	ROOM TEMPERATURE RATING (20 C)
W21	RFH2-2.5	2.5 watts	3 watts
W22	RFH2-6	6 watts	7 watts
W23	RFH2-9	9 watts	10.5 watts
W24	RFH2-12	12 watts	14 watts

SELECTION TOLERANCE: ±1%, ±2% and ±5%.

TEMPERATURE COEFFICIENT: For most resistors the temperature coefficient will be found to be in the region of 50 ppm and in no case will it exceed 100 ppm/°C.

STABILITY: After 2,000 hours D.C. cyclic load at 70 C the change in resistance will be less than 5% in accordance with DEF 5115.

AGEING: After three years storage change in resistance will not exceed 1%.

WRITE NOW FOR FULL DETAILS

WELWYN ELECTRIC LIMITED

BEDLINGTON - NORTHUMBERLAND - ENGLAND

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

FACTORIES IN AUSTRALIA AND CANADA

5 core solder so fine it goes through the eye of a needle

ERSIN MULTICORE 5 CORE SOLDER NOW AVAILABLE IN GAUGES DOWN TO 34 S.W.G. GIVING UP TO 4,950 FT. PER LB.

From 16 s.w.g. — virtually the standard gauge ten years ago — the trend has been to 18 s.w.g. in the production of electronic and television equipment. Today the trend is to even finer gauges and, recently, the demand for ERSIN MULTICORE 5 CORE SOLDER in 22 s.w.g. has increased considerably.

New plant installed at our works in Hemel Hempstead now enables us to provide ERSIN MULTICORE SOLDER with five core of flux in even gauges to 34 s.w.g., effecting substantial economies in soldering costs. The table shows the lengths as compared with 16 and 18 s.w.g.

60/40 alloy is available from stock in even gauges from 22 s.w.g. to 28 s.w.g. and can be supplied to special order in even gauges to 34 s.w.g. Other alloys can be supplied in special order in all these gauges.

22 s.w.g. which has hitherto been supplied only on 1 lb. reels, can now also be supplied on 7 lb. reels. Gauges from 24 s.w.g. upwards are generally supplied on 1 lb. type reels in catch-weights of about 12 ozs. per reel.

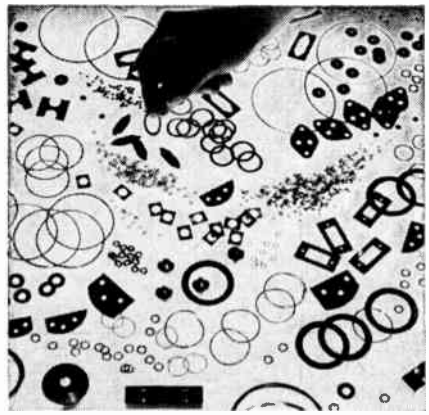
Standard Wire Gauge	*Diameter in inches*	*Diameter in mm*	*Approx. No. of feet per lb. 60 Tin/40 Lead*
16	.064	1.626	102
18	.048	1.219	182
22	.028	.711	536
24	.022	.558	865
26	.018	.46	1,292
28	.014	.375	1,911
30	.012	.3146	2,730
32	.0108	.274	3,585
34	.009	.233	4,950

For samples and literature please write on your company's letterheading to:

MULTICORE SOLDERS LTD., MAYLANDS AVENUE, HEMEL HEMPSTEAD, HERTS. (HEMEL HEMPSTEAD 3636)

IM

1



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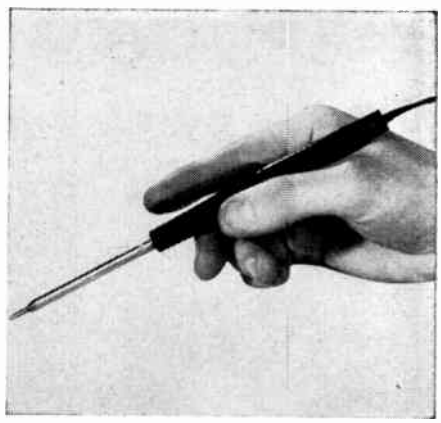
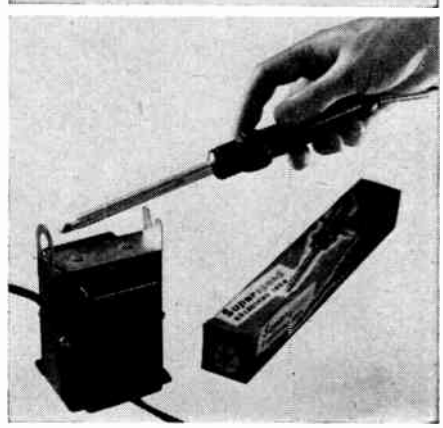


Everything you need for precision soldering from Enthoven

4

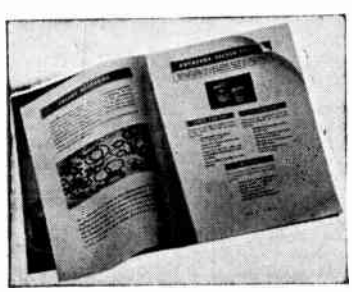


3

5

Tools, materials and knowledge. Two of the neatest irons ever made. The finest, most reliable materials—backed by over 150 years' experience of smelting and refining non-ferrous metals. And intimate knowledge of modern soldering techniques, the product of special experience built up over the years, confirmed when necessary in one of Europe's most advanced metallurgical laboratories. This is what Enthoven offer you.

A comprehensive booklet describes the complete range of Enthoven Solder Products. Ask for your free copy.



1 Washers and preforms, cored and solid, standard and special.
2 Miniscope soldering iron for fine work.
3 Superspeed six-second heat soldering iron.
4 Preservative, metal, Tricene de-oxidant, lacquer, flux, and thinners for printed circuits.
5 Superspeed solder... stellate cored, wide range of alloys, gauges and packings.

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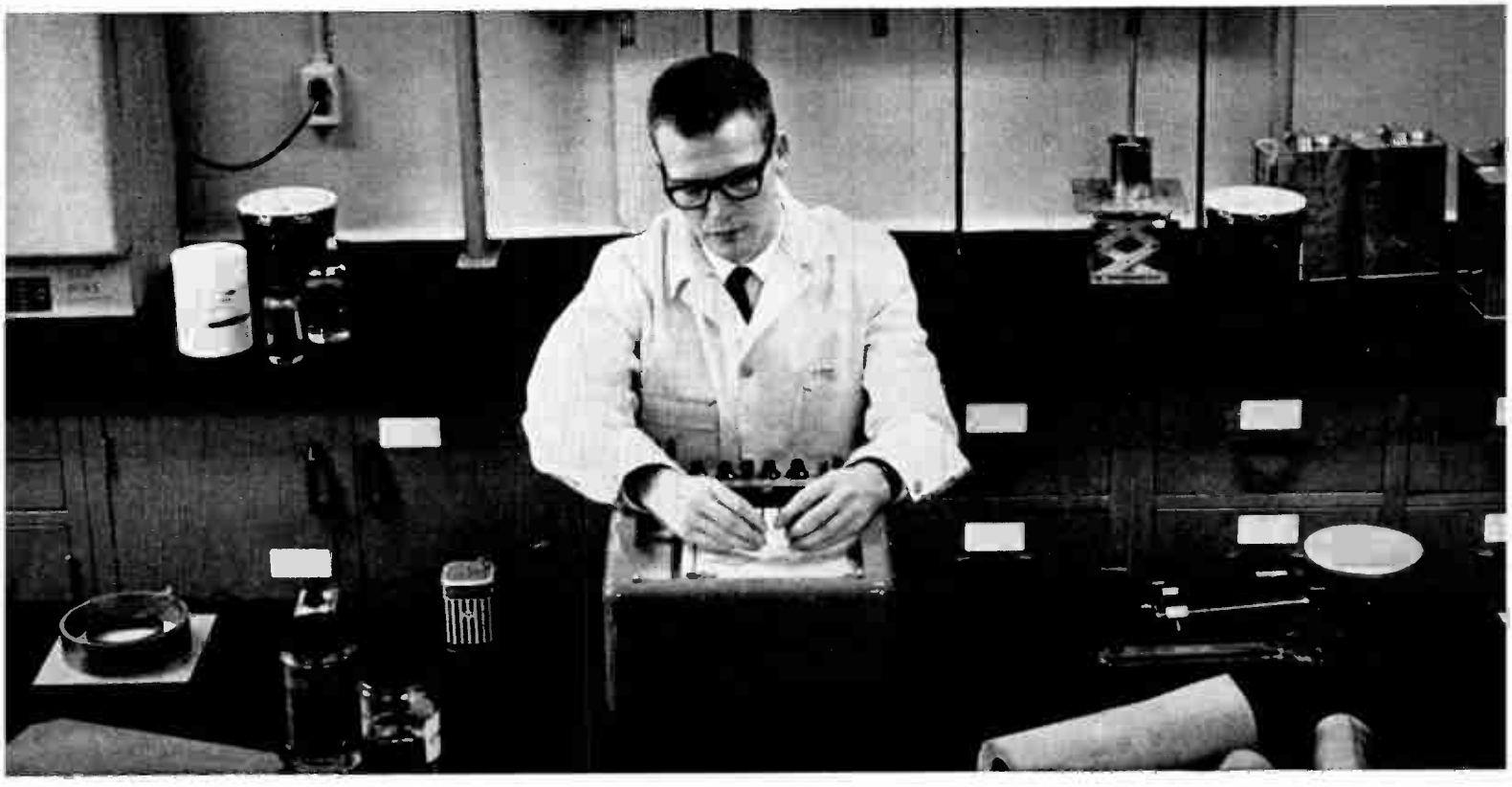
Our range of epoxy resins is complete.



And so is our technical assistance.

Whatever your application, you can get the epoxy resin you need from Dow, including liquid systems for electrical applications, road coating, lacquers, laminating and adhesives; solid systems for paint coatings; novolac based resins for improvement of heat stability, heat distortion temperatures, chemical resistance and gel time; flexible resins for elongation and flexibility; and flame retardant brominated resins.

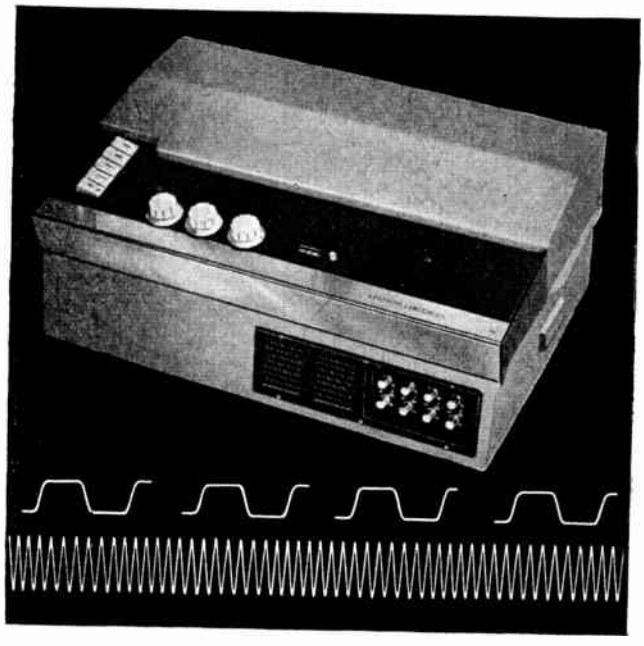
And, in addition to making the most and finest epoxy resins, we will be happy to help you solve your technical problems. Dow Chemical Company (U.K.) Ltd., 105 Wigmore Street, London, W.1. Tel: WELbeck 4441 or St. Ann's House, Parsonage Green, Wilmslow, Cheshire. Tel: Wilmslow 2851.

* *Trademark of The Dow Chemical Company*

DOW

For further information circle 207 on Service Card

Record data precisely with the LABCORDER



The answer to today's need for a fast flow of reliable data is the EPSYLON MR 800 LABCORDER. This high quality instrument records on ¼" magnetic tape, eliminating time-consuming hand recording. It provides easier analysis and storage of really dependable data. Careful design and sound engineering make it a moderately priced recorder which is easy to operate, compact and portable.

- *Two wide band FM channels.*
- *Speech channel.*
- *Time marker channel.*
- *Four tape speeds allowing 8:1 expansion or contraction of data time scales.*

For digital recording, an alternative model, the MR 800D is available. Features include four digital channels and high packing density.

Please write or telephone for descriptive literature.

EPSYLON LABCORDER

EPSYLON INDUSTRIES LIMITED
Faggs Road, Feltham, Middlesex, England.
Telephone: FELtham 5091/5

STONE PLATT GROUP

SERVISCOPE* SERVES THE PRINTING INDUSTRY

W. R. Royle & Son Ltd., who are specialists in the production of fine colour printing, have recently installed two of the latest Vario Klischograph electronic colour engraving machines, both of which are equipped with Telequipment Oscilloscopes. These machines are designed to produce colour corrected separation positives of a very high standard, and have eliminated the laborious retouching hitherto necessary.
In order to provide the operators with a precision monitor, Mr. Jeremy Royle, a director of the firm, has installed a Telequipment double-beam rack mounting oscilloscope in each machine.
The oscilloscope, when connected to the output signals, provides each operator with a precision display of the actual picture signals as the scanning proceeds against a special graticule enabling them to see that various parts of the extremely complicated machines are functioning correctly.
This unique application of the Telequipment double-beam rack mounting Serviscope demands very high standards of stability in the D.C. coupled vertical amplifiers and once again demonstrates the high standard of Telequipment instruments.

Double-beam rack mounting Serviscopes cost from £125: a descriptive leaflet will be sent on request.

TELEQUIPMENT ... of course!

*Serviscope is a registered trade mark of Telequipment Limited, 313 Chase Road, Southgate, London, N.14. Fox Lane 1166
Scottish Office: 30 Castle Street, Edinburgh. Balerno 3120 AS20

Telex 25573 for resistors

For further information circle 305 on Service Card

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SO MANY TYPES EACH WITH SPECIFIC APPLICATIONS
IN A VAST RANGE OF OHMIC VALUES
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When you're top of the league it's tough staying there. The Delanco organisation work as a team, think as a team, and sometimes argue among themselves, as most teams do, but with one aim, to keep Delanco Top of the League, for service and quality.

If your requirements are in the electrical insulation line, you'll find our team a very useful and helpful combination, and they know the game backwards.

If you can't get up to our ground, (and you'll be very welcome if you can), all you have to do is drop us a line and we will set about answering your problems and in the meantime the full DELANCO technical catalogue will be sent to you.

Electrical Insulation materials, and machined parts. Vulcanised Fibre in sheet, Rod and Coil. S.R.B.P. and S.R.B.F. in sheet and machined parts, and strip. High heat materials. Mica. Moulded products. And many other products . . .

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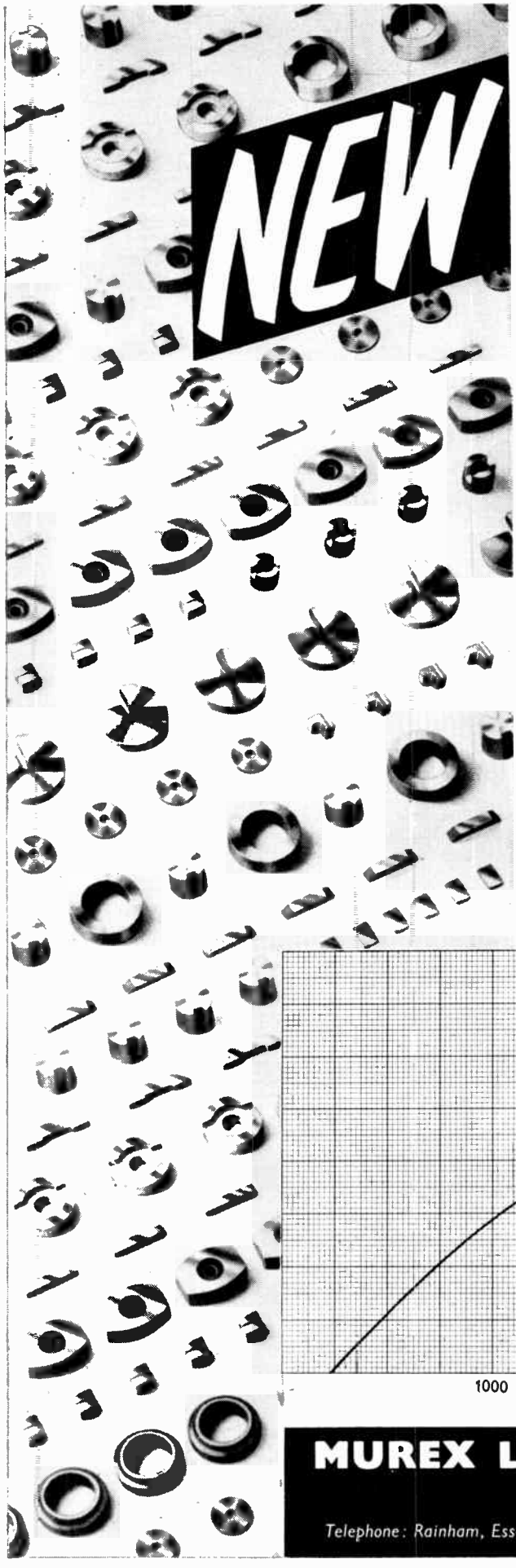


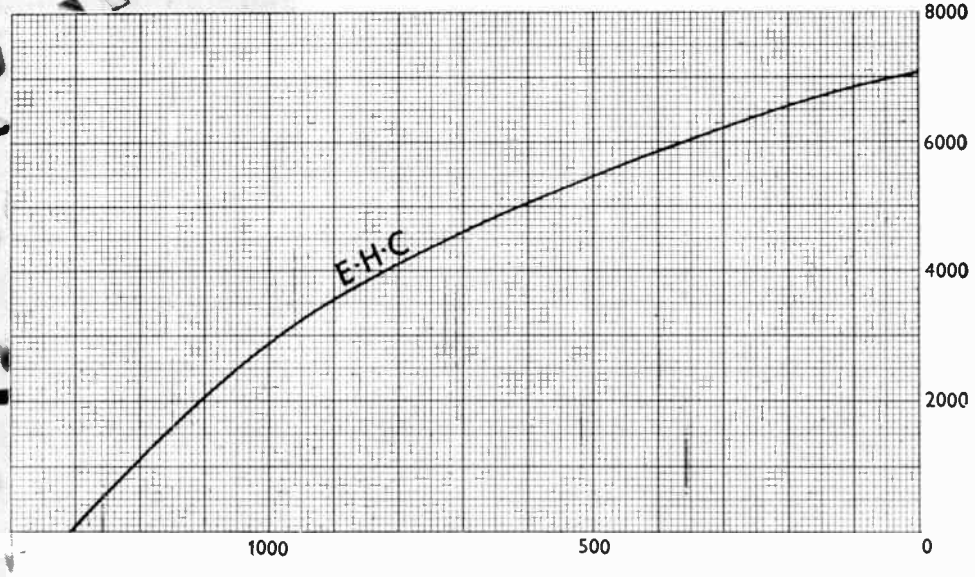
E.H.C.

A new Murex magnetic alloy of extra high coercivity for sub-miniature components...

This new sintered magnet alloy has been developed by Murex for use where space restrictions require subminiature components of extra high coercivity with

HIGH ENERGY OUTPUT AND GREAT STABILITY AT HIGH TEMPERATURES

** Qualified technical staff are always available to advise on magnet design and performance.*



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(Powder Metallurgy Division)

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PC range of

MINIATURE MINIATURE MINIATURE MINIATURE MINIATURE MINIATURE MINIATURE MINIATURE

PLUG-IN-RELAYS

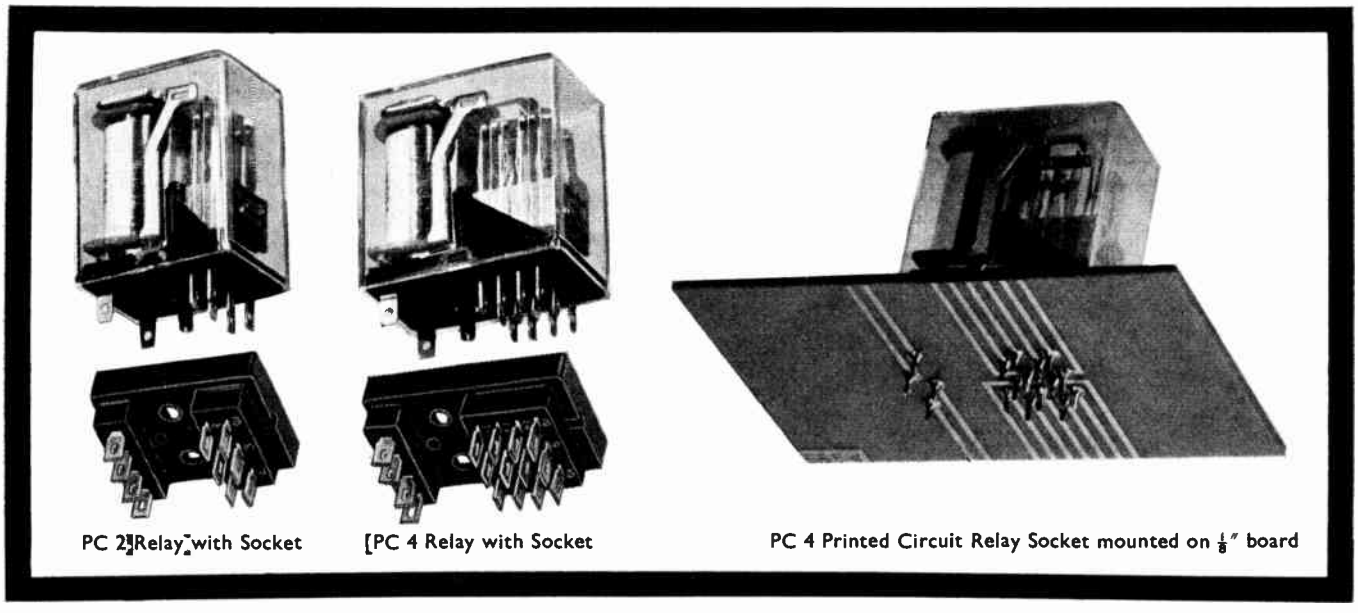
light current and heavy duty types

FEATURES
Designed and manufactured by Perivale Controls over six years ago, the PC Miniature Plug-in Relay was first of its kind then—and it still leads. Built-in features of this wholly British relay include:

★ Complete interchangeability with most relays of foreign manufacture.
★ Operational accuracy derived from unique setting techniques.
★ High quality but competitive prices.
★ Speedy delivery even for specials.

SPECIALS
Flexibility of design is such that special derivatives seldom present a problem. Speedy delivery is offered as a service and enquiries for small or large quantities are invited.

STANDARDS
Over 100 different standard types for diverse applications. Designed for long term reliability and cost economy PC Miniature Plug-in Relays have standard operating voltages in the range 4 volts to 140 volts D.C. with a wide tolerance on nominal, and a myriad of contact configurations allowing for single or multiple operations in various combinations of make/break/changeover.

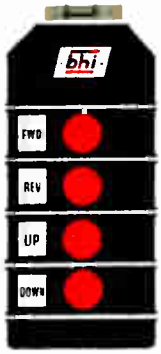


PC 2½ Relay with Socket | PC 4 Relay with Socket | PC 4 Printed Circuit Relay Socket mounted on ⅛" board

PERIVALE CONTROLS COMPANY LIMITED

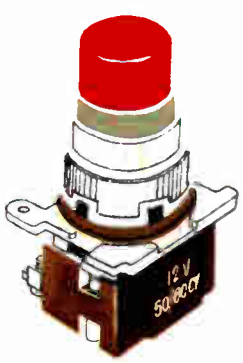
TELFORD WAY · EAST ACTON · W.3 TEL: SHEPHERDS BUSH 1015 (5 lines)

A DAVALL INSTRUMENTATION COMPANY OF THE BENTIMA GROUP

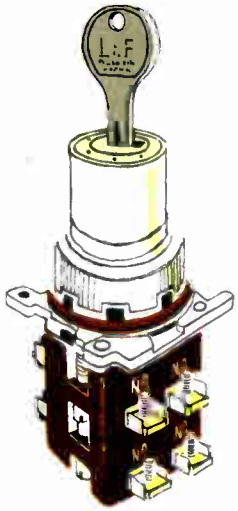


91,000 Type pendant one or more standard contact blocks for pushbutton operation in hard rubber case.

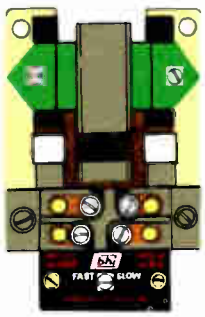
91,000 Type Joystick control multi-directional control by small positive-action joystick.



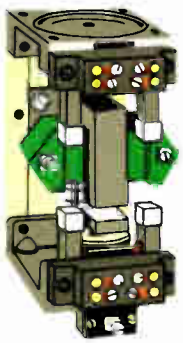
91,000 Type Illuminated pushbutton combined indicator lamp and pushbutton for panel mounting.



91,000 Type Key-operated switch cylinder-lock switching with usual choice of contact arrangements.



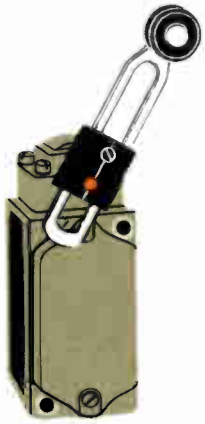
Single-contact pneumatic timer delayed contact operation or resetting.



Double-contact pneumatic timer any combination of instantaneous contact, delay after energisation or after de-energisation.

bhi

Brookhirst Igranic Ltd
Elstow Road · Bedford



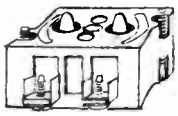
Oil-tight limit switch adjustable roller lever.

Oil-tight limit switch forked operating lever.

Oil-tight limit switch wobble stick operator.

Ring the changes in control with BHI 91,000 Series Heavy Duty Oil-Tight Units

Basis of the 91,000 range is a standard contact block which can be used singly or ganged. Pushbuttons, multi-directional joystick levers, knob or key operation are available, all occupying the same amount of panel space. Indicator lamps, illuminated pushbuttons and press-test buttons which light up when pressed complete a truly versatile range.

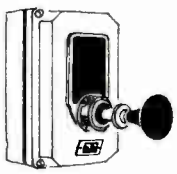


Ganged contact blocks

Up to four contact blocks per gang. Two contact sets per block, either N.O., N.C. or Changeover. Silver contacts. External screw connections. Put them together in any combination.

Pushbuttons

Positive action pushbuttons; choice of five colours, five operators – standard, long, mushroom, jumbo, staydown mushroom. One-hole panel fitting to standard 91,000 series size.

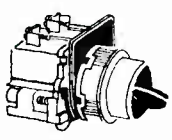


Joystick master controller

Up to eight switching positions about a central off position. Up to 12 N.O., N.C., or C/O circuits. 91,000 series one-hole mounting. Positive latching if required.

Rotary versions

Rotary versions add versatility by plunger operation from cam. Seven different cams give seven different contact sequences . . . with further variation according to the arrangement of contact blocks. Operation by key, lever or knob. Complete unit takes same space, same fixing hole as pushbuttons.

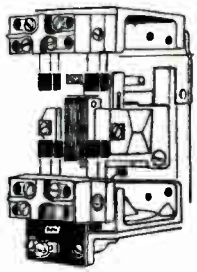


bhi

Brookhirst Igranic Limited
Elstow Road · Bedford
Telephone: 67433 · Telex: 82261

Pneumatic Timing Relay with 0.2 to 60 sec. delay – screwdriver changeover of mode of operation

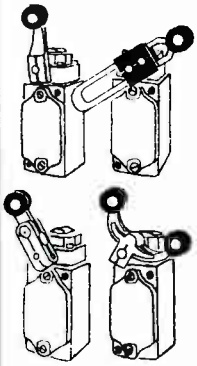
One or two timing heads can be used with a single coil, each set separately to provide delay after energisation or de-energisation. One timing head and one instantaneous contact can be used. Setting up is quick, and timing then remains consistent. Contacts will make 8A or break 5A at 600V ac over a long, reliable life. Two-screw fixing, choice of operating voltages, backlash-free timing adjustment make this a simple yet versatile unit with many uses. It's the BHI type 906 pneumatic timer.



M GROUP

Oil-tight, and positive in action, one basic switch can be fitted for operation dozens of different ways

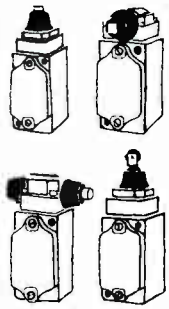
A standard moulded block enclosing contacts of the single-pole, changeover, twin-break type is mounted in a die-cast housing. Oil-tight cover; operation is through an oil-tight diaphragm. The contact block can be replaced by contactless switching if required. Two tapped and two through holes in the housing are provided for mounting. Action is so designed that contact is fully positive even at minimal operating speeds. Spring-return or stayput operation available on most versions.



. . . Rotary Operators

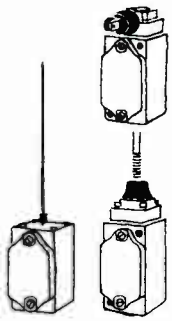
In which the operating lever can be clamped at any angle on a rotating shaft. Also available with bare shaft for your operator.

Adjustable rod
Roller lever
Adjustable roller lever
Precision roller lever
Forked lever
rollers in line or offset



. . . Linear Operators

Top push button
Side push button
Side push rod
Top push roller
Side push roller
vertical or horizontal
Cats whisker
Wobble stick



Full technical data is available from BHI. Ask for: full details of the 91,000 range

Publication ZB88
Type 906 pneumatic timer

Publication ZB56
Oil-tight Limit Switches

...and YET ANOTHER STEP FORWARD...

An improved AvoMeter

Model 8 Mk III

This new model incorporates increased sensitivity in the lower AC ranges and wide frequency characteristics, with the traditional AvoMeter features including the AVO automatic cut-out mechanism and interlocking rotary switches for quick range selection.
With the aid of a range of d.c. shunts measurements can be made up to 400 amps d.c.

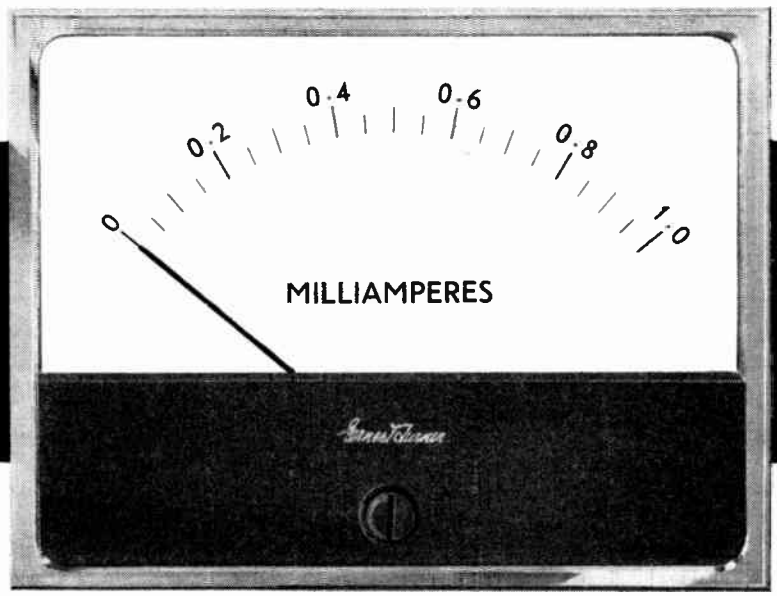
Avo Main Distributors with Servicing Facilities :
Wireless-Electric Ltd., Wirelect House, St. Thomas St., Bristol 1
Farnell Instruments Ltd., Sandbeck Way, Wetherby, Yorkshire

Fused ohms circuit provides increased protection against inadvertent overload.

Improved temperature coefficient over whole range.
Now measures up to 400 amps d.c.

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

A8/9



Clearly . . .

Ernest Turner

Ernest Turner present a new series of rectangular instruments which fulfils the requirement for a clear-front meter of functional appearance.

Combining the best features of the established range of Ernest Turner instruments with clean, square-cut lines, the series will blend well with all panel layouts, whether the meter is used singly or in banks, and a useful feature is the lower insert which can be supplied in a choice of colours if required.

The movement in each model is a well-tried Ernest Turner type with a reputation for reliability built up over many years of continuous development. Full details of sizes available, dimensions and ranges are given in Catalogue No. 85/21.

ERNEST TURNER ELECTRICAL INSTRUMENTS LTD
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If air displacement must be audible

you don't need AIRSCREW FANS

Airscrew pay particular attention to quiet vibrationless running

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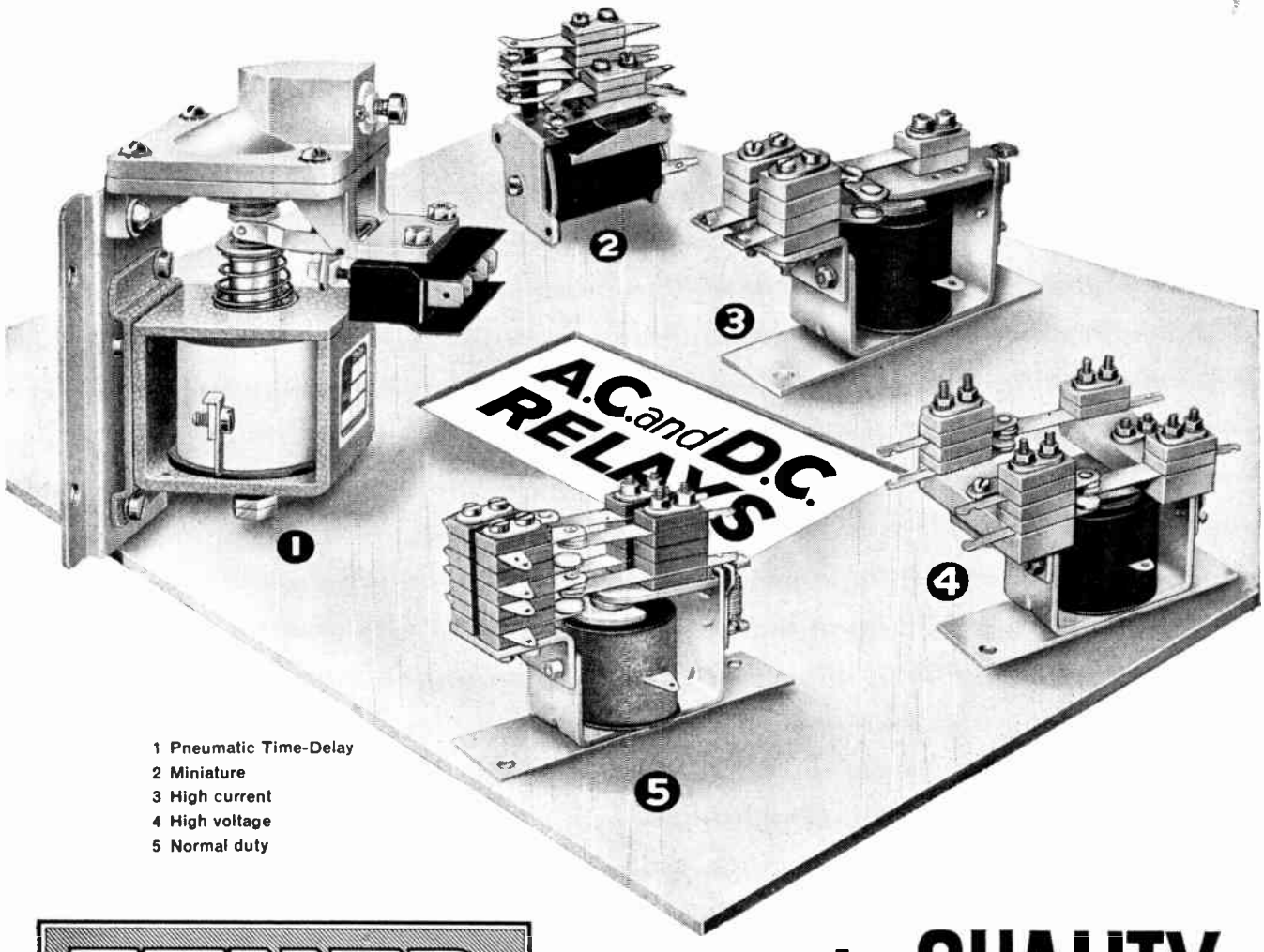
AP261

Whether your Relay purpose is General or Special



1 Pneumatic Time-Delay
2 Miniature
3 High current
4 High voltage
5 Normal duty

ETHER LIMITED purpose is **QUALITY**

There are ETHER Relays for *every* purpose. For normal duty in the general and control field, high current and high voltage types, miniatures, single and double acting pneumatic time-delay types, for a.c. or d.c. Throughout the range one common characteristic distinguishes them all—high quality. Every type is precision built—and every relay can be relied on for unfailing service over a very long life. Equally important, ETHER Relays are economically priced.

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LADDER FILTERS

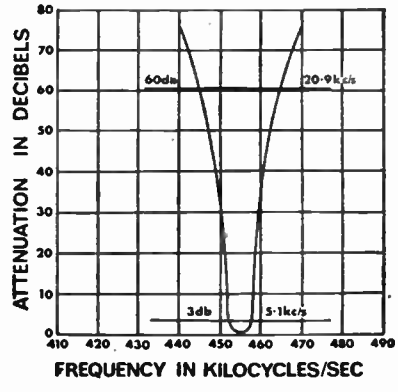
ADVANTAGES

Fantastic space saving
Excellent stability with time and temperature
Single or multiple resonant units

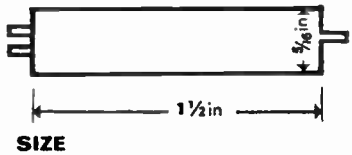
TYPICAL SPECIFICATION

Centre Frequency	300 to 600 kc/s ± 2 kc/s
Bandwidth	2 to 45 kc/s at 6 db
Insertion Loss	1 to 15 db (dependent on B/W)
Impedance	Either 1200 or 1500 ohms in and out, dependent on B/W
Case Size	8 mm diameter 38 mm long
Operating Temperature Range	−40°C to +85°C
Shape Factor 60/6 db	1.3 : 1 to 2.6 : 1 Dependent on B/W

Curve below shows response of our ladder filter type TL 10 D 16A. Note the outstanding shape factor

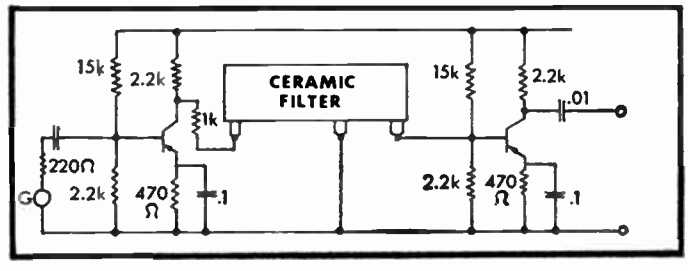


Keep your eye on Brush



SIZE

This illustrates the typical dimensions for a ladder filter. The case is a plated brass cylinder with glass end seals and pigtail leads. A 1½ inch length will provide sufficient volume to give 80 db stop band rejection.



BC BRUSH CLEVITE COMPANY LIMITED

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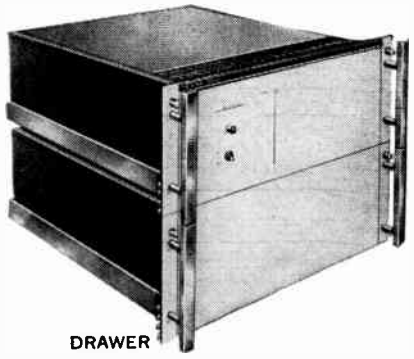
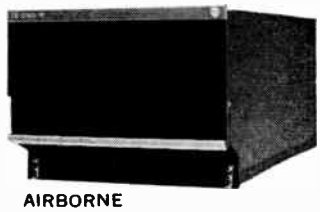
Announcing a new line of adaptive microminiature Kineplex® modems with rates up to 6,000 bits per second!

Available in three types: Drawer, cabinet or airborne. They're small; for example, the single drawer type is only 22½" x 17½" x 8¾". They employ Kineplex® techniques, operate on a 3 kc bandwidth over HF and wireline. Data rates can be controlled externally. Computer-assisted design techniques have reduced prices dramatically. If you have large amounts of data to move between computers or from remote sources to computers, contact us today about our new TE-216 modems.



DRAWER



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COLLINS RADIO COMPANY, Dallas, Texas, U.S.A.
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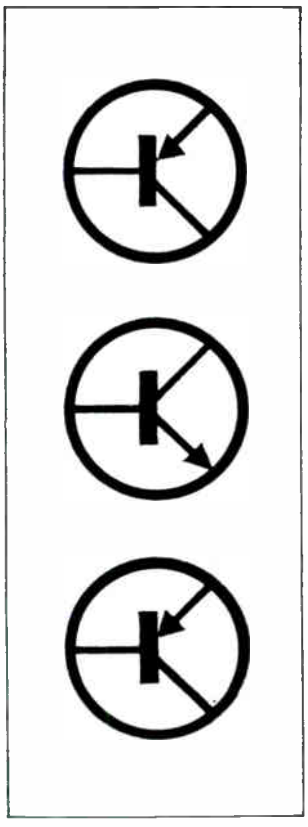

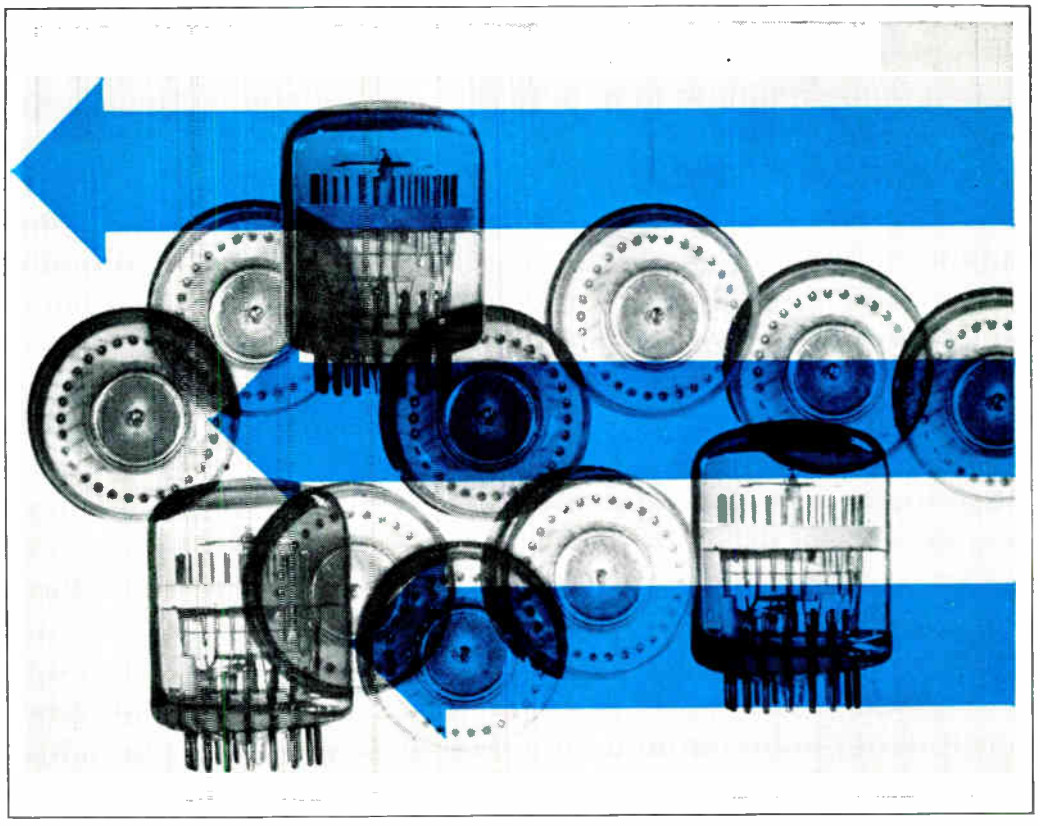

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Dekatron* cold-cathode tubes have a long tradition of international service and reliability and the latest all-glass miniaturized GS 10H is no exception. Capable of handling counting speeds of up to 4 k.p.s., this extensively tested tube, in conjunction with a transistorized single pulse drive, reduces the process of multi-stage, uni-directional counting or selecting to its simplest, most economical and most reliable terms. The tube is also capable of fully reversible, bi-directional operation when incorporated in a suitable circuit. Readout, as in other Dekatron tubes is made directly from glow-position or by means of one of the range of Digitron* register tubes.
For data sheets please write or phone:— The Technical Services Dept.

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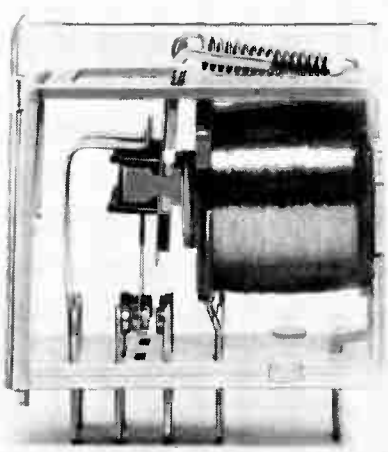
PLESSEY COMPONENTS GROUP

PCH 122

How big do you expect a good reliable 15A 2-contact relay to be?

Try this for size



The Siemens & Halske Type 15 relay is designed specifically for domestic electrical appliances but its excellent specification makes it an ideal choice for many other uses:—

2 changeover contacts each capable of switching 15 amps (which can be used in parallel).
Coil and contact connections designed for ¼" A.M.P. connectors.
AC or DC coils available, rated 3.4VA or 2.3 watts.
Silver or Silver/Nickel contacts.
Makrolon visible inspection dust cover.

Extremely compact, size only 2¼" x 2¼" x 1¼".
Very competitive price, especially for quantities.

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B&R

SIEMENS

PNP
PLANAR PASSIVATED

2H1254 2H1255 2H1256 2H1257 2H1258 2H1259 HT100 HT101	TO-18 Case	**A unique range of double-diffused 100 Mc/s switching transistors.** BV. . . . . up to 50V h_{FE} . . . . specified max/min values within range 14 - 150 $V_{ce(sat)}$ 0·3V $t_d + t_r$ 25nanosec
2N1254-9	TO-5 Case	

2H1254-9 Type Approved CV 7484-9

2N1131 2N1131A 2N1132 2N1132A 2N1132B	TO-5 Case	**Medium power general purpose transistors available in either TO-5 or TO-18 case style.** Min f_t 60 Mc/s BV. . . . . up to 60V h_{FE} . . . . specified max/min values within range 20 - 200 $V_{ce(sat)}$ 1·5V
2N721 2N722	TO-18 Case	

NPN
PLANAR PASSIVATED

2N706 2N706A 2N706B 2N707 2N708 2N753 2N914	TO-18 Case	**A preferred range of 300 Mc/s transistors with excellent switching characteristics.** BV. . . . . up to 56V h_{FE} . . . . specified max/min values within range 9 - 120 $V_{ce(sat)}$ 0·4V

2N717-720A 2N870-1 2N910-2 2N956 HT400-1	TO-18 Case	**70 Mc/s medium power general purpose transistor available in either TO-18 or TO-5 case style.** BV. . . . . up to 120V h_{FE} . . . . specified max/min values within range 20 - 100 $V_{ce(sat)}$ 1·5V
2N696-9 2N1613 2N1711 2N1893 2N1889-90	TO-5 Case	

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M & P HM 24

SEPTEMBER, 1965

STC components review

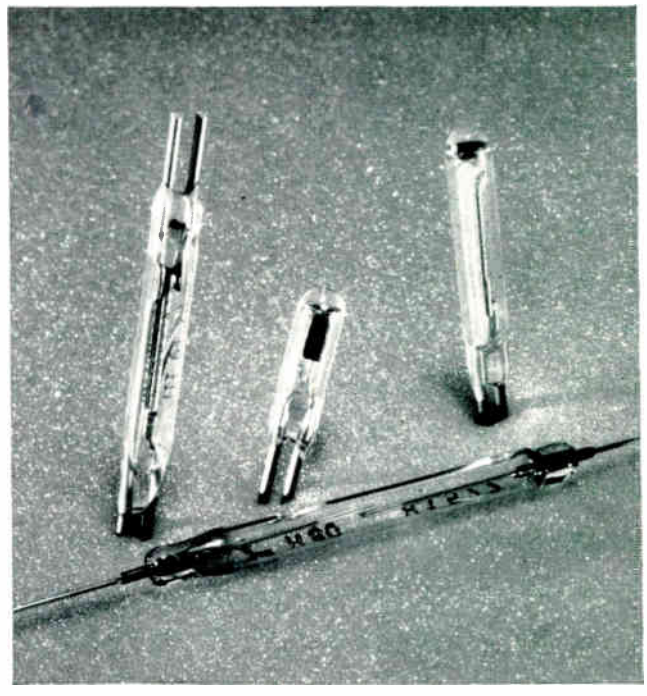
Magnetic materials

STC Magnetic Materials Division offers Europe's biggest single source supply of the widest range of professional, soft type, magnetic materials. These include Permalloy strip wound cores, Permalloy powder cores, powdered iron cores, ferrite ring cores and ferrite pot cores.

STC manufacturing and quality control ensures consistency of product quality, highest permeability and high Q values. The ferrites have achieved high reliability and performance in communications, data processing and control equipment including wide-band and pulse transformers, magnetic amplifiers precision high Q inductors, instrument current transformers and interference suppression inductors.

For customer convenience, STC maintains a torroidal winding service and a winding service for pot cores.

Write, 'phone or telex for product summary or specific data sheets to STC Magnetic Materials Division, Edinburgh Way, Harlow, Essex. Telephone: Harlow (STD code OBS96) 26811. Telex: 81146.



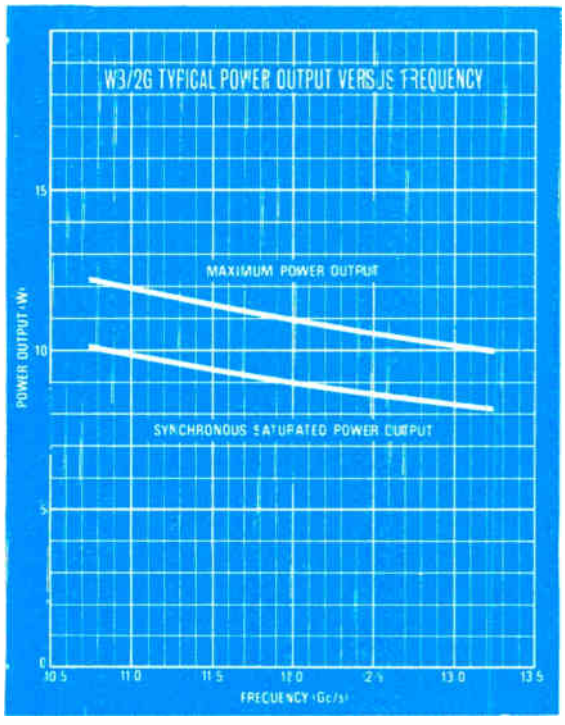
Reed switches and relays

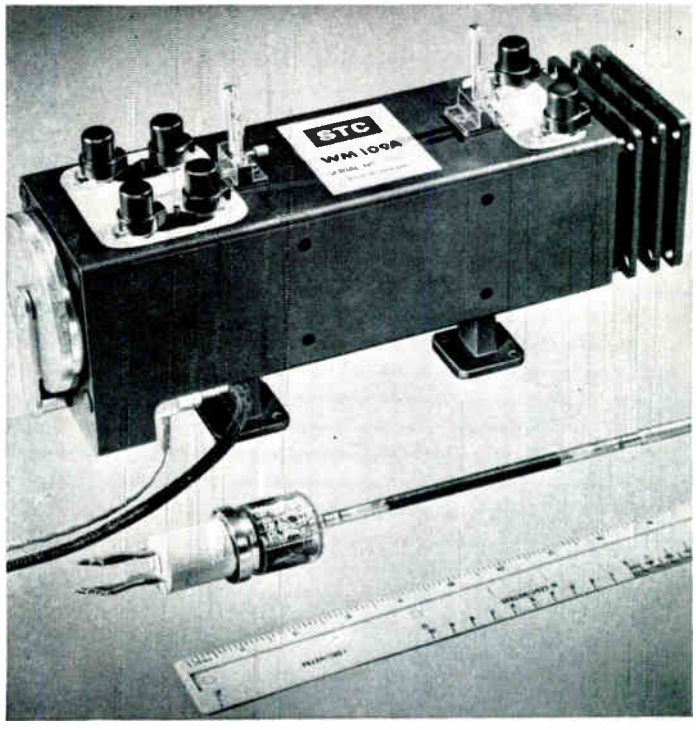
Four basic types of STC reed switches and relays are manufactured with more than a hundred variations within the basic designs. The reeds are enclosed in sealed glass envelopes filled with inert gas. This construction provides millions of maintenance-free operations for each switch.

The reeds can be operated by permanent or electro-magnets. The very small Pigmy reed is a make switch with both leads at one end of the envelope. The F-Type make switch also has leads at one end and the F-Type changeover reed a pair of leads at each end.

The Herkon reed is the world's most reliable reed switch. Hundreds of thousands are in use in telephone exchanges and similar applications. Failure rates have been negligible. Of special interest to designers of data logging and similar equipment is the HR84 relay system where special Herkon devices, with up to sixteen reeds per relay, are mounted on magnetic iron strips. The strips, as well as acting as a magnetic circuit for the relays, hold the units in position.

For data sheets describing the above and other reed switches and relays, use Reader Enquiry card or write, 'phone or telex STC Electro-Mechanical Division, West Road, Harlow, Essex. Telephone: Harlow (STD code OBS96) 26811. Telex: 81184.





New TWT brings more power for J-band communications

STC's type W3/2G travelling-wave amplifier tube, which has a maximum power output of 12 watts, is designed for communications service in the frequency band 10·7 to 13·2 Gc/s with possible extension to 15 Gc/s. The tube operates in a compact mount, type WM109, which incorporates a permanent magnet system, r.f. coupling and matching elements, mechanical alignment and deflection adjustments and a convection cooler. In the mount illustrated above, the tube ejection control is located at the cooler end but an alternative mount is available with front end ejection control.

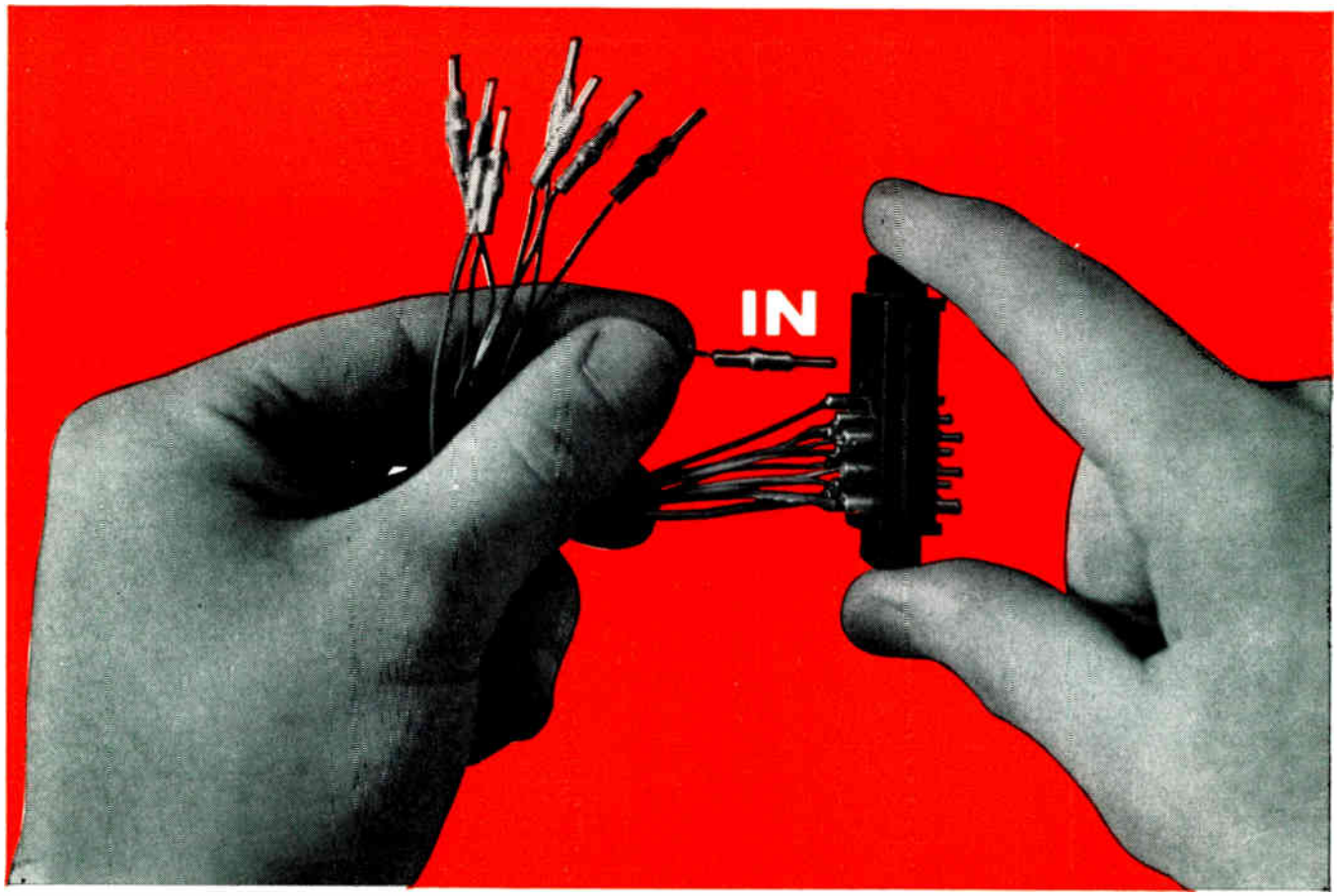
Abridged data for the W3/2G and a selection of other STC travelling wave amplifiers available are included in the adjacent table.

Tube Type	Frequency Range (Gc/s)	Max. Power Output (W)	Gain (dB)	Noise Factor (dB)	Mount Type	RF Connection (WG Flange)
W3·2G	10·7 to 13·2	12	40 to 45	26 to 30	WM109	WR75
W4·2G	7·0 to 8·5	15	40 to 46	26	WM108	UG51/U
W5·2G	5·85 to 7·2	25	36 to 45	28	WM107	UG344U*
	7·2 to 8·2	18				
W5·3G†	5·85 to 6·5	23	37 to 43	30	WM107	UG344U*

* Alternative waveguard flanges available.
† This tube has a typical AM PM conversion factor of 0·75 db.

For full information write, 'phone or telex for data sheets to STC Valve Division, Brixham Road, Paignton, Devon, or London Sales Office, Footscray, Sidcup, Kent. Telephone: FOOtscray 3333. Telex: 21836.

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



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- Robust, slim, glass filled Diallyl-phthalate moulding
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- Contact springs of beryllium-copper
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- Ambient temperature range —55°C to —200°C
- High current ratings, 10 and 20 amp
- Simple removal tool supplied with contacts

Write for leaflet P661—
or telephone Miss Woolgar at
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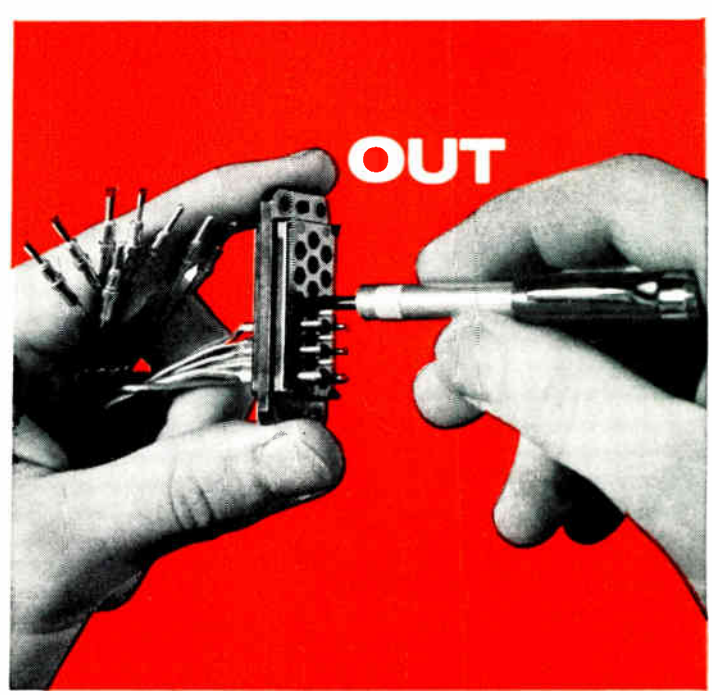

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Fields of use include :

laboratory measurement of distortion, gain and frequency response of high quality audio amplifiers. High output power matching into a load impedance of 3.75 ohms, 15 ohms and 600 ohms, provides ample power to drive loudspeakers or small vibration generators.

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- ★ 20 c/s to 20 kc/s in 3 decade ranges.
- ★ High output, 6 watts, with low distortion.
- ★ Frequency response 0.5 dB.
- ★ Balanced or unbalanced output.
- ★ High thermal and electrical stability.
- ★ Long scale, 60 ins.

U.K. List Price £98.

DAWE

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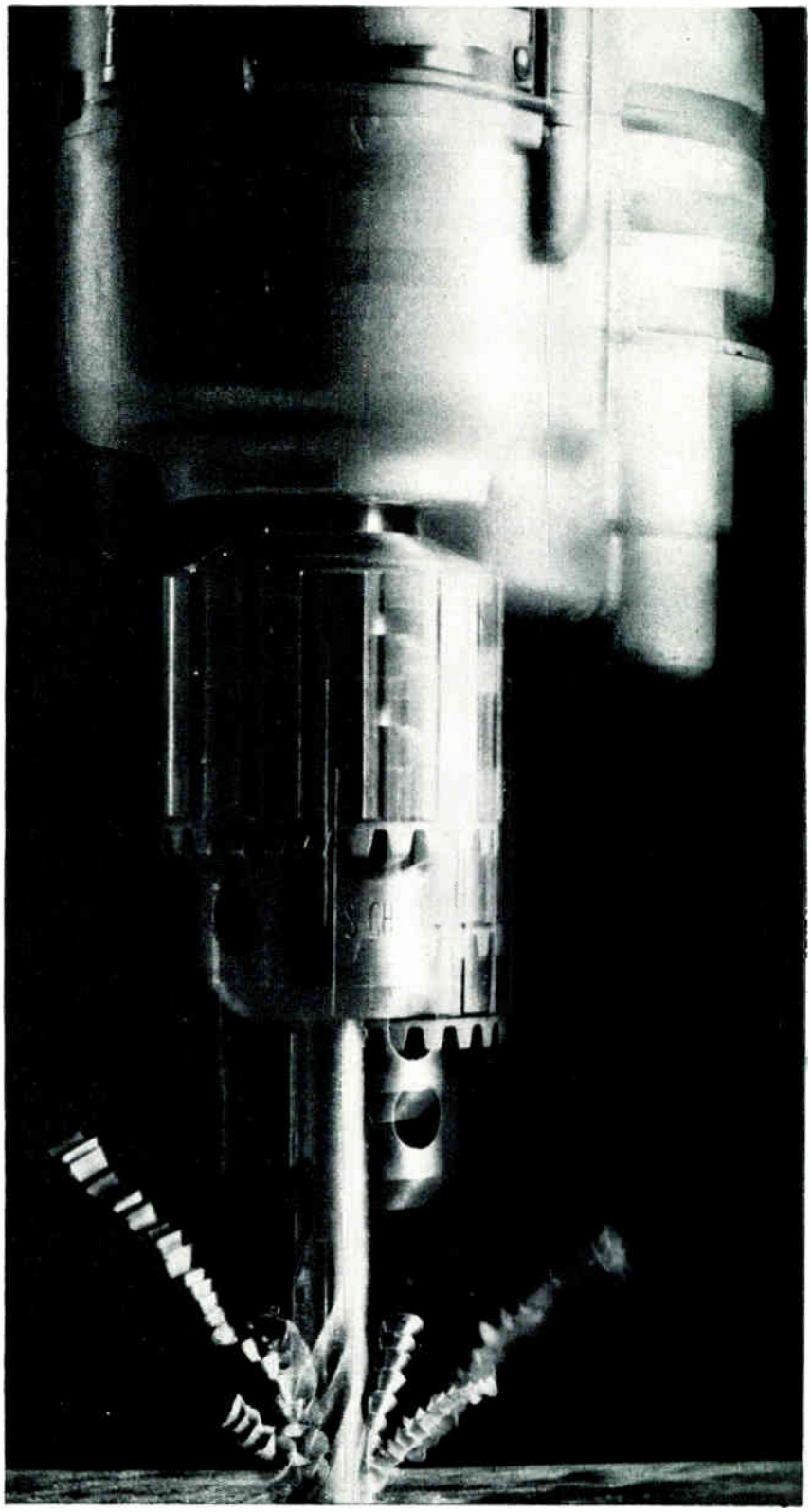
When a breakthrough is imminent

. . . you will find 'SELLOTAPE' Electrical Tapes contributing to the safety and reliability of heavily loaded, hard-worked components in motors, transformers, relays and coils. And in miniaturised components, particularly, where space for insulation is minimal, these specialised products carry out a host of essential jobs such as the insulation of windings during impregnation or baking, the securing of lead-out posts and the holding of parts during assembly and manufacture. 'SELLOTAPE' Electrical Tapes take this sort of thing in their stride, because they have been developed in close collaboration with electronic engineers to keep abreast of the constantly changing techniques of this fast growing Industry.



Sellotape

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polyester thermosetting tapes like it hot!

They have to because they have been developed for use in electronic components that are heat processed during manufacture or that operate at high temperatures. The tapes are based on various gauges of Polyester film, noted for its excellent volume resistivity and high dielectric and mechanical strength. The film is coated with thermosetting adhesive, which, on curing has increased bond strength and solvent resistance. The result is a range of electrical tapes designed to meet the stringent requirements of component manufacturers.

'SELLOTAPE' Extra-Thin Polyester Thermosetting Tape 1613—the thinnest in the range, specially developed for use in miniaturised components, and where maximum conformability is required.

'SELLOTAPE' Polyester Thermosetting Tape 1607—the most widely used in the range, shown in the drawing securing fine windings on a stick wound coil. The 0.001" based tape remains stable at 180°C for short periods and can be used continuously at 130°/155°C.

'SELLOTAPE' Heavy Duty Polyester Thermosetting Tape 1608—has that extra degree of toughness and insulation required on heavy coils etc. An ideal casing for capacitors.

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electrical tapes

'SELLOTAPE' Double-Sided Polyester Thermosetting Tape 1609—simplifies many tricky securing and holding operations in coil manufacture. 0.001" thick film is coated on both sides with thermosetting adhesive, providing the ideal means of securing lead-out posts, starting off, insulating and securing primary windings and leads, and in holding interleaves.

'SELLOTAPE' High Strength Polyester Thermosetting Tape 1614—a 0.005" based tape for the extra tough jobs found in the production of large motors, turbines, switchgear and heavy duty heater pads. Also used for 'ground insulation' in domestic appliances and equipment.

. . . and a special paper-based thermosetting tape for low cost components—**'SELLOTAPE' Creped Paper Thermosetting Tape 2701**—will withstand processing temperatures of 180°C and continuous electrical operation at 105°C. Good insulation and moisture resistance properties make the tape an obvious choice for use in coils, transformers, relays etc. for holding, lead and slot liner binding, and finishing off.

Write for full details of the complete range of 'SELLOTAPE' Electrical Tapes or call in one of our technical representatives to ensure that you use the right tape for the job.

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SELF-ADHESIVE Sellotape PRODUCTS

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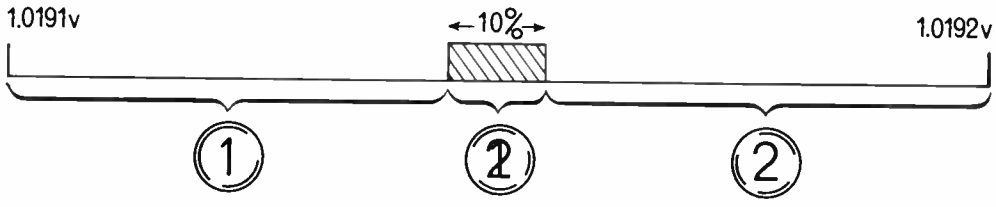
EVERY LM1440 DIGITAL VOLTMETER IS BACKED BY A MINISTRY APPROVED TEST HOUSE

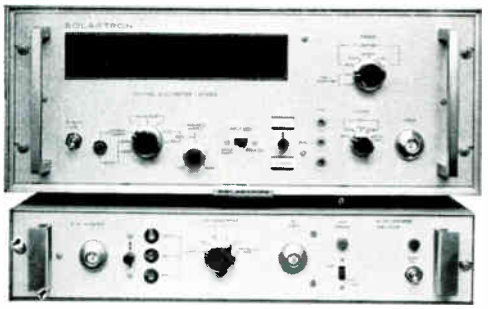
*The LM1440 undergoes a vigorous test programme – including accuracy checks at 45°C
*Final 0.005% calibration is set-up using NPL certified standards.
These are some of the factors which have contributed to the consistent high performance of instruments with proven reliability at home and abroad.

Effective sixth digit calibration

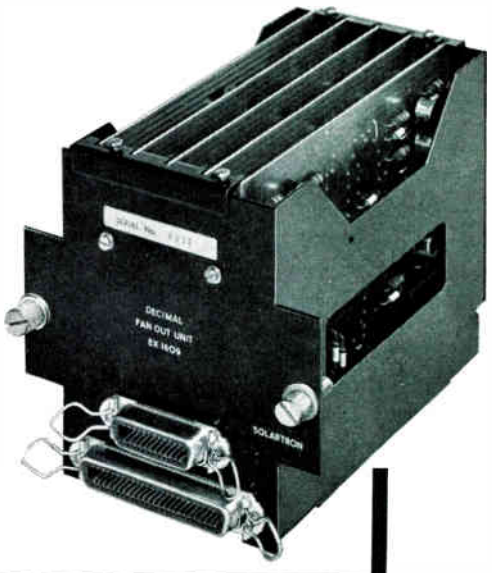
With *flicker point* calibration new circuit techniques ensure that changes in the least significant decade occur exactly at the mid-voltage level. This gives effective resolution of 10 parts per million (0.001%) on calibration.



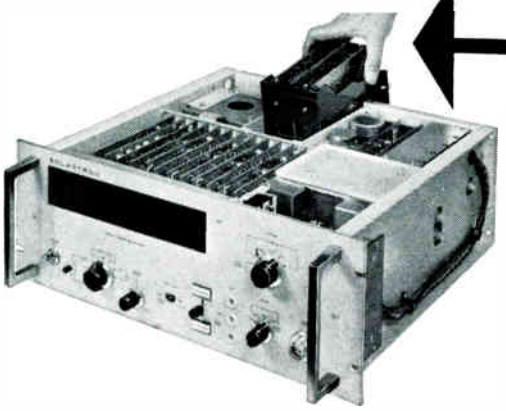
The internal Weston cell is effectively adjusted to exactly halfway between 1.0191 and 1.0192 allowing overall calibration to be adjusted to 0.002% in daily use.



With the LM1219 AC-DC converter the applications of the LM1440 can be extended to 0.08% for AC measurements. From 30 c/s to 2.5 kc/s.



Modular plug-in fan-out units are now available for either BCD or decimal output. Additional encoders give a typewriter or punch facility.



To meet increasing demand for the LM1440—and its optional autorange version—Solartron is now equipping a second Standards Room

SOLARTRON

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LONDON
14th May, 1964.

The Approval and this Certificate may be withdrawn at any time at the direction of the Director General of Inspection.

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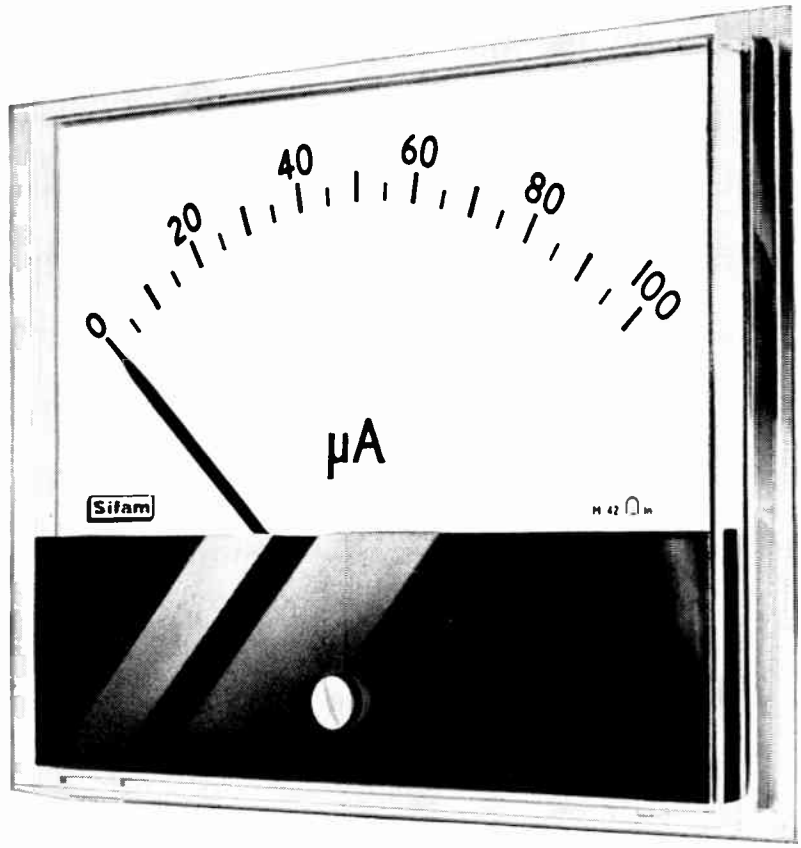

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The elimination of any solid surround to Sifam 'CLARITY' instruments eliminates top shadow, especially when instruments are mounted above eye level. This feature also provides greater readability, thereby minimising the risk of human error in recording readings.

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Please write for Data Sheets 106/C & 106/C1.

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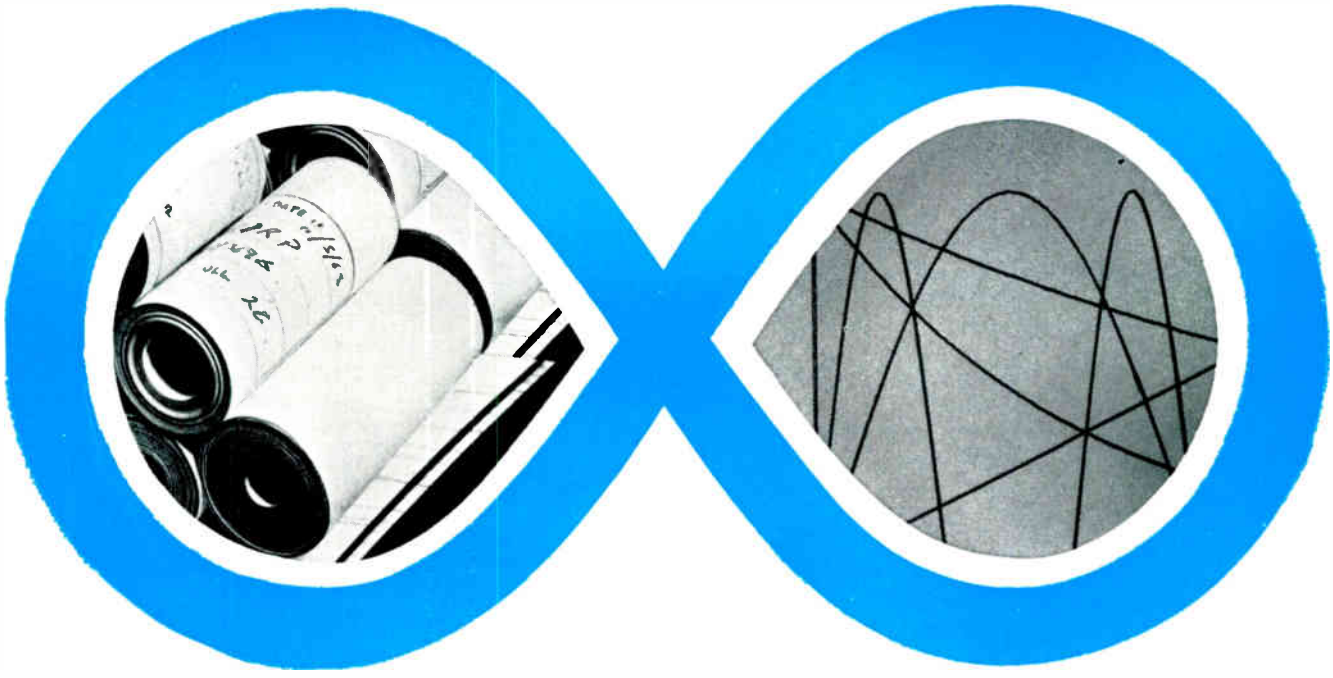
SI. 51



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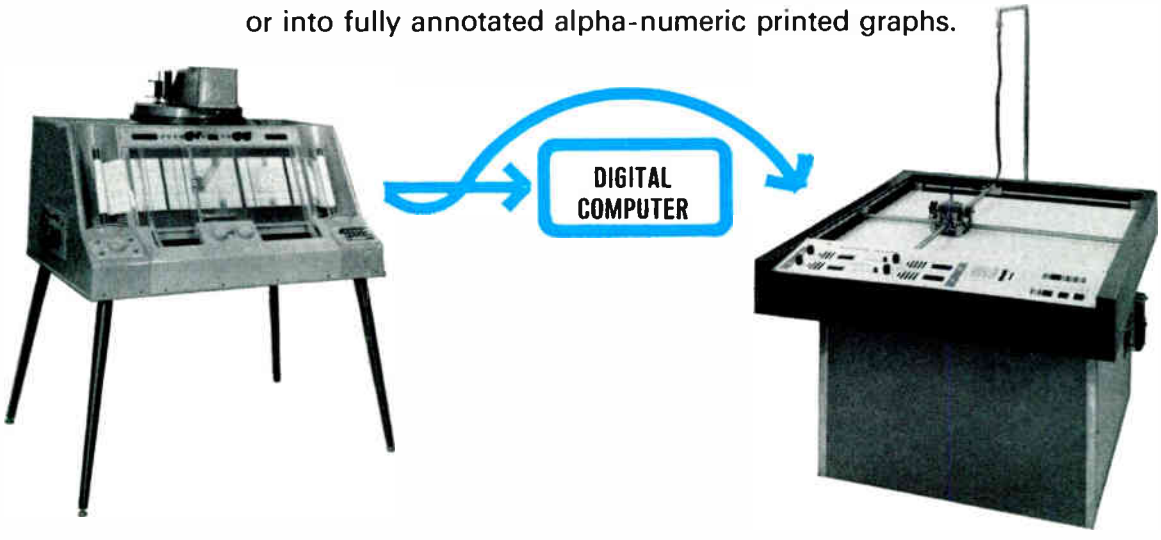

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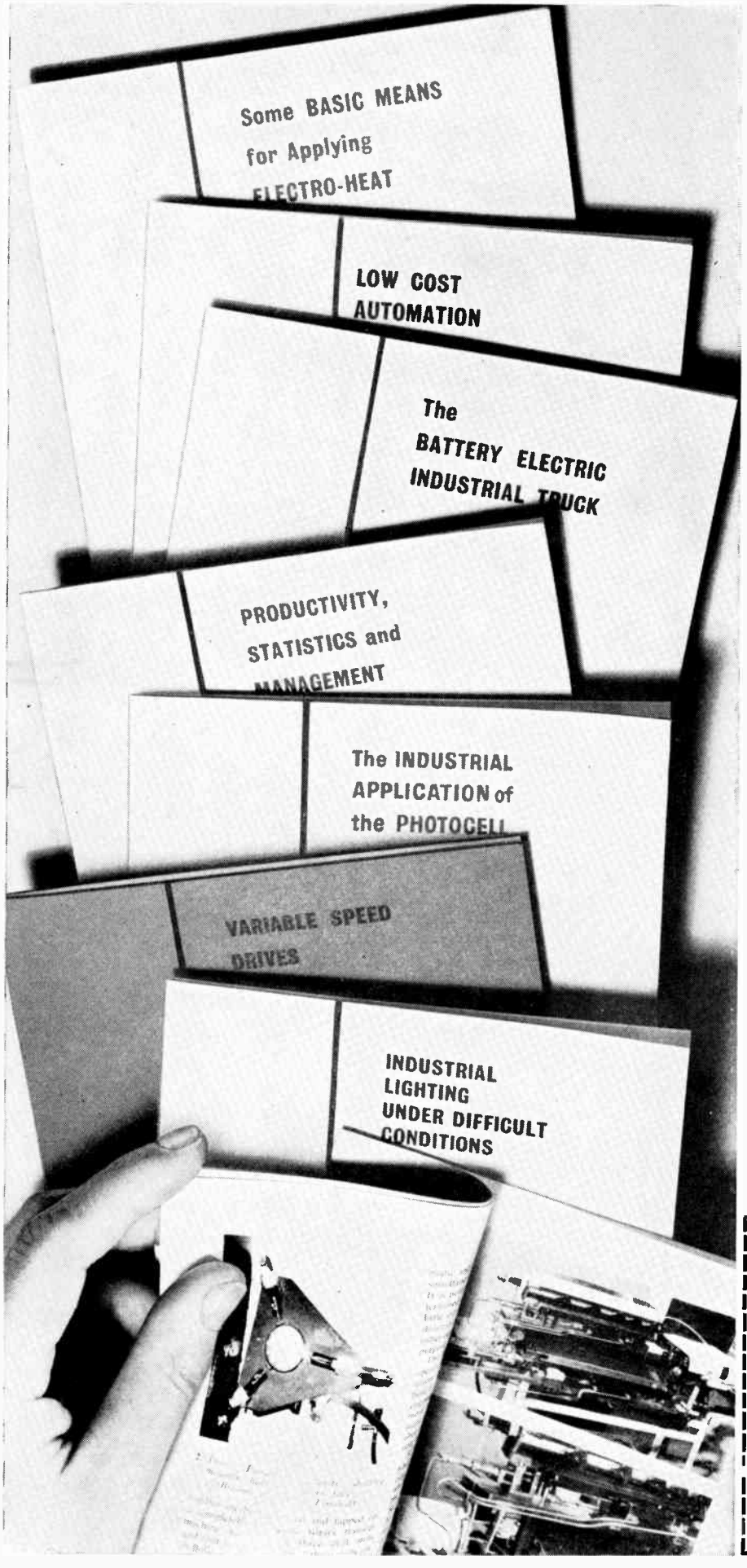

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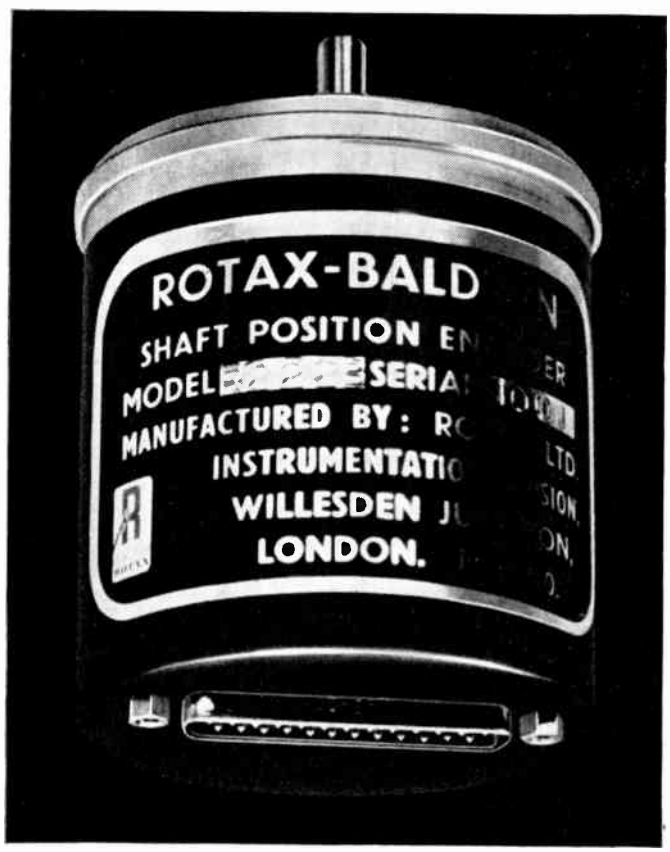

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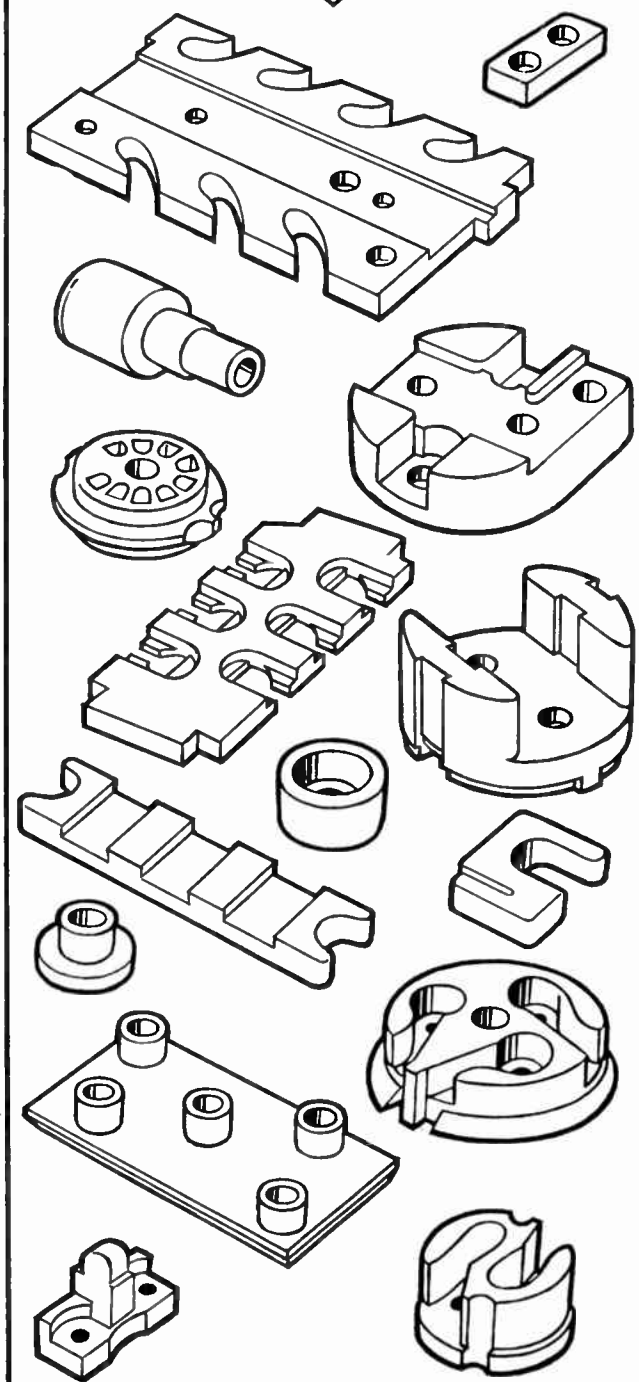

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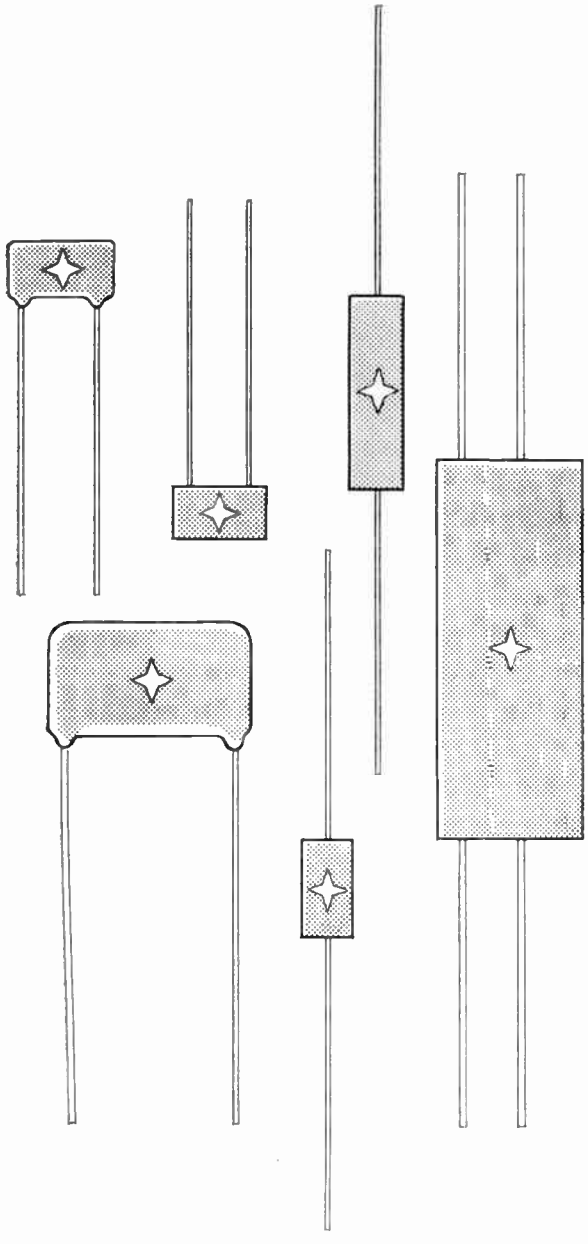

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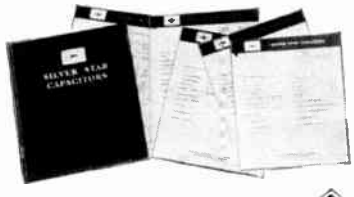

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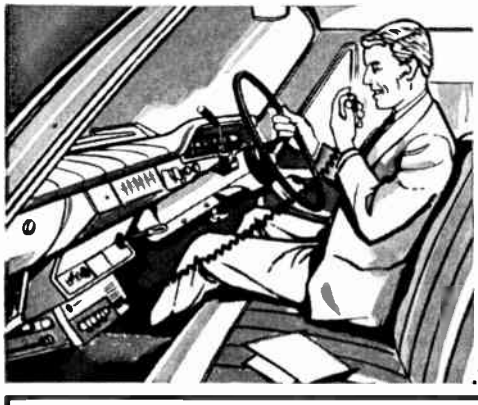

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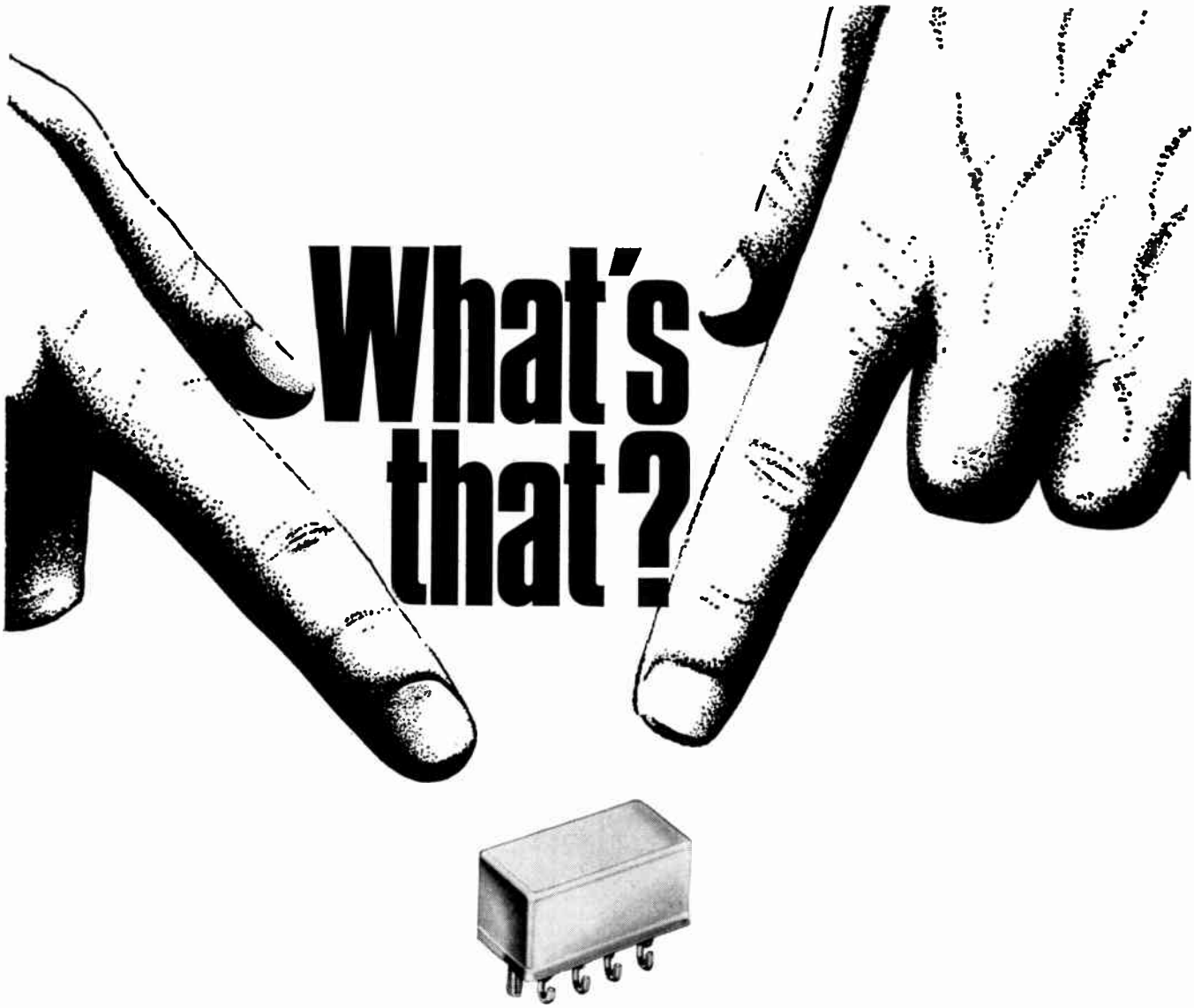

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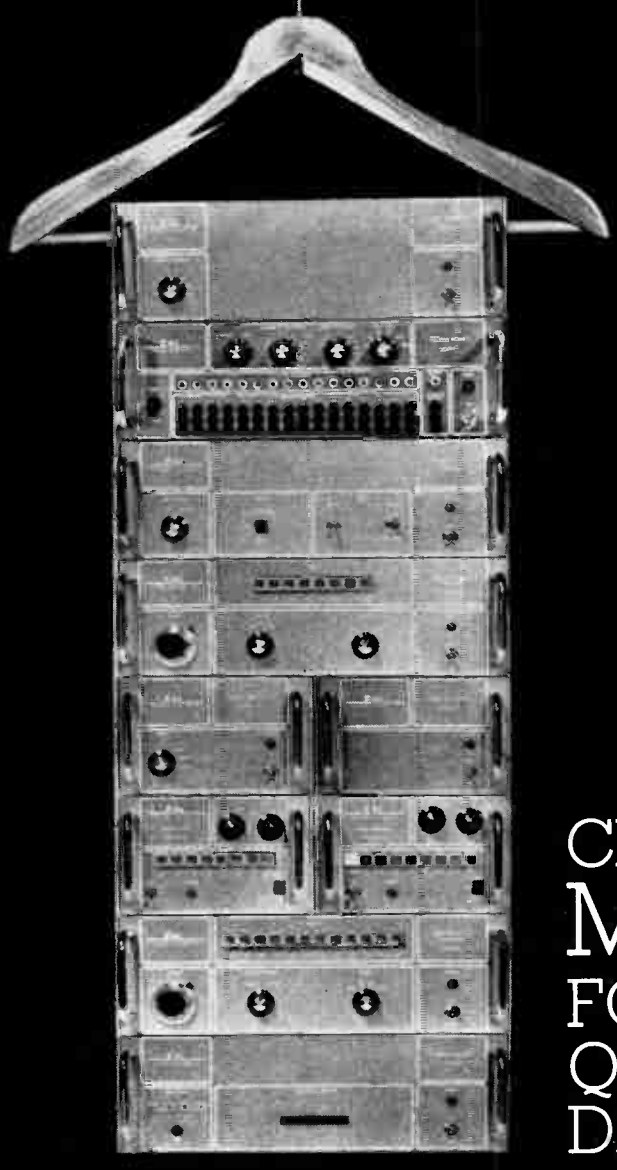

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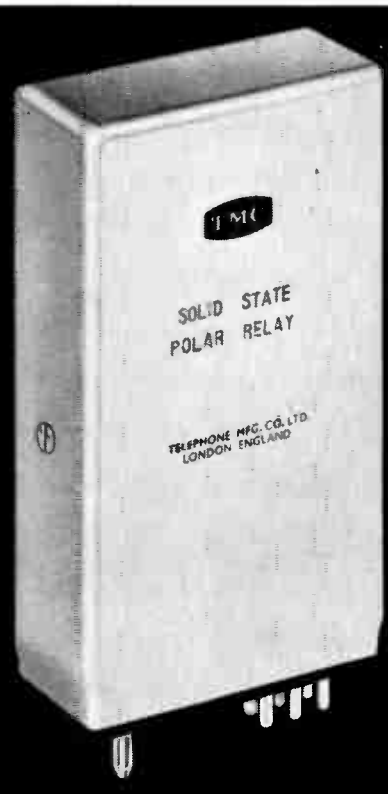

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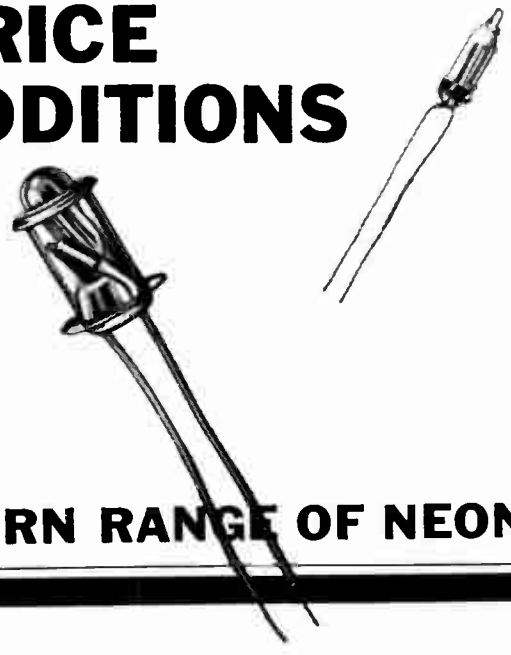

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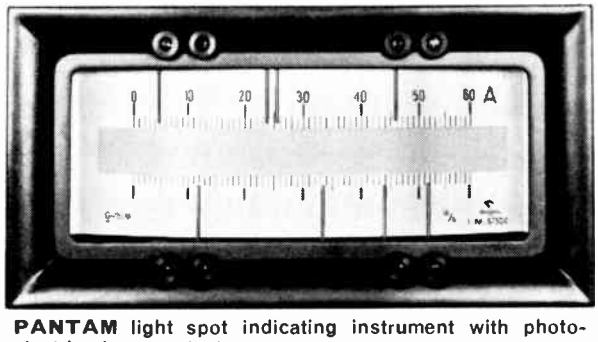

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Left: **PANTAM** pointer indicator with photoelectric contacts.
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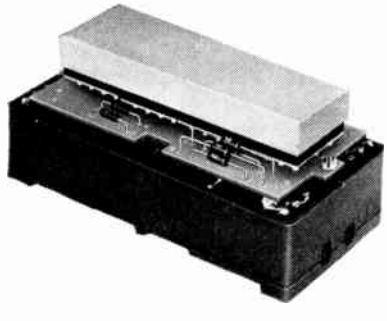

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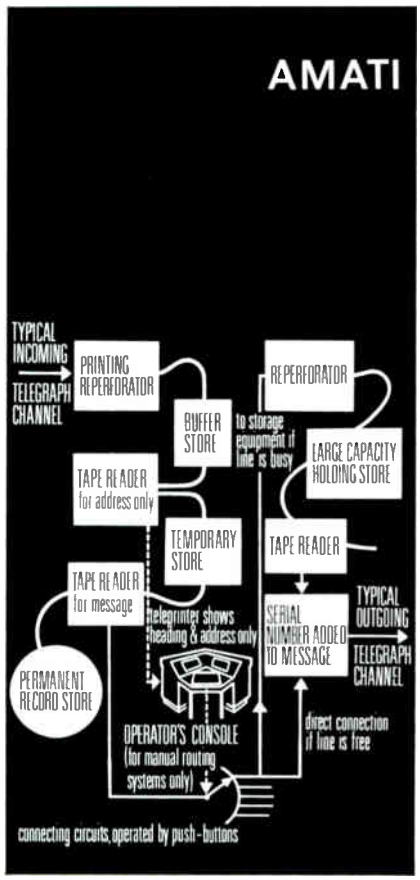

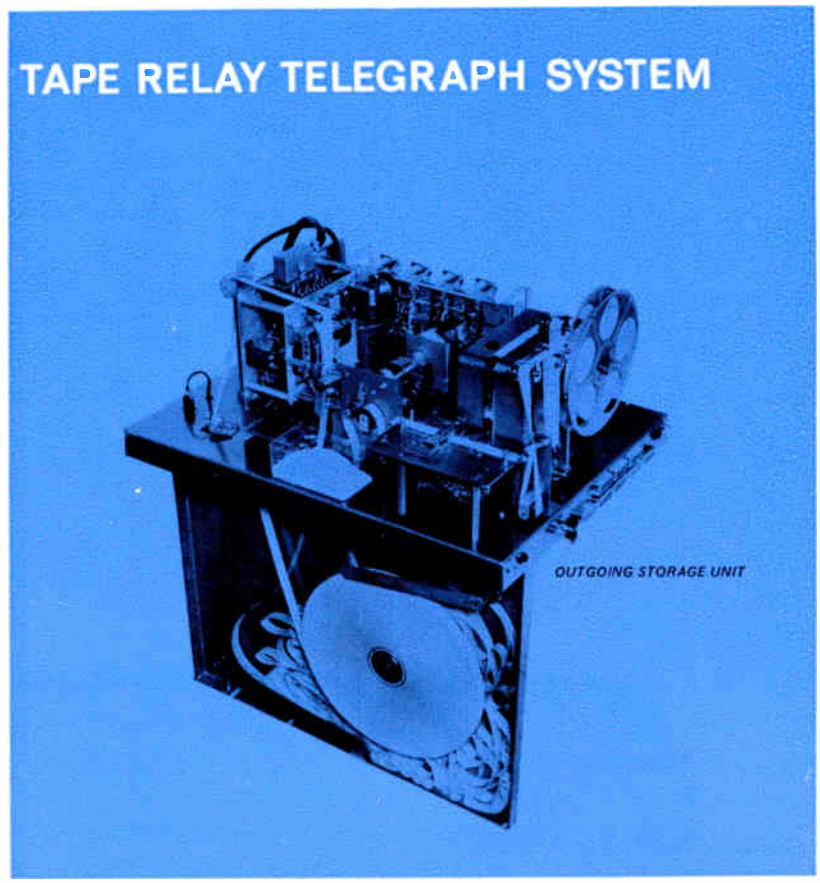

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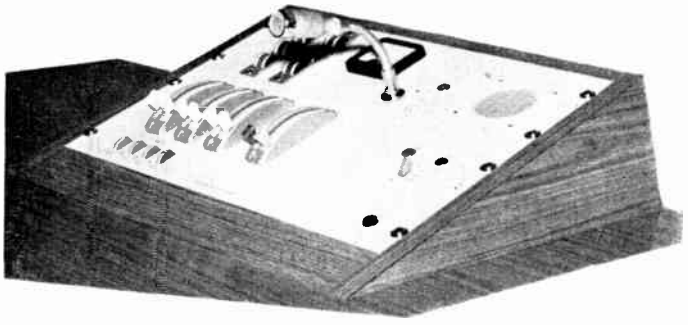

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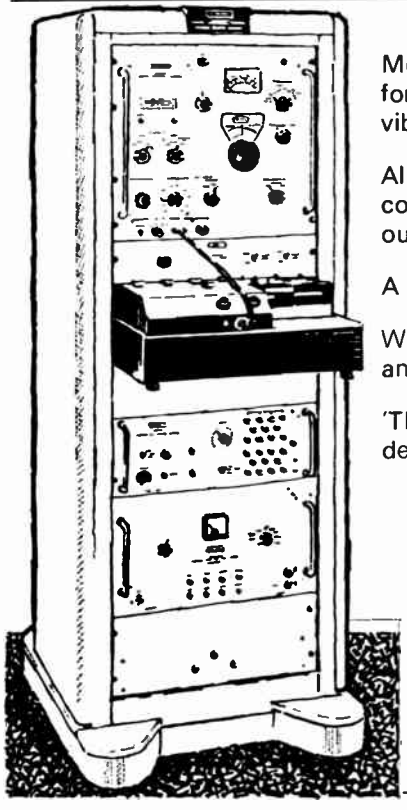

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711

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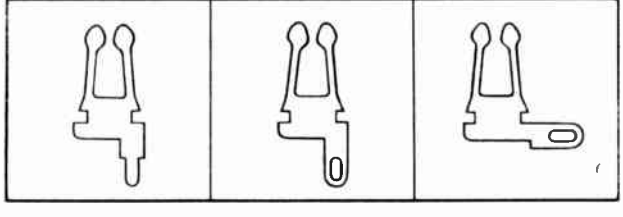
Permacon edge connectors



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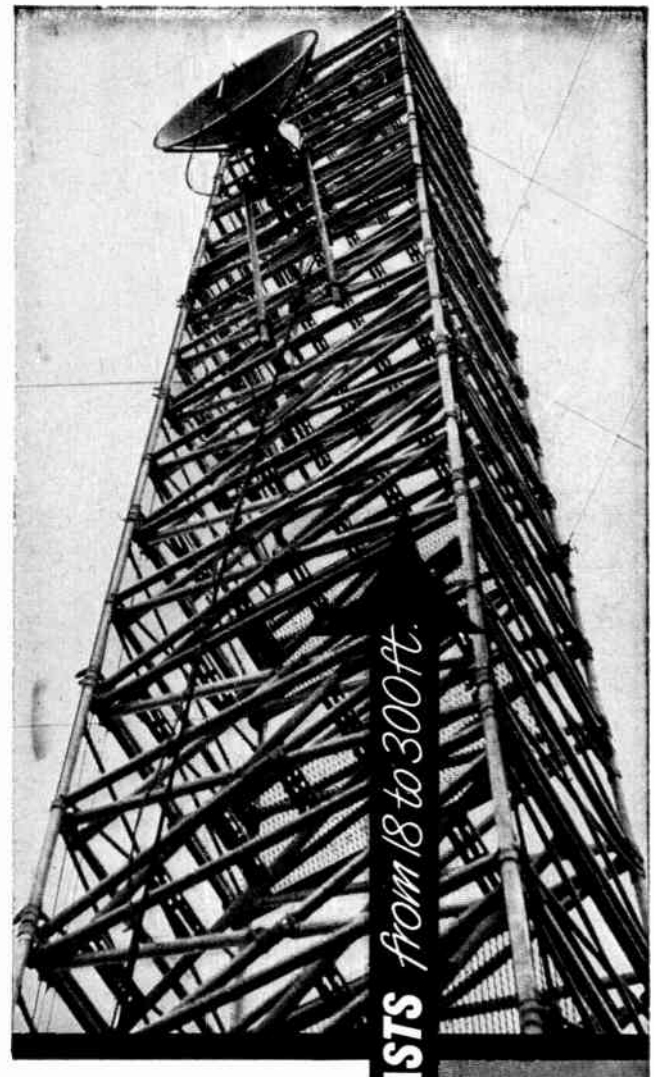

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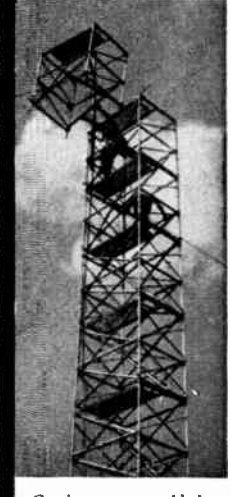

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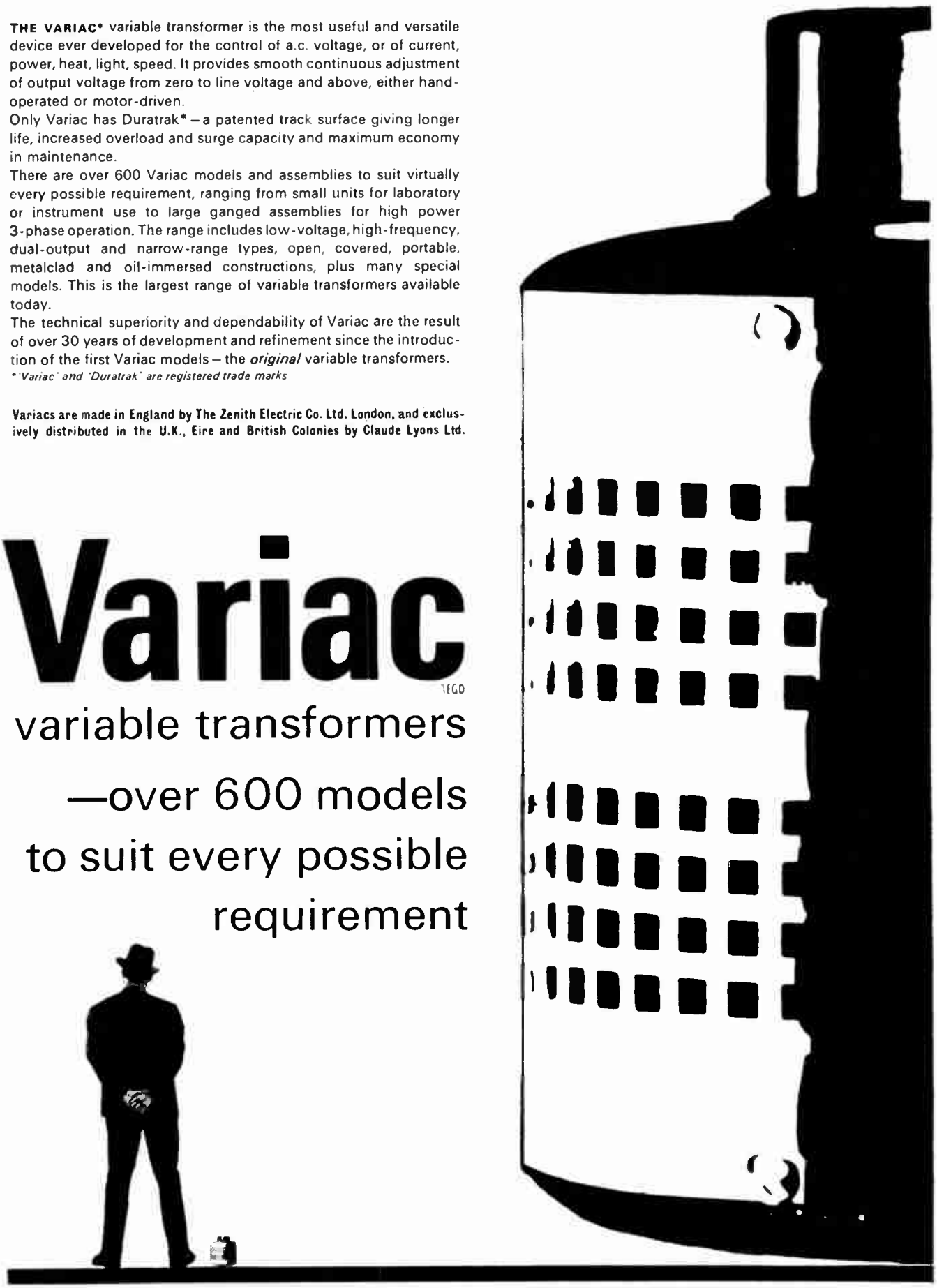

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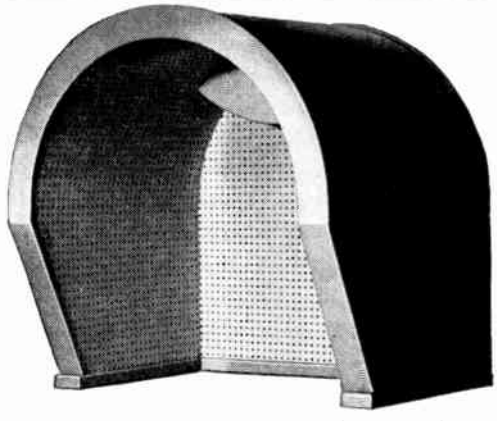

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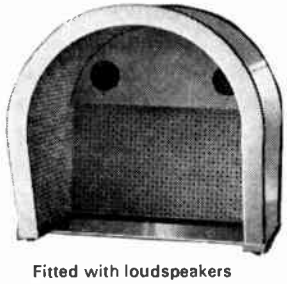

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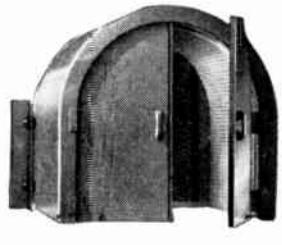

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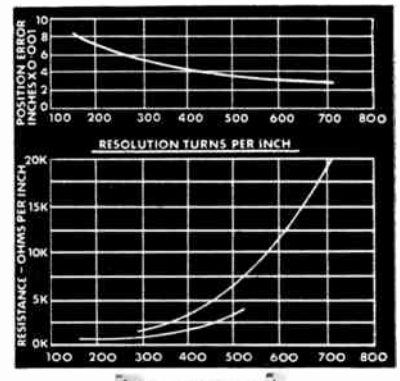

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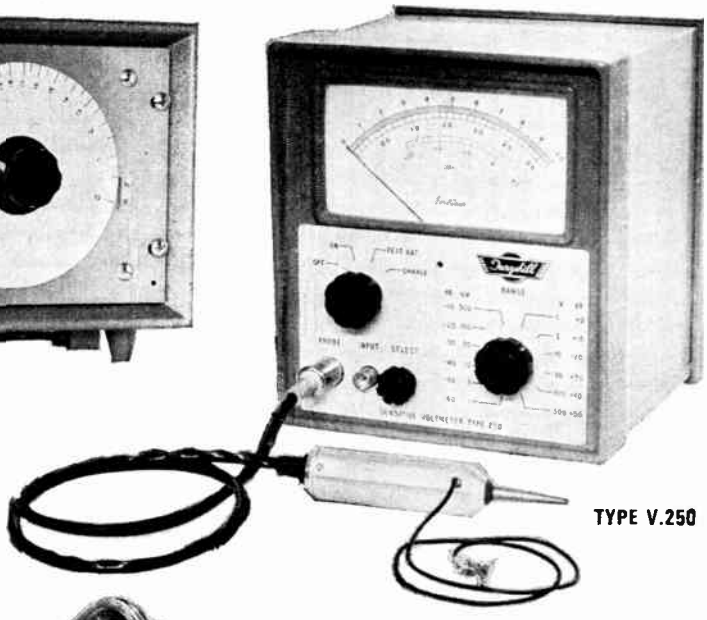

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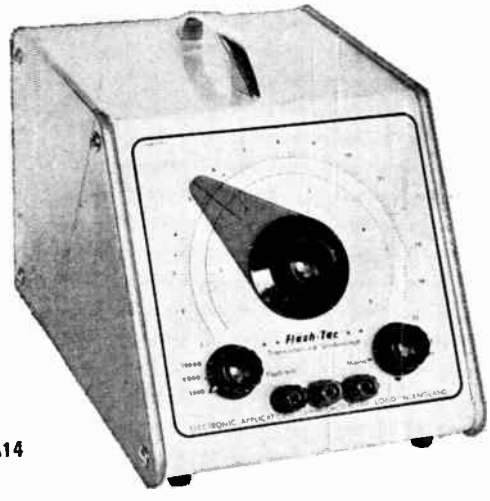

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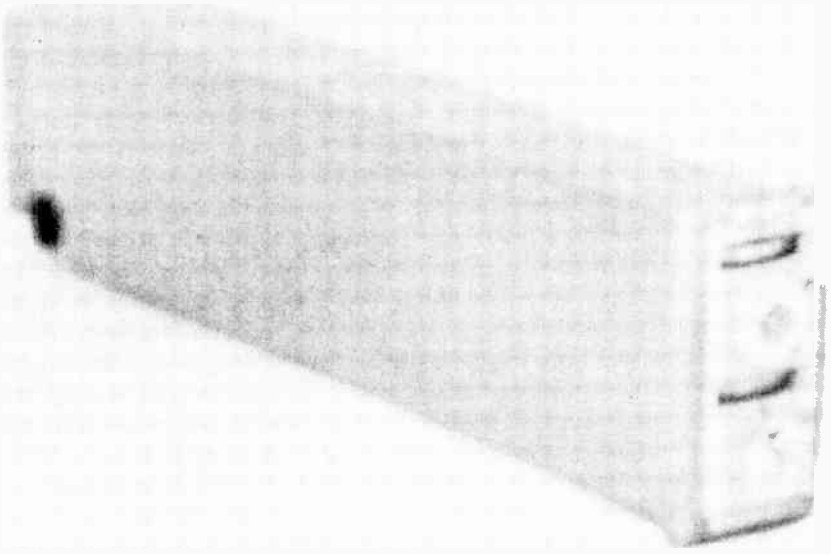

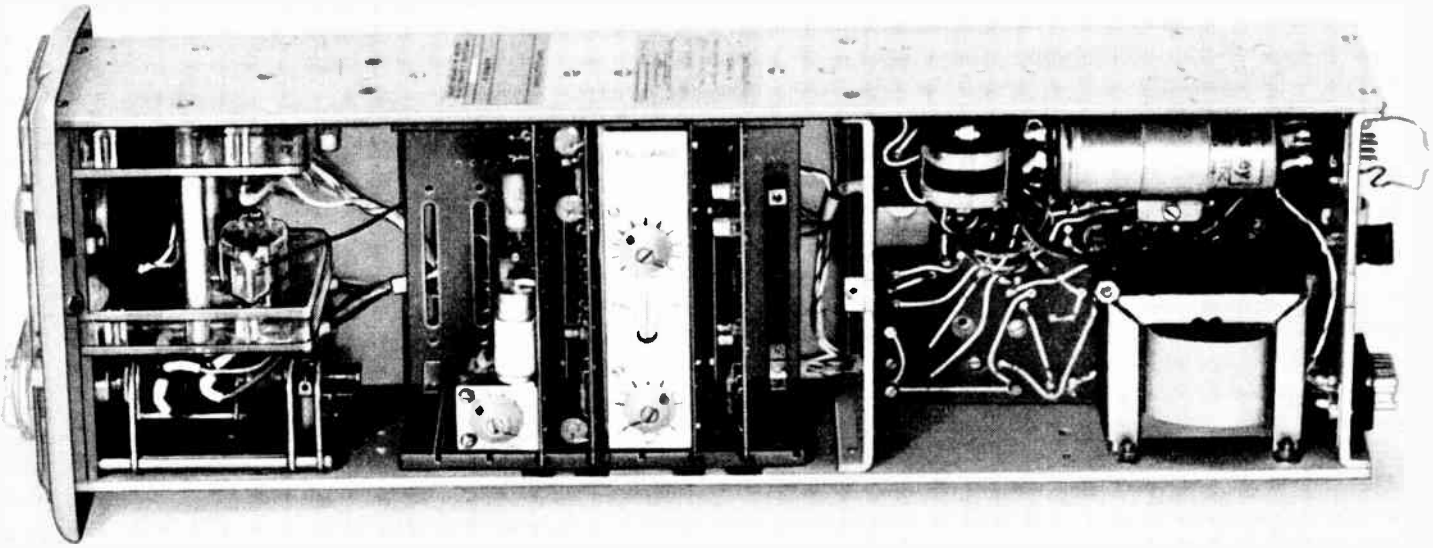

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The Postmaster General has announced that, starting early next year, the G.P.O. will gradually change the present method of specifying telephone numbers. The present method, using a mixture of letters and digits, is to be replaced by one in which digits only will be used.

There are three main reasons for the change. First, out of the growth in international dialling there arises the need for standardization. By the end of the century it is estimated that there will be 600 million telephone subscribers in the world, most of whom will be able to dial each other directly. International dialling can only be satisfactorily accomplished if every national system is on the same basis. Secondly, the development of our own telephone service necessitates larger telephone exchanges and more of them. In the six big cities of London, Birmingham, Edinburgh, Glasgow, Liverpool and Manchester each new exchange requires a unique three-letter code to identify it; only 320 of the possible 628 combinations are suitable. Of these 240 are already in use and the remainder will be needed by 1970. By changing over to an all-figure system, the number of usable codes can be increased to 800. Finally, the growth in the number of telephone calls made each year must be met by decentralization in the big cities. The introduction of switching centres at city peripheries, designed to serve exchanges within prescribed sectors, will result in less congestion and greater efficiency. Re-allocation of exchange names to conform to this sectionalization would be difficult and confusing (and in London impracticable). With all-figure telephone numbering such a transition can be achieved without difficulty.

The changes that the new system will involve will not be as complicated as they might seem at first sight. For trunk dialling, national numbers will be used. At present a subscriber's national number consists of his S.T.D. code followed, if he is in one of the six big cities, by his exchange code and ending with his personal number. In future this national number will be all-numerical and will not exceed ten digits. For local calls within the six big cities, a seven-digit number (exchange code and personal number) will be used. In all other places, local calls will be made by dialling personal numbers only.

The transition period will be about three years, during which time subscribers may choose, in consultation with the G.P.O., when they would like to have their numbers changed.

It is beyond dispute that a more efficient telephone service is desirable. The way in which this should be achieved and the priorities to be adopted give rise to controversy. Some 50,000 potential subscribers in the U.K. are at present awaiting connection to the telephone service. We wonder if they will look kindly upon these proposed improvements.

Ultrasonic Welding of Rigid Thermoplastics

By B. R. BICKNELL*

A new application of ultrasonics is described here. It is shown that with ultrasonic energy it is possible to weld rigid thermoplastics. General principles, equipment used and typical applications are discussed.

ANYONE who has assembled plastic models from a kit of component parts will know that the cementing of the parts together is no easy job; it needs care and takes time.

To the home constructor difficulty of assembly is, in some peculiar way, part of the 'fun'. To a manufacturer it means production time and increased costs.

Until now thermoplastic component parts have been joined together in production mainly by using adhesives and solvents or by heating. Ultrasonic techniques of plastic welding, developed by Branson Instruments in the U.S.A., show great promise for the future and may well eliminate a great many of the cementing and heating operations being carried out today in the assembly of plastic component parts.

Welding Operation

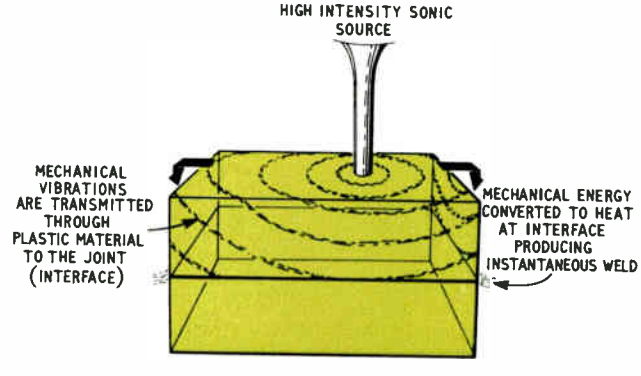
The simplest way to illustrate this new process is to quote an example. Consider a two-part polystyrene box which requires to be sealed at the interface (Fig. 1).

This seal is accomplished by bringing a high-intensity ultrasonic source into intimate contact with one part of the box and applying a burst of vibrational energy to it. The plastic part transmits the vibration introduced into it in a similar way to that in which sound waves travel in air, each particle being displaced a little later than its neighbour in the wave formation shown. As the actual workpiece transmits the energy applied by the probe the surface of the material is not heated or marked. However when the vibrations reach the interface, a low amplitude reciprocating motion is imparted to the joint and rapid dissipation of energy occurs. This mechanical energy applied to the interface is almost instantaneously converted to heat because of the friction between the two parts and this heat causes the plastic to melt and form a weld around the whole periphery of the box. The total process time for this kind of application is often as small as 0·2 second.

The Basic Equipment

The equipment required for this type of welding basically comprises an ultrasonic power generator, an output transducer and a mechanical coupling which transmits energy from the transducer to the plastic. Fig. 2 shows a typical set-up. Towards the bottom and on the left is a tran-

Fig. 1. Plastics are sealed together by the local heating of the mating surfaces brought about by the friction resulting from ultrasonic vibration



* Dawe Instruments Ltd.

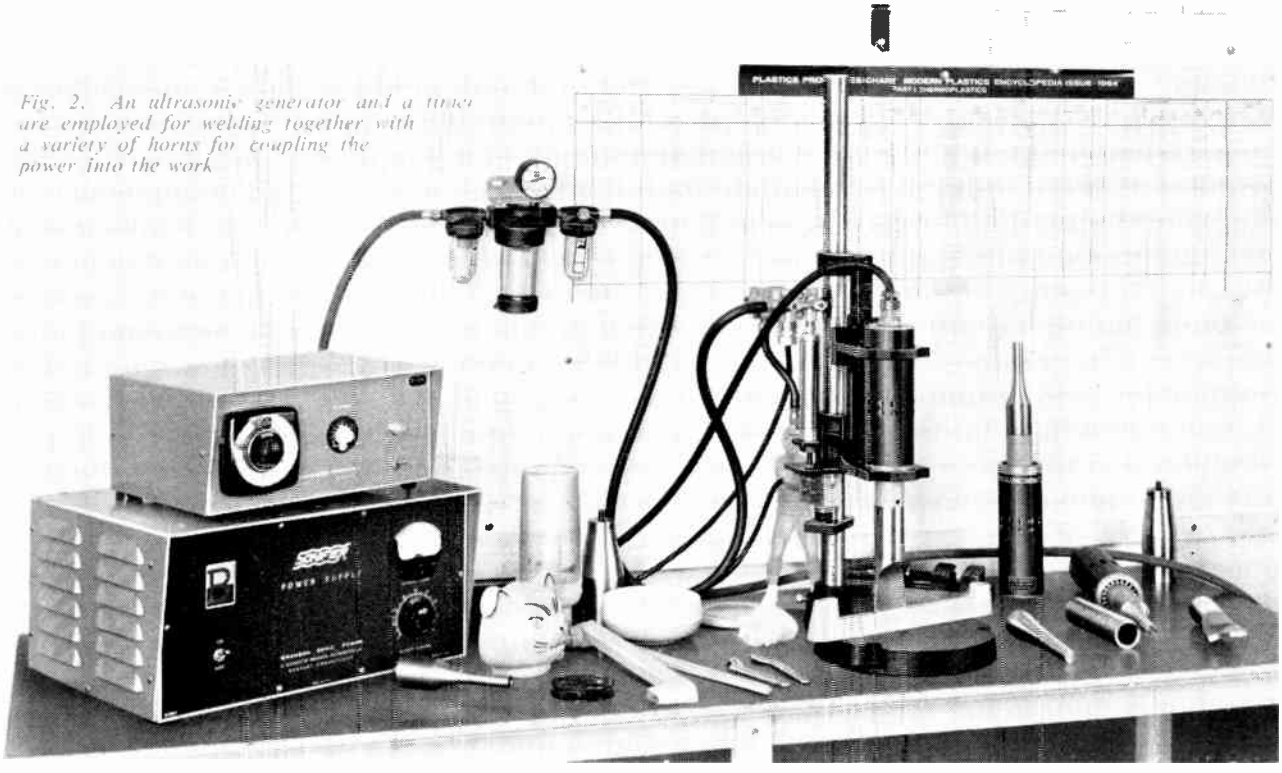


Fig. 2. An ultrasonic generator and a timer are employed for welding together with a variety of horns for coupling the power into the work

sistorized automatically-tuned ultrasonic generator on top of which is an adjustable cycle timer for controlling the pneumatically-operated stand on which the transducer and coupler are mounted. A foot switch brings the coupler down on to the workpiece, and initiates a cycle of events. First, the ultrasonic energy is applied to the plastic to be welded for a pre-set period of time. The generator output is then switched off but the coupler remains pressed down on the plastic part for some time to allow the welded joint to set.

Equipment Design Consideration

The main design consideration in plastic welding is the transmission of the maximum amount of power from a transducer into the workpiece.

Power ratings in watts output from the generator do not give any indication of the energy available for welding. It is not possible in normal systems to convert electrical energy into mechanical motion with 100% efficiency. Piezoelectric transducers can convert electrical energy to mechanical energy, in the form of vibrations, with a conversion efficiency as high as 90%. Power outputs in the present system are as high as 1,700 in./lb sec. Equipment available in the near future will deliver up to 3,200 in./lb sec.

The actual usable power capabilities of ultrasonic equipments are controlled by the operating characteristics of the load and the electrical driving source. Fig. 3 shows a simplified electrical equivalent circuit for a ferroelectric system from the power supply to a mechanical load.

The capacitor and inductor in the mechanical branch of the equivalent circuit represent the mechanical resonance of the tranducer system.

The inductor is the equivalent of the mass and the capacitor of the stiffness. The resistor in the electrical branch represents electrical loss both dielectric and leakage. With good ferroelectric material such as PZT (lead zirconate titanate) this loss accounts for only a small percentage of the total input power to the transducer. R_i, the resistor which represents the internal mechanical losses of the transducer, is the one which accounts for the greatest percentage of loss in the system.

In fact, the entire circuit can be reduced to the two principal absorbers of power, the internal loss and the load, represented by two resistors R_i and R_L, when the power delivered to the load at constant voltage quite closely approximates:

$$P_{out} = P_{total} \frac{R_L}{R_i + R_L} \qquad \ldots(1)$$

Importance of the Value of the Load Resistance

Power delivered to the load is a function of force and velocity. The actual mechanical power is equal to $\frac{1}{2}FV$ where F is peak oscillatory force and V is the peak oscillation velocity, velocity being $2\pi FA$ (A is peak amplitude of swing). Obviously the same power can be delivered to the load with different combinations of force and velocity and it is these different combinations which yield results for particular types of loads or materials.

The ratio of force to velocity is the mechanical resistance R_L. Since the actual amplitude of the transducer is relatively small, compared with the force available, and since most applications require a fair degree of movement to create frictional forces, mechanical transformers or horns are

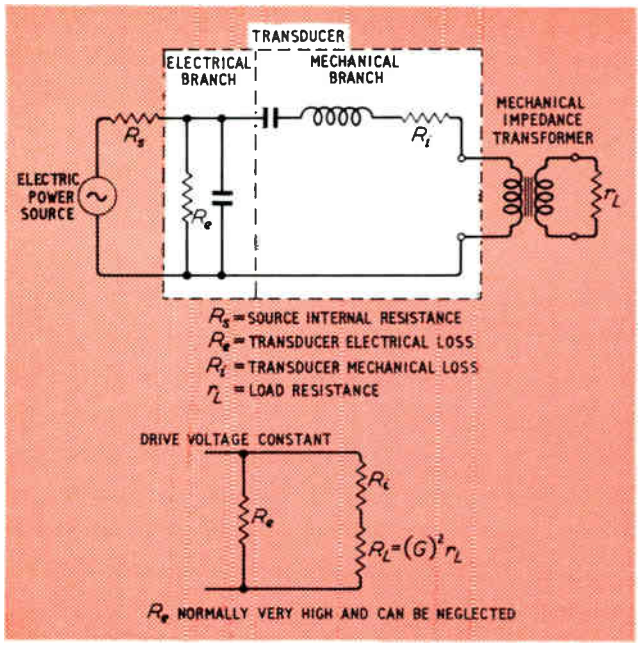


Fig. 3. Equivalent circuit of transducer and load

used and coupled to the transducers to alter this force and velocity ratio, and match the resistance to movement presented by the load.

This means that for maximum transfer of energy from the transducer to the workpiece a special coupler or matching horn is required for each workpiece. In practice, a standard range of couplers covers most applications (typical couplers are shown in Fig. 4).

All horns are designed as half-wave resonant sections and all the horns shown in Fig. 4 have been designed for general plastics applications bearing in mind the fact that the object is to induce elastic vibrations into the plastics at the point of contact without marking the surface.

The matching of the load impedance is the fundamental criterion of ultrasonic welding and is an extremely complex and critical design problem. A load does not simply represent a resistive component but also contains reactive components. The load itself varies under ultrasonics and if the generator does not rapidly match the load variation in its output circuitry, resonance is quickly lost and power delivered to the load falls off.

Basic Parameters of Ultrasonic Welding

The equipment gives complete and easy control of factors affecting welding by:

1. Matching load impedance by mechanical impedance transformers or horns. Horns are interchangeable and screw into the converter assembly.
2. Static pressure exerted on workpiece prior to application of energy set by operating an air regulator in pressure line of the pneumatic stand. Pressure is variable between 0 and 60 lb and thus ensures intimate contact of joining surfaces prior to weld and good energy coupling to workpiece.
3. Actual ultrasonic weld time set up on timer mechanism variable between 0 and 6 sec.
4. Hold time control variable between 0 and 6 sec. Operates after ultrasonic weld time has expired and allows the material to solidify under static pressure preventing the mating surfaces from springing apart.
5. Activity control on generator. Controls power output for different applications.

Additional Facilities

With correct materials and proper operating conditions, a single generator can seal a peripheral weld on a square box of 5×5 in. with a $\frac{3}{32}$-in. wall.

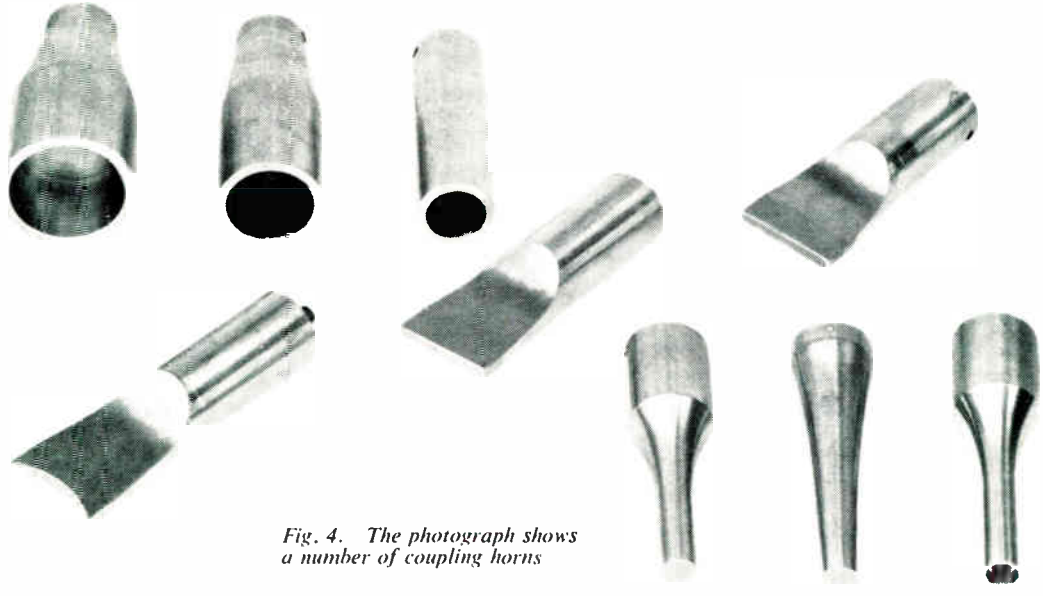


Fig. 4. The photograph shows a number of coupling horns

If larger assemblies are to be sealed, a separate sequencer equipment is available which will operate more than one converter head from the same generator.

A manufacturer or engineer is thus able to utilize any number of ultrasonic heads or converters and large workpieces can be sealed using as many converters as are necessary.

Materials

As ultrasonic welding involves a form of thermal fusion the process is best suited to those materials with a high modulus of elasticity and a low melting point.

As the process is also one of transmitting energy waves through material, other properties such as density, specific heat, thermal conductivity and acoustical transmission are also important. Table 1 gives details of various materials and their response to ultrasonic welding.

Table 1: Ultrasonic weldability of plastics

Material	*Near field*	*Far field*	*Remarks*
Polystyrene	Excellent	Excellent	Excellent acoustical properties, produces strong, smooth joints
SAN	Excellent	Excellent	—
ABS	Excellent	Good	—
Rubber-modified PS	Excellent	Good-poor	Welding characteristics are determined by degree of impact resistance
Fibrous glass-filled Ps	Good	Good	—
Polycarbonate	Excellent	Excellent	Dependent upon sufficient energy (use of multiple tools) and good joint design
Acetal	Good	Good	In small assemblies, horn placed near the joint
Acrylics, injection moulded	Good	Good	—
Acrylics, cast or extruded	Poor	Poor	—
Nylon	Good	Good	Proper joint design required for controlled material flow to achieve best weld line appearance. Parts should be 'just moulded' or oven dried. Energy requirements are high
Polypropylenes, unfilled	Excellent-poor	—	Horn design is critical. Filled PP's need individual testing
Butyrates	Good-poor	Good-poor	Depending upon formulation and part configuration
Polyethylene, high density	Good	Good-fair	—
Polyethylene, low and medium density	Good-poor	Poor	—
Acetates	Poor	Poor	Some formulations show promise
Vinyl	—	—	Limited success found with rigid form

Strengths of seals are rated as excellent, good or poor. Near field refers to seals made within 0·25 in. from tip welder. Far field refers to seals made from 0·25 in. to 10 in.

Materials having a relatively low modulus of elasticity do not transmit the sonic vibrations as well as those with a high modulus and as a result of this, seals are limited for these materials to a region within access of the tool tip as the material itself damps or absorbs most of the energy imparted to it.

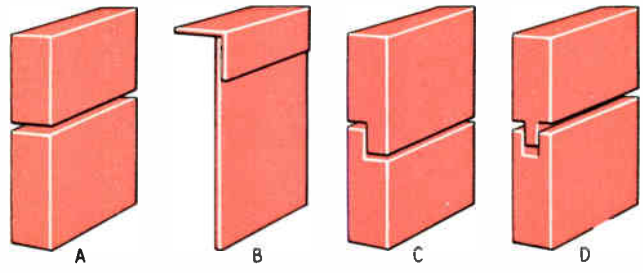


Fig. 5. Various joint designs suitable for ultrasonic welding techniques. Designs B, C, and D are preferred since friction is maximized by using sliding surfaces perpendicular to the butt surface

Part and Joint Design

Part design and size with material thickness are particularly important and whenever possible should be kept as small as possible.

When the size of the joint has been decided the actual joint itself should be designed to give maximum frictional contact between the parts.

In Fig. 5 various joint designs are shown and designs B, C and D are preferred since a maximum frictional contact is given.

Economy

Savings of over 75% have been generally reported against standard solvent techniques and undoubtedly this is one of the strong points of welding by ultrasonics. Reproducible non-reject results are obtained without drying ovens or messy joints. The fact that the parts can immediately be handled is an indirect benefit of this process and must be included in considerations of economy.

The fact that no toxic or inflammable adhesives are used is, of course, a great advantage.

Applications

Typical single-point applications include polystyrene balls, container boxes, toy harmonicas, polystyrene double-wall cups and various types of tape spools.

Polystyrene and its derivatives are particularly good materials for ultrasonic welding as they transmit the impressed energy over a large area and have a relatively low melting point.

Typical multipoint applications include toy guns, heater assemblies and any design above an area of 5 × 5 in. with a $\frac{3}{32}$-in. wall.

New applications of standard welding equipment are continually being discovered. Recent developments include the insertion of metal parts into solid plastics, peening and the re-activation of adhesives.

It can safely be predicted that within the next few years ultrasonic welding will be one of the largest applications of ultrasonics.

PRESSURE TRANSDUCERS USING MINIATURE SEMICONDUCTOR STRAIN GAUGES

By N. SION, B.Sc.(Eng.), M.A.S.M.E., A.M.I.Mech.E.*

Semiconductor strain gauges have a large output as compared with foil types and thus permit the use of simpler ancillary equipment. This article describes the design of transducers which embody them.

THE present-day trend in transducers for the aerospace or automated industries calls for small, lightweight but rugged, units whose outputs are high enough to be fed directly into many types of measuring equipment without amplification.

Among the pressure transducers generally in demand are those measuring gauge pressure of up to 10,000 p.s.i. as required by the heavy industries and as low as a few p.s.i. for the medical or allied fields. Other transducers measure absolute pressures, usually in the lower pressure ranges, and still others measure differential pressures with either high or low line pressures.

At a time when automation is often heard, the demand for pressure-sensing tranducers is indeed increasing and hence, to play their part, they should be of low cost and be of reasonable accuracy—say 1% where a closed-loop system would not be called for. To make this feasible, the designer has his eye on the ease of manufacture with a view to mass producing the units with a minimum of rejects, and using readily available components produced nationally.

Design Parameters

With these basic requirements in mind, the design of a pressure transducer centres upon the transducing elements which, in this case are miniature semiconductor strain gauges and a pressure-sensing element which, again in this case, is a diaphragm machined from the solid, either in metal or alloy to suit the range or requirement. Attention is then paid to the physical dimensions of the whole for size and compactness.

Strain Gauges

To keep to the requirements of high output, semiconductor strain gauges are used instead of wire or foil gauges as they can have a sensitivity some 50 to 80 times greater. Semiconductor strain gauges are made of high-purity single-crystal germanium or silicon, though the latter is more common and is commercially available. Though silicon gauges are more expensive than wire or foil gauges, the advantages they offer often justify their higher cost.

Semiconductor strain gauges exhibit a piezo-resistive effect which is a change of resistivity with applied stress. A measure of the rate of this change can be effected by introducing the term 'gauge factor' G which can be defined as $\Delta R/R\epsilon$ where

ΔR = the incremental change in resistance due to a strain
R = initial unstrained resistance at temperature T; i.e., a different value of R for each T
ϵ = applied strain, conveniently measured in microstrain.

The gauge factor, and hence the output from the gauge, can be controlled by the addition of impurities; i.e., by doping the silicon crystal with either boron or phosphorus. The first imparts the p-characteristic which is a positive resistance-strain relationship whereas phosphorus doping imparts the n-characteristic, which is the negative resistance-strain relationship. The level of doping is paramount in setting the gauge factor and its temperature variation, as well as the resistivity and its temperature variation. These effects can be improved by increasing the doping but at some loss of gauge factor.

In practice, preference is shown towards the p-types rather than the n-types since the former gauges offer a higher resistance, a higher gauge factor and less temperature variation on gauge factor.

In virtually all cases of pressure transducers, the gauges are wired up as a Wheatstone bridge with four active arms, as shown in Fig. 2. Two arms are under compressive strain and the other two tensile strain and the result is cumulative for highest output. The gauges are also matched for their high gauge factor so as to produce a proportionally high output of millivolts per volt applied. High-resistance gauges are recommended where an overall high full-scale output voltage is required, since a greater voltage can be applied here.

Standard production miniature semiconductor strain gauges are of 120 ohms resistance but 200-ohm or 300-ohm types are also used in certain applications, whereas in the U.S.A. miniature 500-ohm gauges are known to be in use.

* Ether Langham Thompson Ltd.

The amount of power dissipation within the gauge sets the voltage to be applied. A current flow of 10 mA is recommended though 12·5 mA have been passed at 3 volts on a 120-ohm bridge with no harmful effects. But this largely depends on the material upon which the gauge is bonded and how well it acts as a heat sink. A warming-up time of a few minutes is allowed until stable conditions are reached.

Many manufacturers of semiconductor strain gauges state that their gauges can withstand a strain of 3,000 microstrain without damage. Although this is true, these gauges are less linear with regard to strain than wire or foil gauges, and when it comes to transducer design, linearity and repetitivity are of greater importance. Hence a strain of about 500 microstrain produces the satisfactory results required.

In the cases considered here where the gauges are bonded on to a circular diaphragm, it soon becomes obvious that there will be some definite pattern of gauges to produce more efficient outputs. Typical patterns are shown in Fig. 1. The strain along the diameter of a clamped diaphragm is not uniform and, therefore, due to the length of the gauges themselves and their positioning, one end of the gauge is strained more than the other, but an overall mean value may be obtained so that the mean strain of one pair of bridge arms matches that of the other pair.

A lot can be written about strain gauge adhesives but it may be assumed here that those who bond gauges would make the correct choice of an adhesive able to transmit the strain with minimum hysteresis over wide temperature ranges and periods of time. A small change of gauge resistance occurs after bonding but this is to be expected due to the shrinkage of the adhesive during its curing period. A recommended period of 12 hours should be allowed before checking the resistance of the mounted gauge to allow the resin to stabilize. Due to this change in the resistance, the gauge factor is also affected by a proportional amount.

Temperature Effects

Temperature has a marked effect on semiconductor strain gauges and the overall problem can be summarized as being due to:

(a) Differential thermal expansions of the gauges and the material on to which they are bonded.

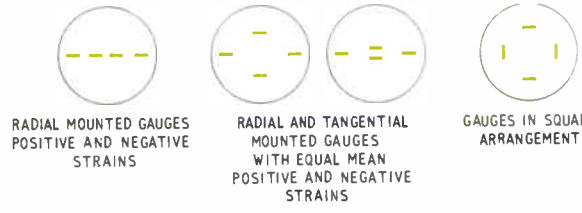
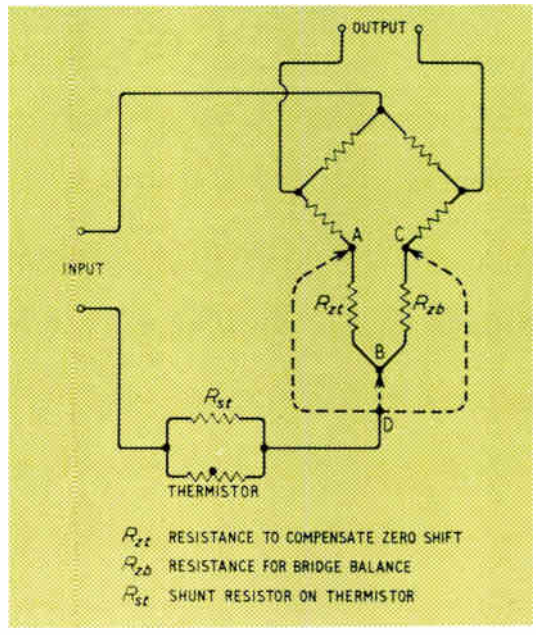
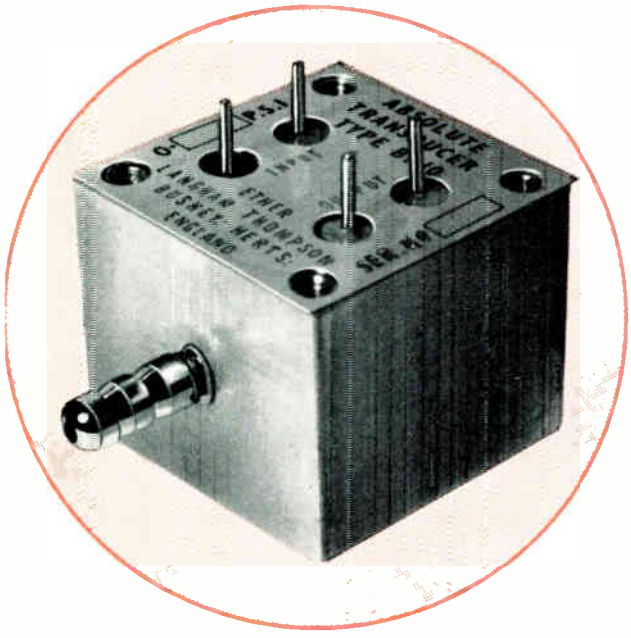


Fig. 1. Typical configurations of strain gauges mounted on diaphragms. The position of zero strain is at 0·574 radius

Fig. 2. Typical circuitry in pressure transducer. Point D can join bridge at A, B or C depending upon conditions





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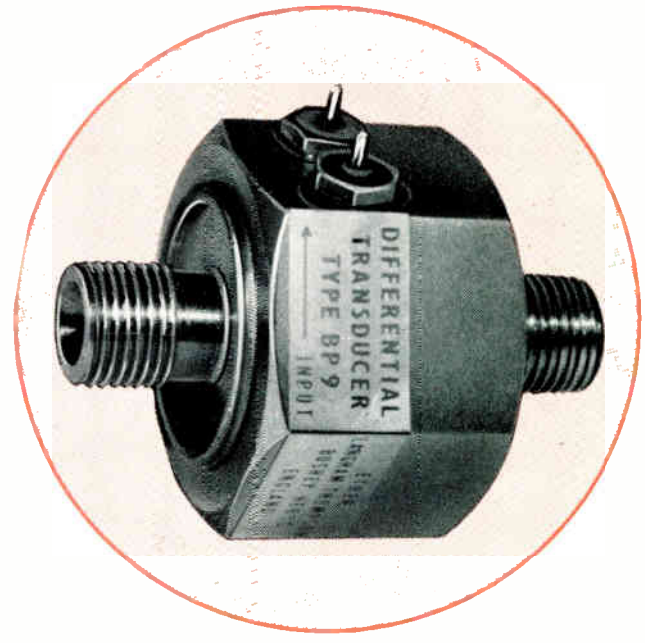
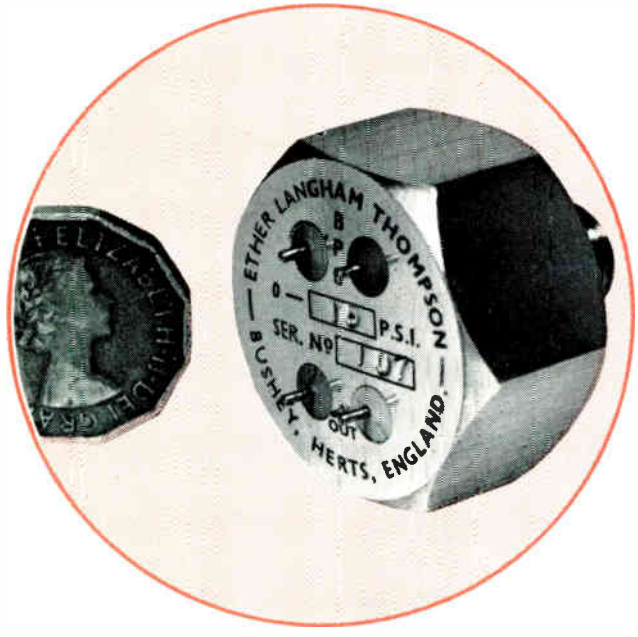


BP 9 differential pressure transducer



BP 8 pressure transducer for aerospace or industry combining lightweight and small size

(b) Resistivity changes of the gauges.
(c) Gauge factor changes with temperature.

These create a zero shift and a span shift, both of which must be compensated to maintain accuracy. To a lesser extent, the individual gauges may not be thoroughly matched after bonding and an initial zero unbalance is noticed in the bridge. This unbalance is easily remedied by the addition to the appropriate arm of the bridge of some extra resistance, until the bridge is balanced at room temperature. This may be a length of copper-nickel wire which has a very low thermal coefficient of resistance and which will not interfere with the compensation that is to follow. From then on, different temperatures show an output thus indicating an apparent strain.

Consider the gauge factor equation $G = \Delta R/R\epsilon$ where temperature effects vary $\Delta R/R$ by a factor m and G by n. Rewriting the equation now gives:

$$G(1 - n) = \frac{\Delta R}{R}(1 + m)\frac{1}{\epsilon}$$

i.e., strain $\epsilon = \dfrac{\Delta R\,(1 + m)}{RG\,(1 + n)}$

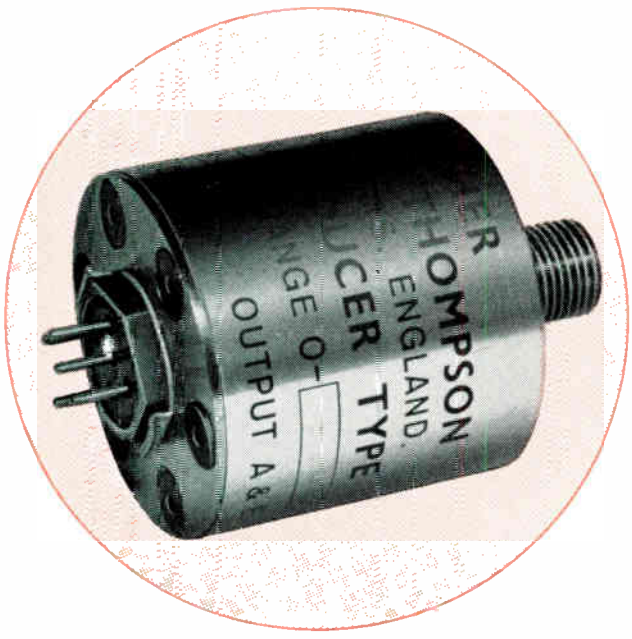
From available data taken over a 40 °C span $m = 6\%$ and $n = -10\%$; i.e., $m = 0{\cdot}0015$ per °C, $n = 0{\cdot}0025$ per °C. These figures include differential expansions of silicon gauges bonded on to steel. Therefore,

$$\epsilon = \frac{\Delta R}{RG} \cdot \frac{1{\cdot}0015}{0{\cdot}9975} = \frac{\Delta R}{RG}\,1{\cdot}00401$$

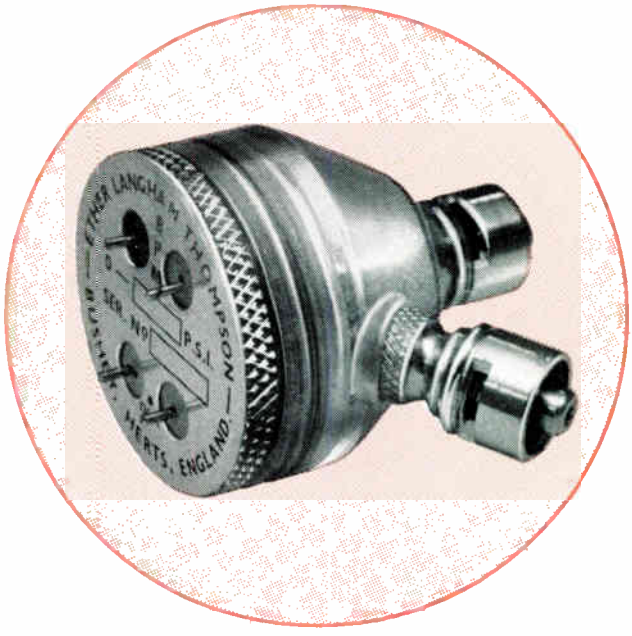
so that there is an apparent strain variation of about 0·4% per °C.

This calls for temperature compensation on any transducer using silicon gauges to maintain reasonable accuracy over a temperature range.

Temperature compensation methods are still largely empirical but the net result is effective. The balance point of the bridge network or zero, shifts with temperature changes. To compensate this effect, the transducer is cycled



BP 7 pressure transducer mainly for industrial use



Medical transducer for the measurement of blood pressure

between its upper and lower temperature limits and the amount of shift is noted by observing the change in output. A length of resistance wire whose temperature coefficient is high, 0·0045 ohm per °C, is added to one arm of the bridge. The amount of wire resistance required is proportional to the nominal bridge resistance, the observed zero shift in mV/V, and temperature coefficient of the wire used and the temperature span. The bridge is then rebalanced with copper-nickel wire.

Compensation of sensitivity variation, or span shift in pressure transducers is usually carried out at the same time as zero shift compensation when a pressure stimulus of say 25–50% of maximum rated pressure is applied. Here, again, the output and its variation with the temperature span is noted. A thermistor with a negative temperature coefficient is used and is shunted with fixed resistance. The value of the shunt is empirical and acts as an adjustment to the slope of the thermistor temperature–resistance characteristic. These shunts can have values between 25–60 ohms depending on the temperature span, bridge resistance and type of thermistor used.

Diaphragms

For diaphragms turned from the solid whose periphery is considered clamped, the equation relating pressure, diameter, strain and thickness is given by:

$$\left(\frac{R}{t}\right)^2 = \frac{8}{3} \cdot \frac{\epsilon E}{1-\sigma^2} \cdot \frac{1}{P} \qquad \ldots (1)$$

where R = diaphragm radius, t = diaphragm thickness, ϵ = strain, E = modulus of elasticity, σ = Poisson's ratio and P = applied pressure.

This equation is multiplied by a factor which varies between 0·7 and 0·96 depending upon the configuration of the gauges bonded on to the diaphragm because their length is spread over the radius. It can be seen that for a fixed radius and thickness, a pressure P should produce a definite strain. But it is observed that for the lower ranges where a thinner diaphragm is called for, a smaller pressure (than theoretically called for) produces the full strain. The explanation is that equation (1) is derived from the linear theory which assumes that the neutral axis within the diaphragm is unstrained and that the deflections are small compared with diaphragm thickness. When thin diaphragms are called for the deflections are larger, in comparison to the thickness, yet still small when compared to the other dimensions and hence the above equation is no longer accurate. The neutral axis is now strained and there is a slight membraning effect. The phenomenon is known as ballooning.[1]

Timoshenko[2] deals with large deflections of diaphragms where the flexural rigidity is assumed zero, i.e., the diaphragm is considered as a flexible membrane. However, those equations do not hold as they call for much thinner diaphragms, about $\frac{1}{3}$ of the required thickness, which makes them virtually impossible to machine. It appears then that for low-pressure transducers, the diaphragms are only slightly within the ballooning fringe. But this could be an advantage in the manufacture of transducer diaphragms as linear outputs from strain gauges can still be maintained provided that a certain radius/thickness ratio is not exceeded. Hence a smaller pressure than the theoretical now actually produces the same strain or, in practice, a lower range is attained for a theoretically thicker diaphragm.

Due to ballooning, the deflection of the diaphragm is reduced for a given strain requirement. The deflection at the centre W_0 is now given by:

$$W_0 = \frac{PR^4}{64D} \cdot \frac{1}{1 + 0{\cdot}488(W_0/t)^2} \qquad \ldots (2)$$

which assumes that there is no displacement at the periphery. The first part of the equation gives the deflection as calculated from the linear theory and the second part gives the percentage reduction of deflection due to ballooning or stretching which, for a chosen radius/thickness ratio, can be taken as a measure of ballooning.

It is natural that the semiconductor strain gauges, being as sensitive as they are to strain, very quickly respond to

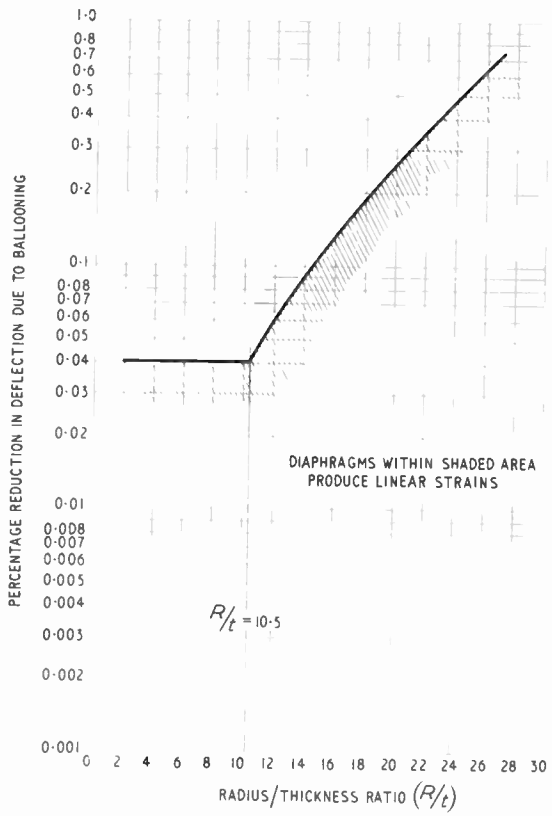


Fig. 3. Region where linear strains are obtainable in steel diaphragms

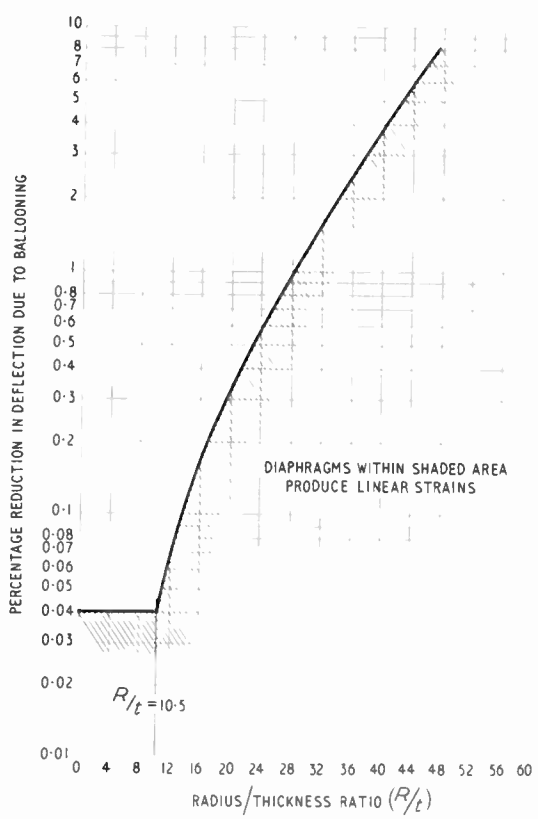


Fig. 4. Region where linear strains are obtainable in aluminium diaphragms

ballooning even if the deflection is reduced by a very minute percentage. Thus the pressure-thickness relationship derived from the linear theory no longer holds. The maximum figure of reduction in deflection that can be tolerated for theoretical relationships to hold is in the region of 0·04% which indicates an R/t ratio of 10·5. However, in practice, linear strains can still be obtained even though the diaphragm is well within the ballooning phenomenon. The curves in Figs. 3 and 4 are arrived at from practical and theoretical considerations and show that if a diaphragm is designed whose radius/thickness ratio is such that it lies within the shaded area, then linear results can be expected. The limiting factor now becomes the machining of the diaphragm to the required thinness without it 'oil canning' or developing a snap action.

Figs. 3 and 4 are dependent upon the stress level maintained in the diaphragm. At the centre the stress, from the linear theory, is given by:

$$f = \frac{3}{8}(1+\sigma)\frac{PR^2}{t^2} \qquad \ldots (3)$$

The stress at the periphery of a clamped diaphragm exceeds that at the centre by a factor of $2/(1+\sigma)$ and care should be taken in the design that the boundary stress does not reach the yield value or the 0·1% proof stress, depending upon whether steel or aluminium alloy is used.

In the majority of transducers stainless steel is used, preferably austenitic and titanium stabilized, e.g., EN 58 B. It should have good welding properties, if needed, and good machinability, but for low-pressure transducers an aluminium alloy is used. Aluminium is somewhat tricky to use as it suffers from undesirable characteristics, viz., hysteresis, creep, fatigue and damping capacity.

A study of hysteresis[3] shows that it can be considerably reduced, if not eliminated, by cycling the diaphragm from a positive stress to an equal negative stress. The width of the hysteresis loop narrows as shown in Fig. 5.

Creep is observed when the stressing is stopped while the strain continues to drift with time. The rate of creep is proportional to loop width, which can be reduced with continued cycling. This procedure tends to work harden the diaphragm, which then shows a well-marked transition from elastic to plastic behaviour[5] should the stresses be exceeded.

Indiscriminate cycling is to be avoided as this affects the damping capacity of the alloy. The damping capacity is defined as the ability of the metal to dissipate internally mechanical strain energy[6] which is the area of the hysteresis loop. This property of the alloy is usually dependent upon the strain values, if they are $< 10^{-4}$, which covers the majority of engineering designs, but very much independent of frequency. This, therefore, suggests that transducer materials should be chosen with lowest damping capacity properties.

Transducer Design

Having established the main parameters of a transducer, viz., the strain gauges, their bonding pattern and the diaphragm, the size of a transducer just follows on, depending upon ease of manufacture and application. The components making up the body, such as the end cap and terminal cap, could be either bolted, or preferably welded to make the unit smaller and more compact. Electron-beam welding may be utilized but the much cheaper method of argon arc welding is quite adequate.

Aluminium welding usually requires higher electrode current than in equivalent steel welding and the excessive heat generated, coupled with the good conductive properties of the alloy, tend to damage the properties of the diaphragm.

During its operation, the transducer may be subjected to pulsating pressures and hence the resonance frequency of the air column in the inlet cavity needs to be known. Typical values of the series tested varied from 800 c/s to several kc/s depending upon the shape and size of the cavity and its inlet.

Static acceleration produces negligible errors on diaphragm-type transducers because of the high stiffness and low mass of the diaphragms. Actual values depend upon diaphragm thickness and these can vary from $50g$ to $400g$ to produce 1% error in output for a low-pressure to high-pressure transducer.

For the same reason of high stiffness/mass ratio the natural frequency is very high. Some transducers, usually the low-range types, may vibrate at their natural frequency and the vibrational errors thus produced have proved to be insignificant. A typical value of error obtained from a lowest range BP8, and hence the weakest in the series, was 0·125% at resonance! The other transducers in the series had such high natural frequencies that it was extremely difficult to find suitable equipment to test them. However, a theoretical analysis can be made. The natural frequency is given by:

$$f_n = \frac{1}{2\pi}\sqrt{\frac{kg}{w}} \qquad \ldots (4)$$

where k = diaphragm stiffness, g = acceleration due to gravity, w = diaphragm weight.

The weight is obtained by considering the diaphragm as a disc and then calculating its weight for whatever density material is used. The weight of the gauges is ignored because of the relative extreme lightness. Hence:

$$w = \rho A t \qquad \ldots (5)$$

where ρ = density of the metal or alloy, and A = diaphragm area.

The stiffness is considered from the deflection equation:

$$\frac{P}{W_0} = \frac{64D}{R} \qquad \ldots (6)$$

under uniformly distributed loading—and P in this case is the distributed load due to its own weight, i.e., $w = pA$. Multiply both sides of equation (6) by area A and substitute for $p = w/\pi R^2$ to give:

$$\frac{w}{W_0} = \frac{64\pi R^2 D}{R^4}$$ which is the stiffness.

Therefore

$$K = \frac{16\pi Et^3}{3R^2(1-\sigma^2)} \qquad \ldots (7)$$

and the flexural rigidity is:

$$D = \frac{Et^3}{12(1-\sigma^2)}$$

Typical values of natural frequencies are plotted in Fig. 6.

Applications

The field where pressure transducers are applied is very wide indeed. In fact they are used anywhere where pressure sensing is required with an electrical output or a remote output. Semiconductor pressure transducers, with their high outputs, can easily be used to monitor pressures in pipelines in the petrochemical industry, or monitor oil pressure in test-bed rigs. They can measure steady or fluctuating fluid pressure. Other applications are the measurement of pressure in hydraulic jacks in the mining industry or to indicate unevenness of pressure of rollers in the printing industry.

Pressure transducers can form the vital sensing part of a closed-loop system either as pressure sensors or to trigger off some pressure alarm system.

Besides the above, units such as the BP 7 and 8 may be used or adapted for use in tanning factories, in foundries and

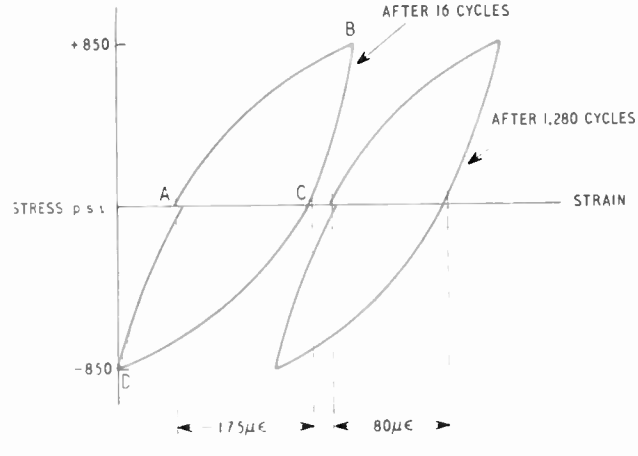


Fig. 5. (Above) Cycling effects on hysteresis loops

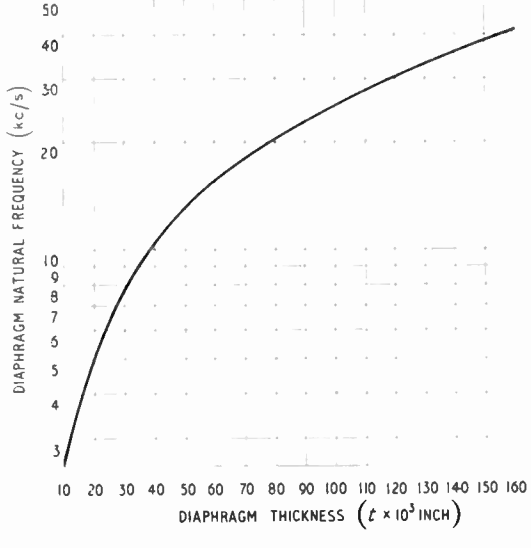


Fig. 6. Natural frequencies of steel or aluminium diaphragms

to further automate the motor car industry by giving a clearer indication of the air-pressure distribution in pipelines which are used to operate various tools, and paint sprayers. Other applications are in registering extrusion and cold-rolling pressure either in industry or the toy-making factories.

Differential pressures are compared by using differential transducers such as the BP 9.

Vacuum pressures need to be accurately monitored and the BP 10 type may find uses in food canning and sealing pots.

The aerospace industry has many uses for pressure transducers to measure pressures in fuel lines, etc., where the temperatures are not likely to be excessive, say above 80 °C.

However, pressure transducers are breaking into the medical field where advantage is taken of the high sensitivity of semiconductor gauges, with the introduction of a transducer capable of measuring the blood pressure in the vicinity of the heart. A catheter is introduced into the arteries and positioned accordingly and feeds into the transducer. However, a small sacrifice is made in the output; the strain is reduced so that diaphragm displacement is minimized, hence cavity volume changes are a required minimum.

Acknowledgment

The author is indebted to the management of Ether Langham Thompson Ltd. for permission to publish this article and to his colleagues for their cheerful co-operation.

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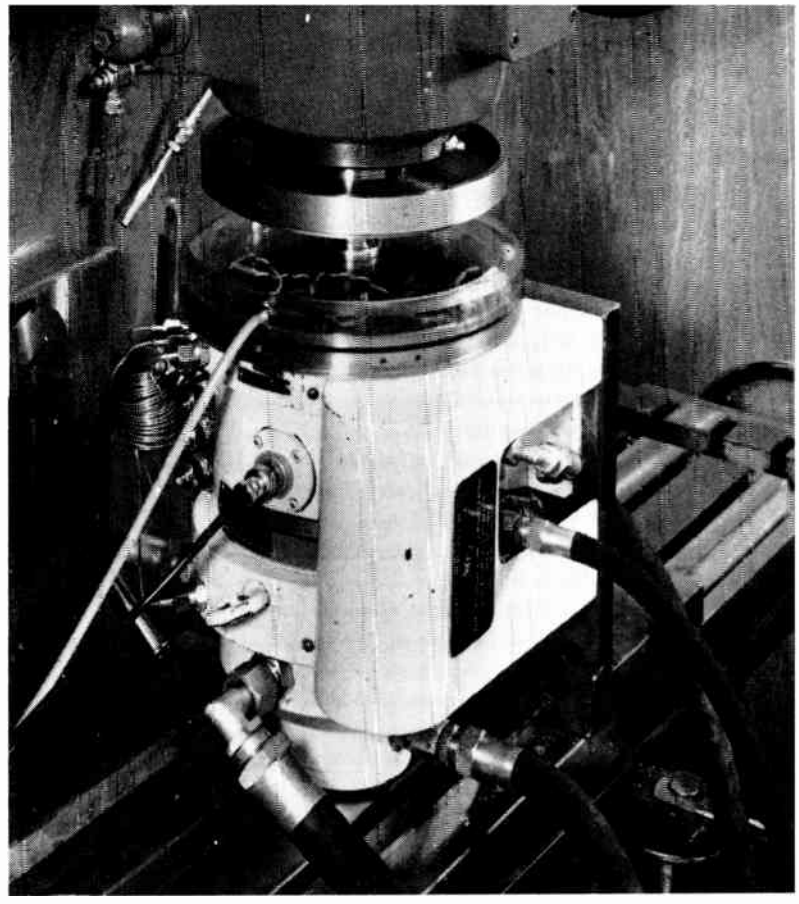
U.K. Civil Airways Radar System Nears Completion

The Marconi Co. Ltd. is providing the Ministry of Aviation with the final link in a chain of microwave paths that will connect all the present Ministry radar sites in the country's civil airways system to the two main air traffic control centres in the U.K. When completed, the system of links will allow air traffic controllers in the Southern and Northern regions to see radar pictures of the air traffic situation in parts of the country which are out of their direct radar range.

The latest link, between Clee Hill and Manchester, will increase to 384 miles the total length of the chain, which comprises ten terminal stations and ten unattended repeater stations. It employs Marconi SX102 broadband radar links operating in the 7,000-Mc/s band, the aerials being 10-ft diameter aluminium dishes mounted on towers. The electronic equipment will be duplicated at every terminal and repeater station, to ensure maximum reliability, and the changeover from main to standby is made automatically upon failure; station performance is continuously monitored and fault indications are sent automatically to the receiving terminal.

This shows the Marconi microwave aerials at the Southern Air Traffic Control Centre (SATCC) near London (Heathrow) Airport. The three dishes on the tower receive radar information signals from the radar sites at Ash, Ventnor and Clee Hill



This shows the PERA hydraulic dynamometer fitted to a vertical milling machine

COMPACT HYDRAULIC DYNAMOMETER

A novel hydraulic dynamometer, suitable for a wide range of power absorption and motoring applications in many industries, has been designed and developed by PERA. Its special features include high torque-measuring capacity in relation to its size, versatility, and consistent accuracy over a wide speed range.

The dynamometer is built around a high-pressure positive-displacement hydraulic pump, delivering against a variable head, which is carried on hydrostatic bearings within an outer case. Oil is transferred between the pump and an external hydraulic circuit through a frictionless oil-transfer section. The consequent absence of any rotational constraint, apart from the torque-measuring device, gives the dynamometer high and consistent accuracy. Friction losses in the pump and leakage have no effect on the accuracy of the complete dynamometer unit. The hydraulic pump incorporated in the dynamometer may be used equally well as a motor to monitor the driving load.

The torque-measuring capacity of the PERA dynamometer over a wide speed range gives it numerous potential applications in the prototype and production testing of prime movers and transmissions such as internal-combustion engine, electrical and hydraulic machinery, and variable-speed drives, and for driving rolling mills, mixers and other process equipment in the steel, chemical, food, plastics, textile and other industries where torque or power input has to be monitored. There is no fundamental limitation on the size of PERA-type dynamometers and production units could be built with torque ratings from a few pounds feet to several thousand pounds feet.

The prototype unit has a maximum torque capacity of 130 lbf/ft from 250 to 3,000 rev/min, working at pressures up to 4,000 lbf/in^2; this corresponds to a power capacity of 25 hp/1,000 rev/min. The unit is 16-in. long and weighs 158 lb. A magnetic pick-up measures speed and a strain-gauge linkage measures torque. Auxiliary equipment consists of a load control valve, power pack and, for prolonged running at high powers, a heat exchanger. When used as a motor, the dynamometer is supplied with oil by a variable-displacement pump. The dynamometer's horsepower and torque ratings are then slightly reduced, but there is no lower speed limitation on output torque.

The addition of a small, external high-pressure boost pump, enables the dynamometer to measure torque over its full rated capacity, down to zero speed (for example, under stalling conditions, or when stopping and starting).

Licences to manufacture and market the PERA dynamometer, which is the subject of British and foreign patent applications, have been issued to the following four firms: Andrew Fraser (Ealing) Ltd., 64/65 Vincent Square, Westminster, London, S.W.1, K and L Precision Engineering Ltd., Back Heaton Park Road, Newcastle-upon-Tyne 6, The Marconi Company Limited, Mechanical Products Division, Felling Works, Bill Quay, Gateshead 10, Pratt Precision Hydraulics Ltd., Bankfield Works, Haley Hill, Halifax.

BIMCAM Association Elections

At the annual general meeting of the British Industrial Measuring and Control Apparatus Manufacturers' Association, Eric W. Wilson (The Leeds Meter Co.) was elected president of the Association for 1965–67.

W. J. A. Copeland (Ether Ltd.) took over as chairman of council for 1965–66 and J. Tham (George Kent Ltd.) was elected deputy chairman.

The members of council for 1965–66 are: K. West (Crosby Valve & Engineering), H. G. Oughton (Foster Instrument), J. C. Page (Teddington Autocontrols), W. T. Flower (Bailey Meters & Controls), B. H. C. Budenberg (Budenberg Gauge), G. A. G. Ive (Radiovisor Parent) and R. Postle (Honeywell Controls).

It was also announced that the BIMCAM offices are now at 23–24 Margaret Street, London, W.1 (Telephone: Langham 9336).

Electrowriter

BUSINESS COMMUNICATIONS SYSTEM

By BRYAN HARTLEY*

For modern business communications it is often desirable to transmit hand-written messages and sketches directly between two or more locations. The Electrowriter, described in this article, has been designed for this purpose. It uses standard telephone lines to interconnect locations which are remote from each other.

THE Electrowriter instrument is an analogue device capable of direct transmission of handwriting, sketches or any other form of graphic data involving two co-ordinate positioning. Reproduction is by means of moving pens and is instantaneous and faithful from one instrument to another, or among several interconnected into a system. Information can be transmitted over any standard telephone circuit of reasonable quality by means of a frequency shift of audio tones. Transmission will pass through telephone systems and radio circuits.

Messages are written on paper with a ball-point pen which is permanently attached to transmitters and transceivers. Transceivers and receivers use a capillary-type pen to record data. The transmitter's transmit-standby switch can be automatically controlled by an optional mercury switch in the pen itself. When the operator raises the pen from its rest or horizontal position the unit is immediately switched from standby to transmit.

Handwriting movements are at frequencies from zero to about 12 c/s. The system has the necessary static and dynamic response to reproduce faithfully all forms of manually-executed graphic intelligence.

Method of Operation

The movements of the pen of the transmitting station are first resolved by means of a pantograph linkage into two curvilinear co-ordinates, one representing the vertical (Y) movement of the pen and the other the horizontal (X) movement of the pen. The X and Y signals are derived from position transducers connected to the pen pantograph. Each co-ordinate is transmitted by varying the frequency of a co-ordinate oscillator (Fig. 1). Two bands are set aside, one from 2,060 to 2,340 c/s for the horizontal co-ordinate, and the other from 1,310 to 1,490 c/s for the vertical co-ordinate. A frequency change from the beginning to the end of one band corresponds to the full range of horizontal or vertical pen travel along a co-ordinate fixed by the frequency which is not being varied. Each point on the writing surface is thus specified by the frequencies of two audio-frequency carriers. The relation between position and frequency is linear for each co-ordinate.

The motion of the pen down on to, or away from, the writing surface is controlled by frequency modulating the horizontal co-ordinate frequency with 120 c/s.

Receiver Operation

In the receiver (Fig. 2) each co-ordinate signal is used in a local servo loop to control the motion of the receiving pen. The co-ordinate motions of the pen are actuated by the rotation of two shafts. Each of these shafts carries a motor rotor and a position transducer. The motors are especially designed D'Arsonval movements producing high torque. They are held to small physical size through the use of a high-permeability rotating core. Balance servo amplifiers energize the servo motors.

The position transducers are variable inductors (rotary transformers are used) the inductance of which is controlled by the rotation of the shafts. These inductors are part of the tuned audio-frequency circuits which are used as the frequency-determining portion of discriminators into which the incoming signals are fed. The discriminator d.c. output is zero only when the position of the shaft corresponds accurately to that called for by the incoming signal; otherwise, a d.c. error voltage is generated which is used to drive the pen motor to correct the error. Limiters are employed in the receiving circuits to render these circuits insensitive to wide variations of the received signal. The normal power output from the transmitter is about −4·7 dBm. The recommended receiver operating range is +10 dBm to −38 dBm of signal.

* Shipton Automation (Sales) Ltd.

ELECTRONICS
COMMUNICATIONS
INSTRUMENTATION
CONTROL

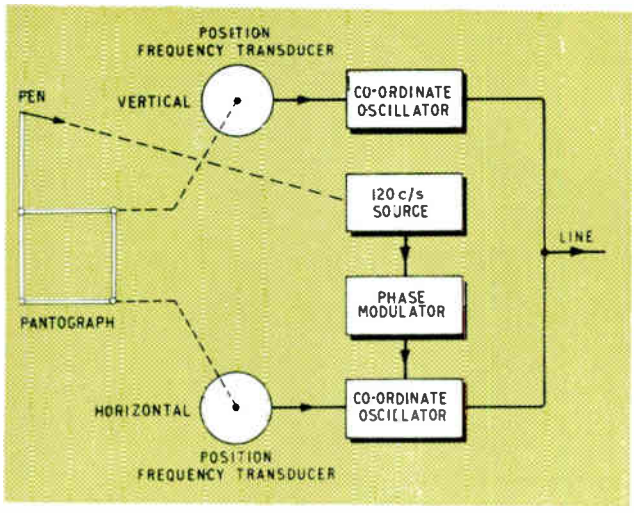


Fig. 1. Block schematic diagram of Electrowriter transmitter

The Electrowriter receiver

The pen motion on to or off the writing surface is obtained from the 120-c/s signal recovered from the horizontal discriminator. This signal component and the low-frequency horizontal servo signal are both provided by one discriminator.

Components

The position transducer is not a conventional variable inductor or capacitor. It is impracticable to achieve stability with such tuning elements at these frequencies. Instead, this instrument uses a rotary transformer, consisting of a stator and a rotary pickup coil. The ratio between pickup coil voltage and stator voltage is a function of angular position.

Each co-ordinate employs a tuned circuit, consisting of very stable components, and tuned to the centre frequency of its respective range. The rotary transformer, in conjunction with a highly-stable amplifier, is used to adjust the frequency above or below the centre value. This arrangement not only provides good stability, but also

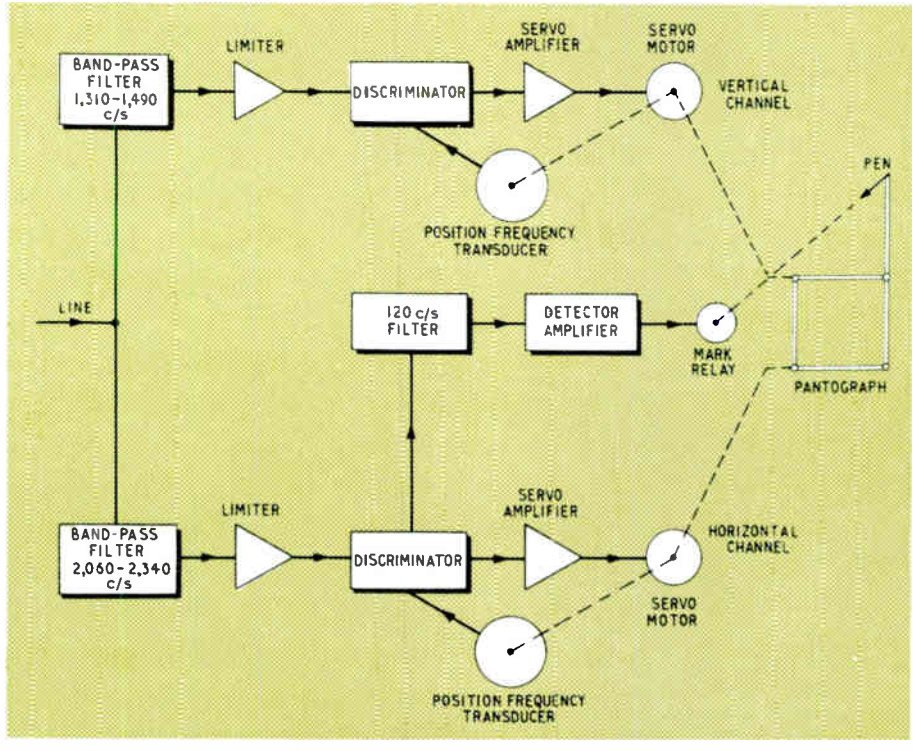
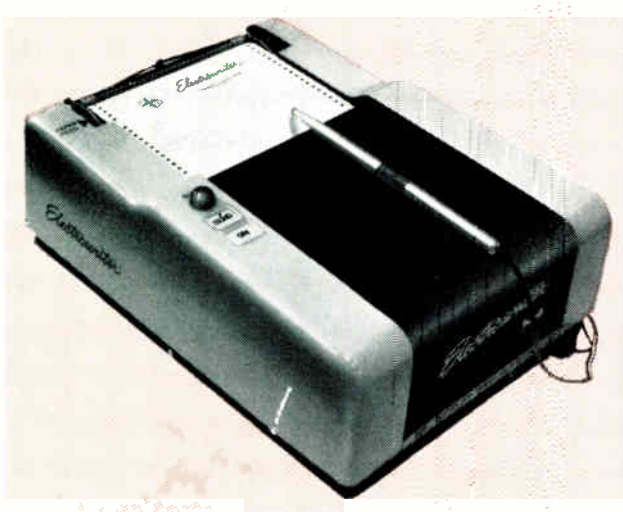
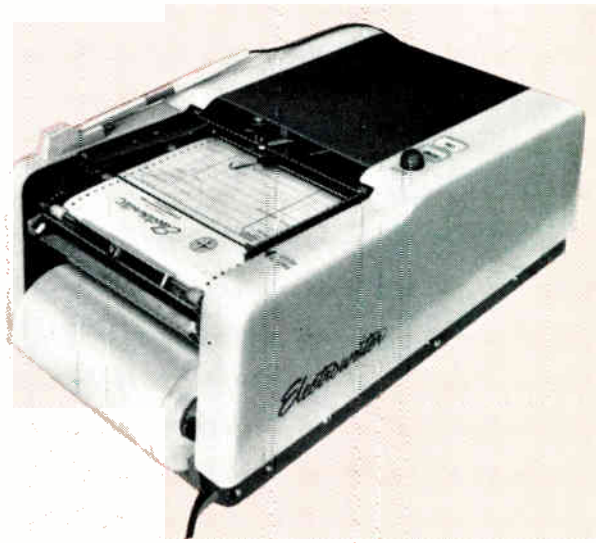


Fig. 2. Block schematic diagram of Electrowriter receiver



The Electrowriter transmitter



The Electrowriter transceiver

makes it possible to adjust the centre frequency and range independently.

Whenever two separate positioning systems are linked together to obtain motion along two co-ordinates, one may expect to find that the separate moments of inertia of the two systems become partly intercoupled. This effect closely resembles electrical crosstalk between the two co-ordinate channels and its presence results in inferior transient response, particularly at high writing speeds. In the Electrowriter instrument this source of trouble is avoided by the use of a mechanical linkage which keeps mutual inertia at zero, regardless of position.

Mechanical Design

Since accurate alignment and long-term stability of the pen-pantograph structure is a prerequisite for satisfactory service, a basically rigid mechanical relationship has been achieved between the very precisely mounted motor shaft (acting as pantograph king pin) and all other functionally-related mechanical elements. A rigid main frame structure serves as a general reference surface.

The pen motors have a maximum deflection of $\pm 30°$. To minimize friction precision ball bearings are utilized. The motors are entirely enclosed. The main arm is of stainless steel tubing for maximum rigidity consistent with the required low moment of inertia. Smaller stainless steel tubing is used for the pen arm. Spring-loaded pivots and pivot bearings are used on the bell cranks to eliminate play.

The paper supply roll is located at the rear of the machine. The paper compartment is accessible through the rear opening of the cover and permits a simple and direct paper path to the writing surface. The paper feed is initiated by moving the transmitting stylus to a marked position at the upper left-hand edge of the page. Under this condition, the pen linkages in all connected receivers are moved to an extreme upper left position where they operate a switch to initiate paper feed. The amount of paper fed out is controlled by a local mechanism. To assure reliable feeding, an 'over-driving' circuit is utilized as follows: when the transmitting stylus is moved into the indicated paper-feeding position, a pair of switch contacts is closed which (1) activates the transmitter paper feed motor cycle, and (2) detunes the horizontal and vertical transmitter oscillators, thus firmly 'over-driving' the receiving pen or pens into the corresponding paper feed position.

Conclusion

The Electrowriter is fast and quiet. It is a relatively new device but already there are a number of large commercial installations in the U.K. and among these is a 24-instrument network for Pan American World Airways at London Airport linking the flight operations office with Airport services and the company's London offices.

The installation is used for fast and accurate transmission of hand-written flight information. Flight plan data including estimated times of arrival and departure received by the flight operations office from the aircraft or from air traffic control are available at speed to receiving points which include the main traffic office, the import and export cargo sections, passenger and baggage coach control sections and ticket desks.

Altogether there are two transceivers, one transmitter and 21 receivers in the Airport Electrowriter system.

Sima Textile Instruments Group

One of the functions of the Textile Instruments Group of the Scientific Instrument Manufacturers' Association is to establish channels of communication between SIMA, the textile and allied industries.

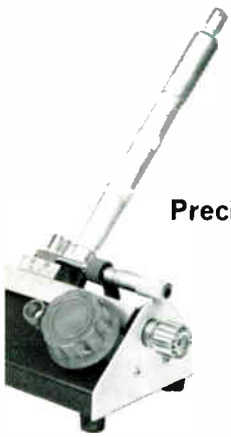
In doing this it has been found that many organizations are interested to know the names of the members of this group and their fields of interest.

Accordingly a list has been compiled and it is available from The Director, SIMA, Sima House, 20 Peel Street, London, W.8.

Six

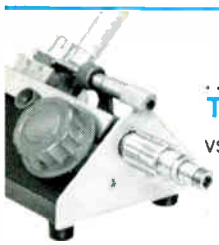
LABORATORY SLOTTED LINES

in One!

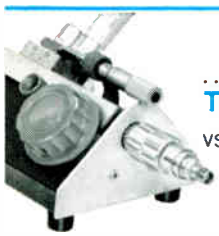


Type 900-LB
Precision Slotted Line

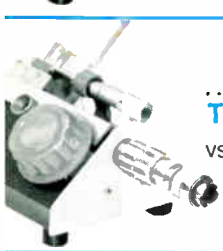
. . . with a
Type GR900 connector
VSWR < 1.002 at 1 Gc/s;
< 1.010 at 9 Gc/s



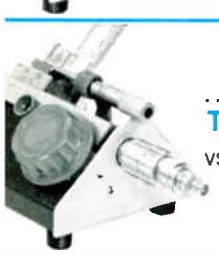
. . . with a
Type N plug or jack
VSWR < 1.010 at 1 Gc/s;
< 1.050 at 9 Gc/s



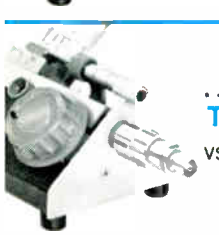
. . . with a
Type TNC plug or jack
VSWR < 1.022 at 1 Gc/s;
< 1.070 at 9 Gc/s



. . . with a
Type GR874 connector
VSWR < 1.017 at 1 Gc/s;
< 1.065 at 9 Gc/s



. . . with a
Type BNC plug or jack
VSWR < 1.022 at 1 Gc/s;
< 1.070 at 9 Gc/s

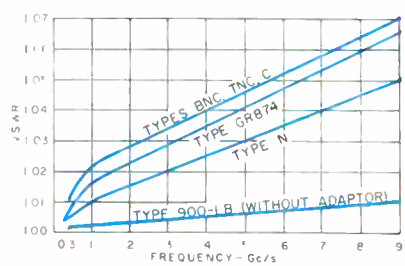


. . . with a
Type C plug or jack
VSWR < 1.022 at 1 Gc/s;
< 1.070 at 9 Gc/s

The availability of several new adaptors greatly increases the usefulness of the Type 900-LB Precision Slotted Line. By simply adding one of nine adaptors (for five different coaxial systems) to the load end of the line, you convert the Type 900-LB to a slotted line for use with Type N, TNC, GR874, BNC, or C systems. What's even more important, the converted line outperforms any of the presently available lines designed specifically to operate in one system only.

When you convert a Type 900-LB Precision Slotted Line for use with another system, you can select the appropriate GR900 adaptor with either a plug or jack connector for mating to the other system. This feature eliminates the need for male-to-male or female-to-female adaptors, which are noted for their inherently high VSWR. Furthermore, a GR900-to-Type N adaptor (male or female), as a typical example, has lower VSWR than a standard Type N connector alone.

There are many other features of this slotted line that make it an exceptionally versatile and accurate instrument for general-purpose laboratory measurements such as VSWR, reflection coefficient, and coaxial impedance. It can be calibrated to a high degree of accuracy with a Type 900-LZ Reference Air Line, for example, or by terminations calibrated by NBS or other standards labs. The GR900 connector used on the line meets or exceeds all specifications of the new IEEE Standard for precision coaxial connectors.

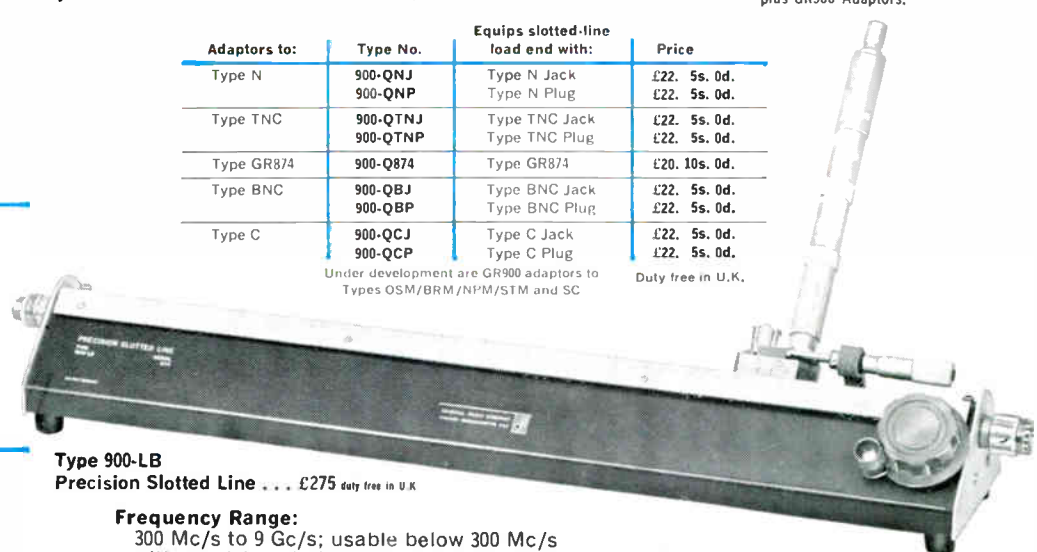


VSWR Specifications for Type 900-LB Slotted Line plus GR900 Adaptors.

Adaptors to:	Type No.	Equips slotted-line load end with:	Price
Type N	900-QNJ 900-QNP	Type N Jack Type N Plug	£22. 5s. 0d. £22. 5s. 0d.
Type TNC	900-QTNJ 900-QTNP	Type TNC Jack Type TNC Plug	£22. 5s. 0d. £22. 5s. 0d.
Type GR874	900-Q874	Type GR874	£20. 10s. 0d.
Type BNC	900-QBJ 900-QBP	Type BNC Jack Type BNC Plug	£22. 5s. 0d. £22. 5s. 0d.
Type C	900-QCJ 900-QCP	Type C Jack Type C Plug	£22. 5s. 0d. £22. 5s. 0d.

Under development are GR900 adaptors to Types OSM/BRM/NPM/STM and SC

Duty free in U.K.



Type 900-LB
Precision Slotted Line . . . £275 duty free in U.K.

Frequency Range:
300 Mc/s to 9 Gc/s; usable below 300 Mc/s with precision air line added.

Residual VSWR: less than $1.001 + 0.001 f_{Gc}$ (e.g., 1.004 at 3 Gc/s)

Constancy of Probe Pickup: ±0.5%

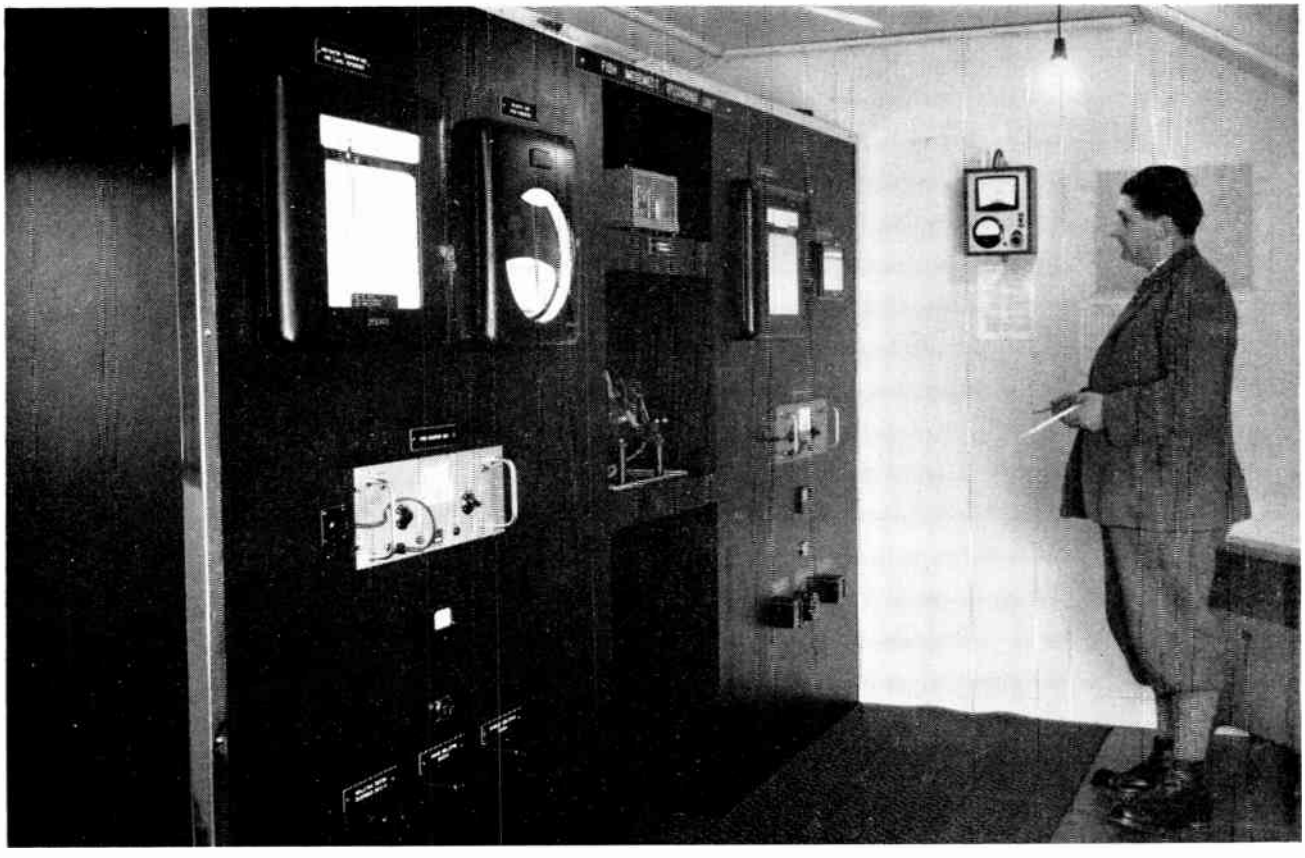
Characteristic Impedance: 50.0Ω ±0.1%

Probe tuner and several other items included in the price.

GENERAL RADIO COMPANY (U.K.) Limited

Bourne End, Buckinghamshire, England

Telephone: Bourne End 2567



Illustrated here is the fish-movement recording equipment

Electronics Aid Water Authority

EXTENSIVE experiments to determine the extent to which the water requirements of industry and water undertakings and other public demands can be satisfied, while still maintaining the natural condition of the river and fish life it supports, are being undertaken by the Lancashire River Authority.

In these experiments not only are the fish counted going up or down river, but a number of other variables are checked, among them time of fish movement, water temperature, air temperature, humidity, water level, turbidity of the water, water head and velocity, dissolved-oxygen content of the water and barometric pressure of the surrounding air.

Fish-Counting Equipment

Submerged approximately 3 ft below the surface of the river is a glass-fibre tube, 4-ft long and 18-in. diameter. This is fitted with three stainless-steel band-electrodes. All fish, whether going upstream or down-stream, must pass through this tube. Each time a fish goes through, resistance to the electric current flowing between the electrodes is increased and the signal output is picked up by two electronic digital counters situated in a cabin on the river bank. The first counter shows the total number of fish, irrespective of size. The second counter shows only those fish over 4 lb in weight. It can be safely assumed that all fish over this weight are salmon and all those under 4 lb are sea-trout; thus separate totals for the two species are easily obtained.

Another instrument, the fish-length recorder, which is an electronic strip-chart recorder, receives these signals from the tube. The amplitude of the signal is directly proportional to the size of the fish being detected, hence the sweep of the pen arm and its trace indicate the length of the fish.

Water and Air Temperature, and Water Level Recorder

Two thermocouples are used for water and air temperature, one placed in the river adjacent to the tube, the other at the rear of the cabin. The temperatures determined by these are fed into a Kent Mark 3 strip-chart recorder and separately recorded on the same chart by different coloured traces. Also recorded on this chart is the water level, determined by a float-operated transmitter.

Turbidity Recorder

Water from the river is pumped through a set of photo-electric cells, and the result, in the form of an electrical impulse, is recorded on another Mark 3.

Both these Mark 3 instruments are fitted with operation pens and these make a mark on the side of the chart every time a fish is detected. Thus the water temperature, air temperature, water level and turbidity can be directly related to every fish movement and the weight and length of each fish is known.

Three other variables are also indicated or recorded; these are water head and velocity, measured by means of an orifice plate and a Kent Commander pressure-difference indicator; dissolved-oxygen content of the water: and barometric pressure of the surrounding air.

In last month's issue the author briefly discussed the need for process-control systems in industry, outlined some of the disadvantages of conventional systems and described a new solid-state controller. Here the author gives details of some practical applications of some variants of the basic controller.

SOLID-STATE INDUSTRIAL CONTROL INSTRUMENTATION

(Concluded from p. 372, August issue)

By JAMES J. PINTO, M.Sc., A.M.I.E.R.E.*

* Kent Precision Electronics Ltd.

INDUSTRIAL process control covers a wide field of applications and the control technique adopted will depend on many factors. All applications and techniques are too numerous to list, but these few given here will indicate to engineers that electronic controllers have great potential in industry.

Motor-Speed Control

The instrument shown in Fig. 6 was used to control the speed of a 10 h.p. commutator motor, within a 100 : 1 range, to an accuracy of 0·5% for full-load variation within the maximum capabilities of the motor. The motor speed was sensed by a photoelectric pick-up which produced pulses corresponding to black and white stripes on a disc mounted on the shaft. These pulses were fed, after amplification and squaring, to a frequency-to-d.c. converter, which produced a d.c. voltage proportional to motor speed over a 100:1 range and linear to within 1%. This was fed to the solid-state calibrated control instrument with a proportional 10-kW thyristor control circuit, and the speed then corresponded to the command signal as set on the scale.

When the solid-state calibrated control instrument is used with large motors, the time taken to overcome armature inertia may be of the order of 10 to 20 sec and hence, since the power is switched fully on, large current overloads will ensue until the speed builds up, causing either damage to the thyristor output circuit or fuse blow-out. In the system under consideration this difficulty has been overcome in two ways: first, the reference voltage which generates the command setting has a large capacitive time constant, or is 'slugged', so that after switch-on the speed builds up slowly ; second, a current overload input is injected into the error amplifier in order to over-ride the error signal when the current is greater than a set maximum. Thus, when the maximum current is reached, the firing angle is retarded and the power is limited to the maximum value. The motor speed then builds up to the required magnitude and when the current decreases below the overload setting normal operation is resumed ; when the speed setting is suddenly changed, the current is again limited to the maximum value. With these two additions to the circuit, the system functions satisfactorily for start-up and control, at any speed setting within the range.

With a 1% proportional band, the motor speed normally hunts about the set value, especially at low speeds. To overcome this defect, functional feedback, comprising the appropriate RC networks, has been added to the operational error amplifier, resulting in stable operation at all speeds under varying load conditions.

The instrument is also connected with a secondary command input to the error amplifier, so that the error signal corresponds to the resultant of the scale setting and the secondary input. With this method of connection, using a secondary input from a transducer that supplies a d.c. signal proportional to the width of the work load in a machine tool, the motor control can be used successfully for control of cutting speeds in extended turning operations, resulting in up to 4 : 1 saving in time.

Constant Current-Density Control for Electroplating and Electrophoresis

Fig. 7 shows the solid-state calibrated control unit in a constant current-density control instrument for electroplating applications. The instrument is used in conjunction with a motorized regulator to control currents of up to several thousand amperes, at potentials of up to about 50 V, and provides an output voltage/current characteristic of the required slope.

If plating is carried out at a constant-current density with a wide variety of loads, the voltage/current character-

istic is a straight line. The automatic constant-current density control instrument consists of a dual solid-state calibrated control unit, the input to which is the actual sensed voltage across the plating bath, with the addition of a fraction dependent on the load current. This fraction determines the slope and can be set, as required, by means of a pre-set control on the front panel of the instrument.

The control instrument has two pointers which are set fairly close together on the scale, at a point representing the bias voltage, the distance between the pointers representing the 'dead zone' of the controller. With the slope setting at zero, and when the sensed voltage is below the set value, one half of the controller is switched-on to energize the motorized regulator in such a direction as to raise the voltage. When the voltage is above the set value, the other half of the controller energizes the motorized regulator to decrease the voltage. The voltage therefore is controlled to a value in the dead zone between the setting pointers.

With ON/OFF controllers, very close control cannot be achieved since hunting occurs due to overshoot. This defect is overcome by using a dual solid-state calibrated control instrument with proportional outputs to control a commutator-type motor. When the voltage differs considerably from the set value the motor is switched fully on ; as the voltage approaches the set value, the motor speed is proportionally decreased so that the voltage 'inches' up to the correct value.

For constant current-density plating, the bias voltage is initially set with the load current at zero ; the load current is then increased to approximately the maximum capacity and the slope control is set so that the voltage corresponds to the required value at that current. The instrument will then control at constant current-density with any load.

Saturable-Reactor-Controlled Voltage and Current Stabilizers

For static regulation of voltage and current at powers up to the megawatt region, the basic solid-state control instrument can be used with a phase-angle-controlled thyristor output to regulate the current in the control windings of saturable-reactor elements.

The choice between rolling-contact motorized regulators and saturable-reactor stabilizers is often marginal. Although the motorized regulator is more easily understood, the saturable reactor is usually more reliable and the price is often competitive. The saturable-reactor control has no moving parts but control is difficult over a very wide range and, furthermore, the output waveform is non-sinusoidal. However, for applications not requiring control down to zero volts or amperes, the speed of response and maintenance-free operation of saturable-reactor control are usually the deciding factors.

Fig. 8 shows a solid-state calibrated control instrument incorporating saturable-reactor elements. A typical industrial application would be the regulation of currents of about 5,000 A.

The actual output current is sensed by a standard 75-mV shunt, or alternatively by a direct-current transformer, which feeds a signal proportional to the output current to the input of the control instrument. When the current is well below the set value, the output thyristor circuit is triggered for complete half-cycles so that the current in the control winding of the saturable reactor is maximum ; when the output current is above the set value, the thyristor control circuit is cut-off and the current in the control winding is zero. At the set value, within a proportional band of approximately 1%, the phase-angle at which the thyristor fires is automatically adjusted so that the current in the control winding of the saturable-reactor element is that

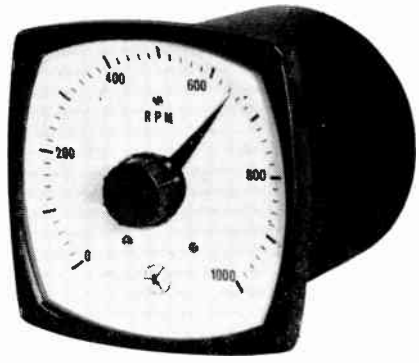


Fig. 6. The solid-state calibrated control instrument used to control the speed of a 10 h.p. commutator motor

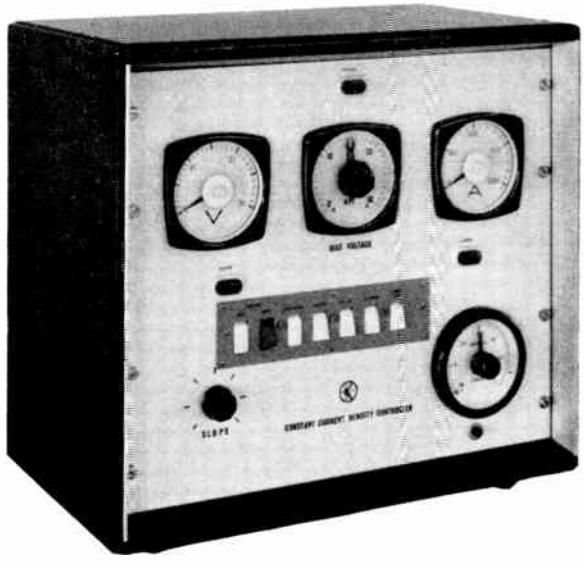


Fig. 7. The control unit of a constant current-density instrument used in electro-plating applications

Fig. 8. A solid-state calibrated control instrument which incorporates saturable-reactor elements for regulating currents of up to about 5,000 A

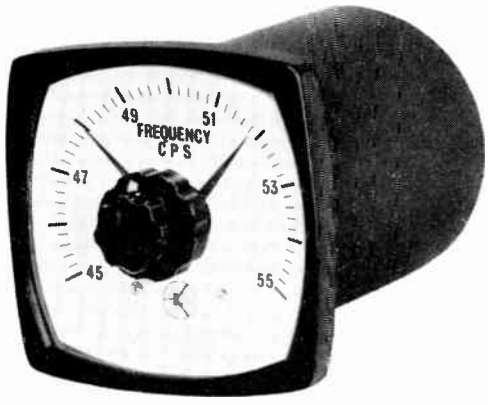


Fig. 9. An instrument used as a standard frequency controller for control, protection or warning during mains-frequency monitoring applications

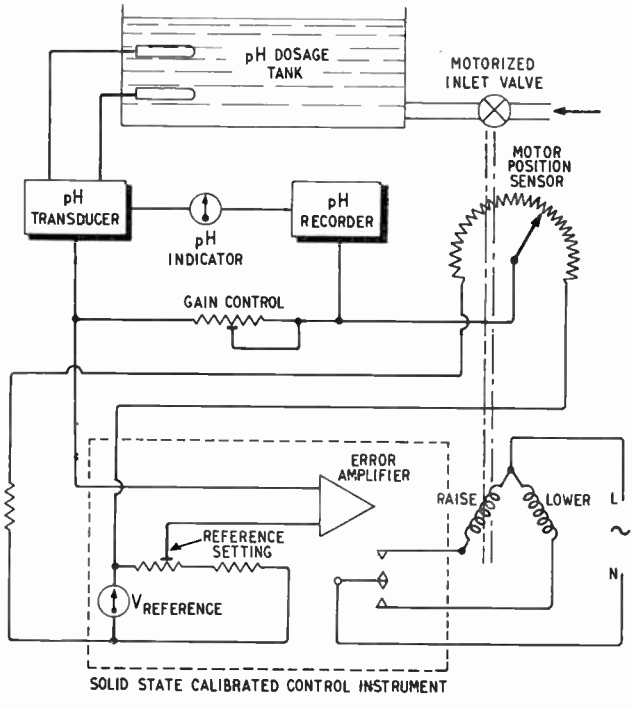


Fig. 10. A block diagram which shows the basic circuit of a pH controller. The pH transducer measures the pH and converts it to a proportional d.c. current

required to control the output current to the set value. Switch-on surges are limited by the introduction of a reference slugging time-constant in the standard control unit, and hunting of the output about the set point is eliminated by the use of functional feedback in the operational amplifier. With the set-up used, the output current was controlled to within 0·5% of the set value, even under short-circuit conditions.

Frequency Control

The instrument illustrated in Fig. 9 was used as a standard frequency controller for control, protection or warning during mains-frequency monitoring applications. The system consists basically of a frequency-to-d.c. converter, which has a d.c. output proportional to the input frequency and is accurate over a small range of, say, 45–55 c/s. The input frequency is initially converted to a pulsed output, of the same frequency, which is then fed into a linear integrator, the output of which is fed to the input of a solid-state calibrated control instrument. The extra frequency-to-d.c. converter circuit is built as an extra printed-circuit card within the standard instrument case and derives its power from that of the rest of the instrument. The auxiliary supply to the instrument is normally the mains a.c. voltage and it can be used to monitor the frequency of its own auxiliary supply, if required.

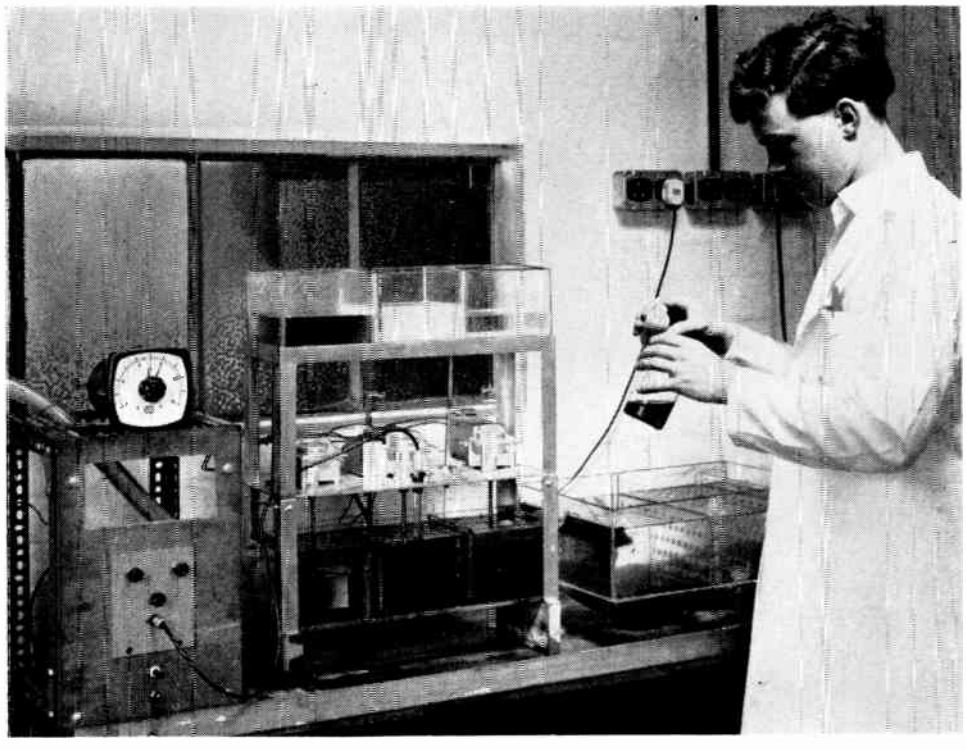
The standard instruments are available with internal relays for ON/OFF control or warning applications. Alternatively, the output may consist of thyristor proportional-control elements. A typical application for the solid-state unit with proportional thyristor output is the frequency control of a motor generator system. The frequency of the system is monitored and the speed of the motor is controlled, by variation of the field current with control in a closed loop, so as to keep the frequency at the set value. For very accurate control, differential and integral feedback may be introduced into the system. An instrumentation scheme was built on the above lines and frequency stability of better than 0·1 c/s in 50 c/s was achieved.

pH Control

A dual solid-state calibrated control instrument has also been successfully used for accurate proportional control of slow-moving processes such as pH dosage and effluent monitoring and control.

The basic circuit of a pH controller is shown in Fig. 10 and the instrumentation scheme consists of a standard pH transducer, which measures the pH and converts it to a proportional d.c. current. This current is fed to a standard solid-state calibrated control instrument, with dual ON/OFF outputs, to control a motorized position-controlled valve in such a direction as to increase pH dosage when the measured value is below that required, and decrease the dosage when it is too high.

In processes such as pH control, the normal time intervals between increased dosage rate and effective pH increase are so long that, if direct ON/OFF motorized regulation was used, the motorized valve would repeatedly close and open and the entire process would hunt between two values which are normally far beyond the limits of accuracy required. This effect is eliminated in these processes by the method of proportional-position control. The motorized valve is connected to a potentiometric position indicator which feeds a signal, proportional to the valve position, to the error amplifier. The input to the error amplifier in the solid-state calibrated control instrument is now the summation of the reference, or demand, value, the measured pH value and the valve position input. When the pH value corresponds exactly to the demanded value, the motorized



A laboratory set-up showing an experimental pH monitoring system undergoing tests

valve is in a position such that the dosage rate exactly corresponds to that required to keep the pH value at the set point. If, due to secondary causes, the pH value varies from the set value, the motorized valve opens or closes by an amount proportional to the magnitude of the deviation, thus correcting the dosage rate. If the secondary causes remain, the system then takes up a new dosage rate position; if the secondary causes vary, or are eliminated, the system takes up the corresponding positions, constantly correcting with deviation proportional to error. The amount of proportional movement of the motorized dosage valve corresponding to a unit error is termed the gain, and this parameter determines the accuracy as well as the speed of control. In the system under consideration, the gain can be simply adjusted by varying the value of the input resistor and therefore the magnitude of the input voltage, which corresponds to the pH value.

The system described above was also used for temperature control of a large oven, using position-controlled gas inlet valves, and the results obtained were entirely satisfactory.

Acknowledgments

The author would like to acknowledge that the solid-state calibrated control instrument, for which a patent has been applied, was developed in the laboratories of Kent Precision Electronics Ltd. Thanks are due to the various firms whose applications of the instruments were discussed.

Designing the Controls of Machines

TO the worker in the old days tools were extensions of his arms. They had been adapted by centuries of use. The levers, knobs and switches of modern equipment cannot evolve in this way. They must be designed deliberately to fit human capacity.

In 'Men, Machines and Controls'* K. A. Provins gives an interesting account of how human factors have to be considered in the design of machine controls.

The range of movement of the different parts of the body affects the placing of controls; and the height, weight, age and sex of the operator influence their detailed design.

Different parts of the body have different capacities for exerting force and for accurate movement, so the function of a control on a machine will often determine its position relative to an operator.

Controls may be classified in terms of the force, speed and accuracy needed to operate them. The amount of force that an operator can exert with a given limb will vary with his posture and with how long he has to maintain the force. Accuracy will depend on the characteristics of the control and the way in which information about the task is fed back to the operator, as well as on his personal characteristics. Speed and range of movement depend on the position and design of controls as well as on the accuracy required.

A table sets out the characteristics of various kinds of controls, such as cranks, wheels, levers and push-buttons, and examines their suitability for different tasks and loads. There is also a short section on power-assisted controls and the layout of machines.

*'Men, Machines and Controls' is No. 7 in the DSIR series 'Ergonomics for Industry'. It may be obtained free of charge from, Warren Spring Laboratory, Stevenage, Herts.

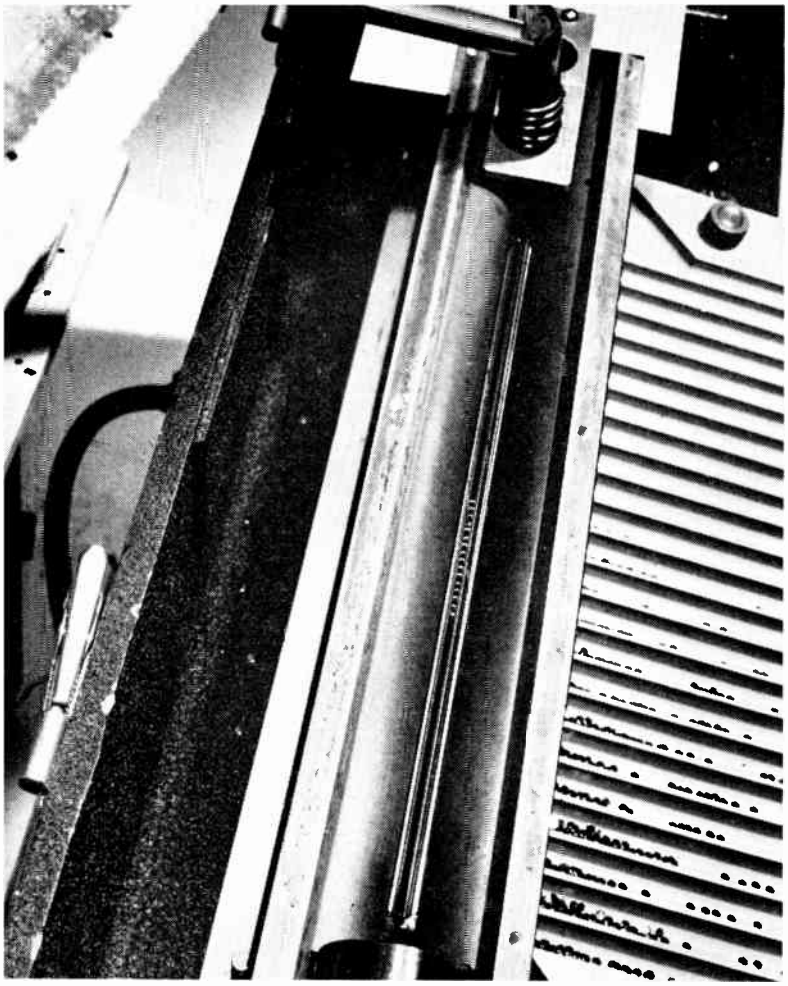


Fig. 1. An overhead view of the gauge rollers

Roller Micrometer at Newmarket Transistors

OF the many complex and precise techniques required in the manufacture of semiconductors, probably one of the most critical is the accurate thickness measurement, in production quantity, of the semiconductor material.

On the germanium alloy junction side of their production, Newmarket Transistors used in the early days an automatic gauging and sorting machine. It incorporated a thickness gauge, electronic comparator and graded the germanium discs into seven or eight categories. The germanium discs were fed via a vibratory feed hopper to a point where they were mechanically fed under the measuring probe one by one. After measurement the appropriate solenoid-operated container was brought into position under the wafer outlet chute. While this machine is suitable for wafers of a certain size, the company has now installed several roller micrometers, which allow for shorter runs necessitating fairly frequent changes in the size setting. The design of these roller micrometers is basically the same as that used for checking roller and ball bearings, but certain refinements have been incorporated which include a dial gauge at each end of the adjustable roller to facilitate checking and setting the gap between the rollers.

The equipment is set up for segregating the wafers into 24 grades in steps of something better than 0·0001 in. At this setting, the machine is capable of checking and grading some 4,000 wafers an hour.

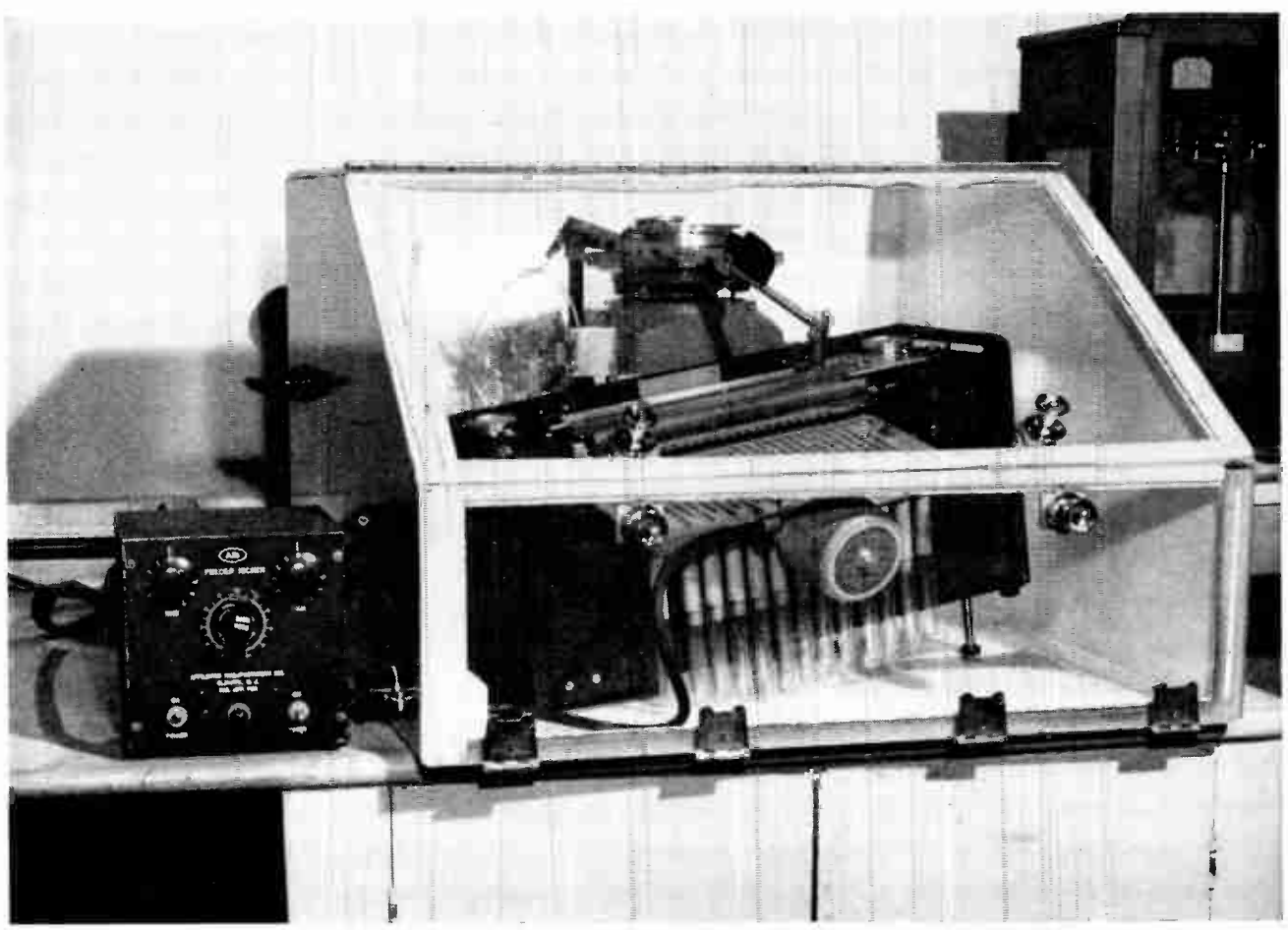
The wafers or discs are loaded into the vibratory feed hopper which delivers them to the input end of the rollers which are set to form a tapered gap and are rotating in opposite directions (Fig. 1). As the wafers travel along the gauging rollers, and each reaches a position when the gap corresponds to its thickness, it falls through and is caught in an inclined chute (Fig. 2) which is one of the series arranged side by side along the full length of the rollers (Fig. 3). The width and number of these chutes are such that they correspond to known sub-divisions of the overall tolerance range, and are machined integrally in an anodized aluminium alloy plate. At the extreme end of each chute is a hole, under which is held a glass collecting tube. To ensure that the graded wafers flow freely down the chutes into the tubes, a further vibratory unit is provided, which can be switched on or off at will and as considered necessary by the machine minder to avoid any pile-up of one particular size of wafer.

The equipment is enclosed in a dry-air cabinet, temperature controlled. Even so, the atmospheric conditions in the cabinet are such that certain precautions still have to be taken. The rollers are kept clean, for instance, by having fitted above them and contoured to their shape, two carbon brushes. These brushes also serve as a guard to prevent wafers from being carried over the top of the roller and wrongly graded or drawn in between the rollers from below and causing damage; they also condition the rollers by removing dust and exercising a burnishing and lubricating effect so that the wafers do not tend to cling. With the same object the rollers are periodically treated with a dry, powdered preparation of molybdenum-disulphide. This powder is rubbed over the rollers which are then polished clean.

The maximum capacity of the roller micrometer it may be noted is $\frac{1}{4}$ in. and an experienced operator can change the size setting in approximately 15 minutes.

Fig. 2. This shows the chutes down which the discs of various thicknesses slide into glass tubes

Fig. 3. The complete machine



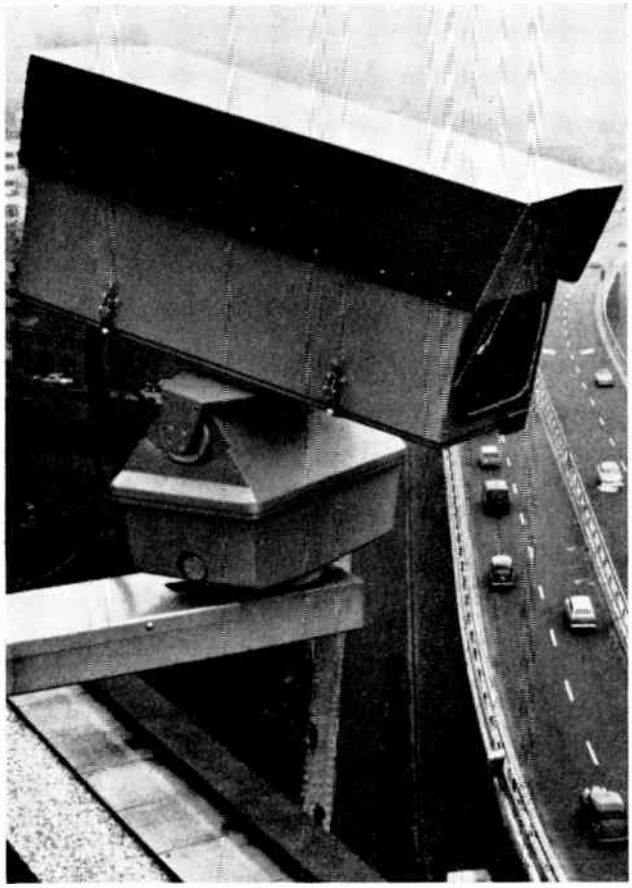


Fig. 1. Shown here is one of the three remote closed-circuit television cameras which overlook the elevated motorway

Remote-Control Communications on Motorway

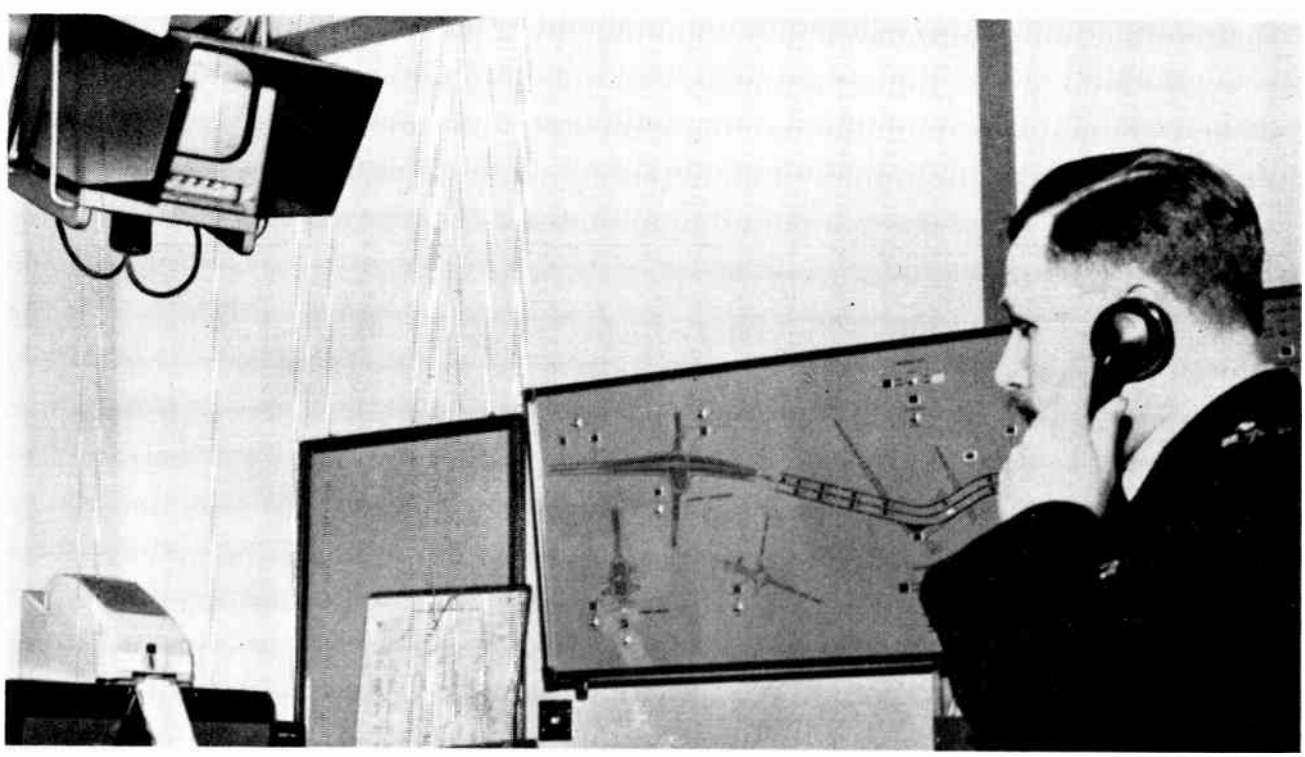
G.E.C. Electronics' Teledata remote-control and indication equipment, used in all the emergency telephone systems on British motorways, has now been introduced on the M4. A comprehensive surveillance and control system operates over the entire length of the elevated section of the new motorway, enabling traffic flow to be monitored and controlled from a central point in Hounslow police station.

Three remote closed-circuit television cameras, mounted on high vantage points (see Fig. 1), feed pictures of traffic conditions to the police station where they are viewed on monitor screens. The duty officer can switch the cameras on or off, control pan and tilt, operate the zoom lenses and initiate the windscreen wipers.

Teledata equipment controls the large direction and diversion signs which straddle the motorway at its exit points, and also monitors the system of loop detectors which are embedded in the road surface and measure traffic flow; all this information is displayed on a mimic diagram in the central control room (see Fig. 2).

The motorway emergency telephone system operates so that the location of any caller can be pinpointed (on a display panel) immediately the telephone handset is lifted; ten telephones, spaced at one-mile intervals, can share a single cable pair under this system.

Fig. 2. The central control room (with mimic diagram in background) at Hounslow police station; here the duty officer can supervise the c.c.t.v. cameras, diversion signs and emergency telephone system



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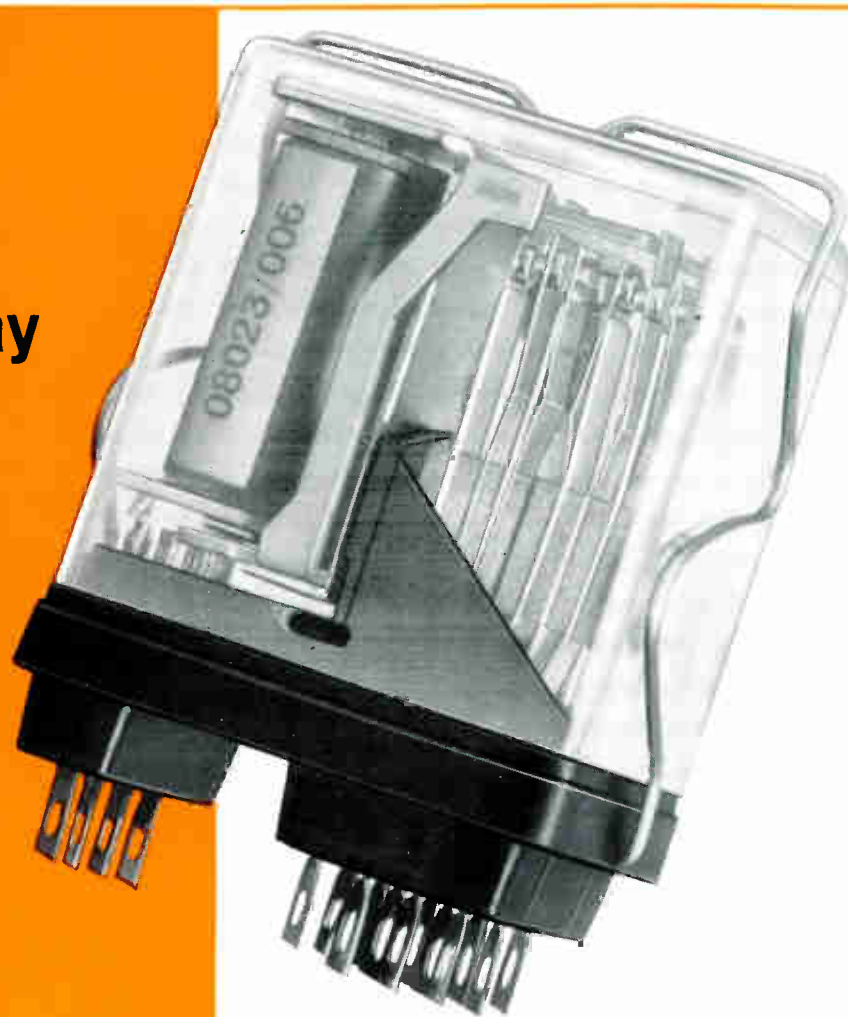

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Last month the author discussed the qualities required in a video map and how they might be realized. This month's article—which is complete in itself—describes the practical approach towards achieving accuracy and high resolution in terms of the Solartron SY.2040 series of equipments.

Accuracy and High Resolution in Video Mapping

*By R. N. HARRISON**

A p.p.i. display starts with a video signal and ends with a picture. A video map starts with a picture and ends with a video signal. Both use a radial scan. Because of this, it might seem that one is virtually the inverse of the other.

In one respect this is definitely untrue. The scan of a display can introduce considerable distortion without unduly impairing its effectiveness. The scan of a video map must introduce the minimum amount of distortion, because every bit of distortion means a loss of map accuracy in relation to the radar picture.

By looking at the distortion which can occur in a display, it is possible to see what has to be avoided in designing a video map. The type of distortion most apparent is loss of circularity. Instead of being round, the range rings tend to ovality along the x or y axis of the display, producing variations in scale depending on the bearing of the radar return. These scale variations are not important. Just as the navigator adjusts his scale to the local latitude, so the radar operator uses the nearest range marks for measurement.

What is not apparent is the concealed bearing distortion associated with oval range rings. In any quadrant, the angular measurement of one half of the quadrant will be expanded to more than 45°, and that of the other half correspondingly contracted. In an extreme case of ovality with an x to y ratio of 5 : 6, bearing error midway between cardinal points would be of the order of 5°.

This is not to suggest that displays normally have errors as great as this. With a modern display which has been well set up they will be very small. But they could be significant in terms of video-map design, particularly near the origin of the trace.

The errors discussed arise from unequal expansion along the x and y axes using fixed-coil deflection. If ± 5 V is the full-scale deflection voltage, the full five volts will be applied at only four points—North, South, East and West—and in association with a zero voltage as far as the other axis is concerned. At 0·001 degree the y deflection voltage will be 4·999 V and the x deflection voltage 0·0875 V. These are of course full-scale deflections, and must keep in step from zero volts upwards.†

It is obviously difficult to ensure that the relationship is maintained precisely from the centre of the c.r.t. to the periphery during the complete rotation of the sweep. The alternative is to apply a deflection voltage along a single axis. There are two ways of doing this. One is to use a rotating map. This however introduces difficulties of its own which are quite considerable. The other is to use a rotating coil assembly.

The requirement is for a rotating coil which will have a significantly smaller total error than is possible with fixed coils. In seeking to meet this requirement, we are shifting the problem into the mechanical field and raising the question of reliability over thousands of hours of operation. Experience has shown that it is possible to achieve satisfactory mechanical design, with errors that are consistently less than the best fixed-coil design, that a long mechanical life within fine tolerances can be ensured, and that electronic side effects do not constitute a problem.

In the light of this, a rotating-coil deflection system was chosen. In examining the design of the video map, this and the microspot c.r.t. can be regarded as the fundamental items around which the rest of the equipment was built.

The neck of the c.r.t. sits within the rotating assembly, located by a collar which ensures that it is accurately centred, and that its phosphor lies in the correct plane at a precise distance from the lens system. The collaring of c.r.ts in a jig which includes a standard focus coil simplifies the initial setting up of the video map, and ensures that when it is necessary to replace the tube—after a life probably in excess of three thousand hours—the change can be made quickly and without need for extensive re-alignment.

The c.r.t. has an optically-flat face so that the compromise over focus must be made electronically, and the lens need have only a shallow depth of focus. What has to be done is to adjust the focus of the spot on the tube face to compensate for the increased length of the electron beam as the spot moves radially from the centre with each trigger pulse. This happens two hundred or more times a second. The effectiveness of the dynamic focus circuit which makes this adjustment is such that the c.r.t. spot, which has a minimum diameter of 0·001 in., does not exceed 0·0015 in. at any point of its travel. The maximum size of the spot does not necessarily occur at the circumference, but in general the circuit is designed so that the spot is at its smallest in the middle of the tube.

The use of a flat-faced tube requires a compensating

* The Solartron Electronic Group Ltd.

† I have ignored the fact that the trace is not truly radial, but has a slight curvature amounting to perhaps one tenth of a degree in an average p.r.f./rotational speed relationship.

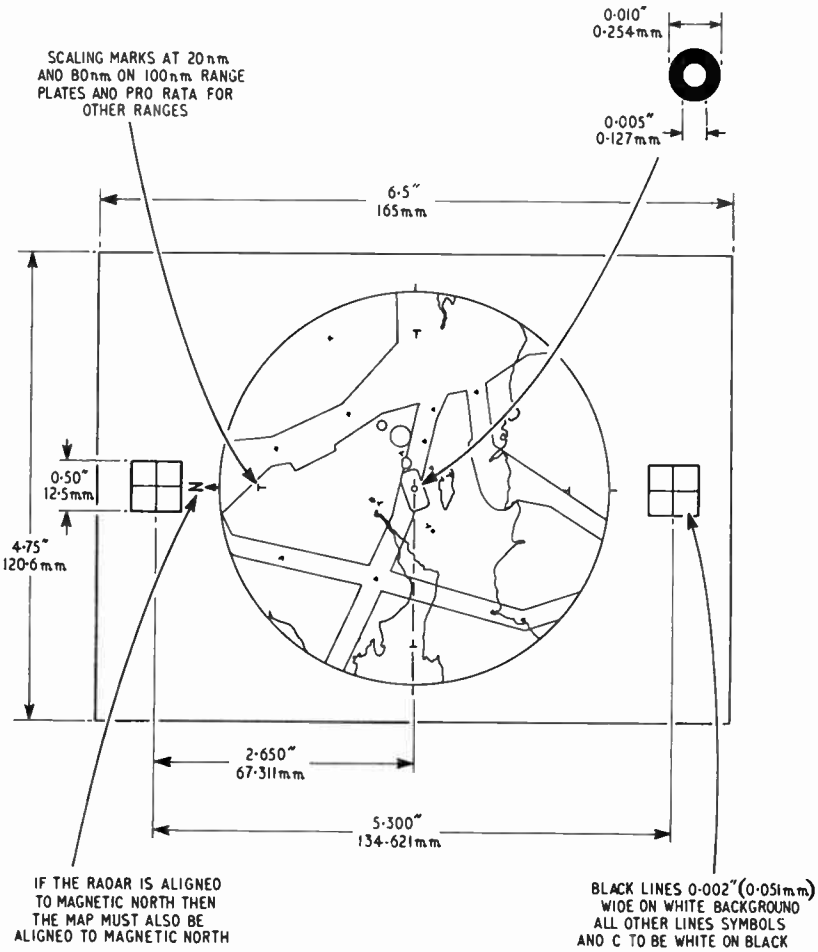


Fig. 1. Layout of master drawing for a video map plate. The dimensions shown are the final dimensions of the plate. The drawing itself will be seven or ten times the plate size

change in the deflection voltage, because the same angular displacement of the electron beam produces a greater linear shift on the tube face towards the circumference as compared with that at the centre. Linearity of spot movement represents one half of the basic accuracy requirement. The other is bearing accuracy, and depends on the synchronization between the rotation of the trace and the rotation of the aerial head.

The c.r.t. spot is projected on to the video-map plate by a lens with a $\times 1$ magnification; this is to say, the working area of the plate has the same diameter as the working area of the tube face. The image of the spot will therefore have virtually the same diameter, 0·001 in. to 0·0015 in.

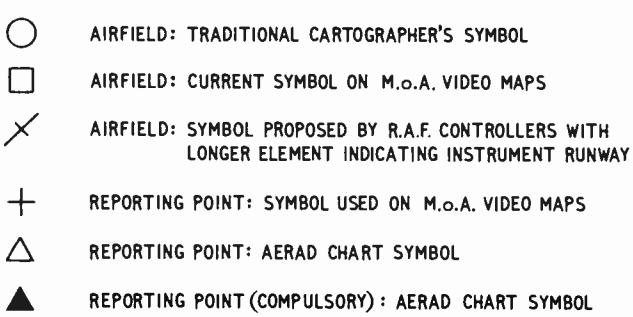


Fig. 2. Part of the choice of map symbols. International agreement could help accuracy

To maintain this, the plate must lie in the correct plane, and the point at which the image is in focus must be coincident with the plate emulsion.

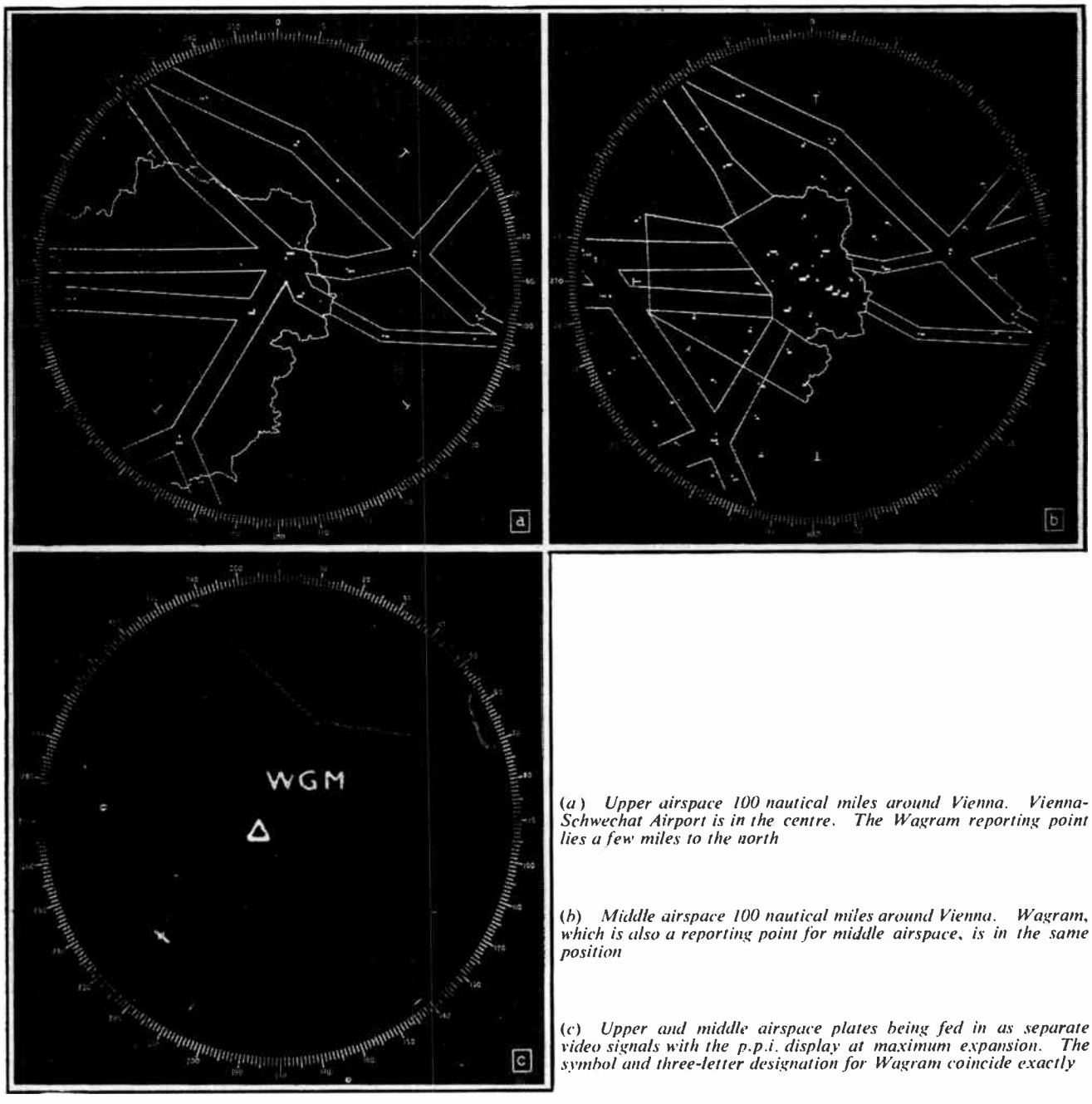
An ability to relate the plate position to the lens with accuracy is one of several positioning requirements. In addition to setting the height of the plate in the optical assembly, it must be possible to make rotational and x and y adjustments. This means there must be a facility to locate the plate precisely in its carrier, and that the plate carrier must itself be capable of controlled movement after insertion in the optical system. Such adjustment would normally be made rarely, say after a c.r.t. change to allow for the slight variation between tubes in the rest position of the spot. Obviously the plate carrier must locate precisely in the optical assembly, and repetition accuracy must be high. The repetition accuracy specified is 0·001 in. or better. That achieved on a day-to-day basis, as estimated from the minimum displacement which would show in the picture on the p.p.i., is better than 0·00025 in.

Optically, the demands on the lens system are not onerous. It is therefore possible to replace the one lens by two separate lenses lying on either side of the vertical axis through the c.r.t., each lens producing an image of the c.r.t. scan on its own video-map plate. This is known as a dual optic system, and meets the operational need to provide alternate maps for the same operator or to give separate maps to different operators using the same radar.

Displacement of the lenses and map plates means that an asymmetric portion of the field of each lens is used, and that theoretically there should be some loss in both resolution and the amount of light transmitted. Neither of these losses is significant. The resolution of the lens is sufficiently high for the loss to be immeasurable as far as the overall video map system is concerned. Reduction in light transmission is small, and the system is designed to assess light or no-light conditions, not to consider graduations.

Light transmitted through the plate passes through an optical condenser situated immediately between the plate and the photomultiplier. Both lenses and condensers are normal optical equipment designed to have a relatively even performance over the visible spectrum. This is possible because the c.r.t. has an 'A' phosphor emitting a blue-green light. In the past it has been necessary to use 'Q' phosphors (which produce a violet light) because of their short afterglow. Where a video map is operating at a maximum range in excess of 30 or 40 miles, afterglow can now be eliminated electronically. In addition to making no special demands on the optical system, the light from an 'A' phosphor is brighter, and gives no trouble with halation in the human eye when the equipment is being set up.

It is usual to use a litho emulsion when making video-map plates. This not only gives good contrast, but allows the maximum light transmission through clear areas.



(a) Upper airspace 100 nautical miles around Vienna. Vienna-Schwechat Airport is in the centre. The Wagram reporting point lies a few miles to the north

(b) Middle airspace 100 nautical miles around Vienna. Wagram, which is also a reporting point for middle airspace, is in the same position

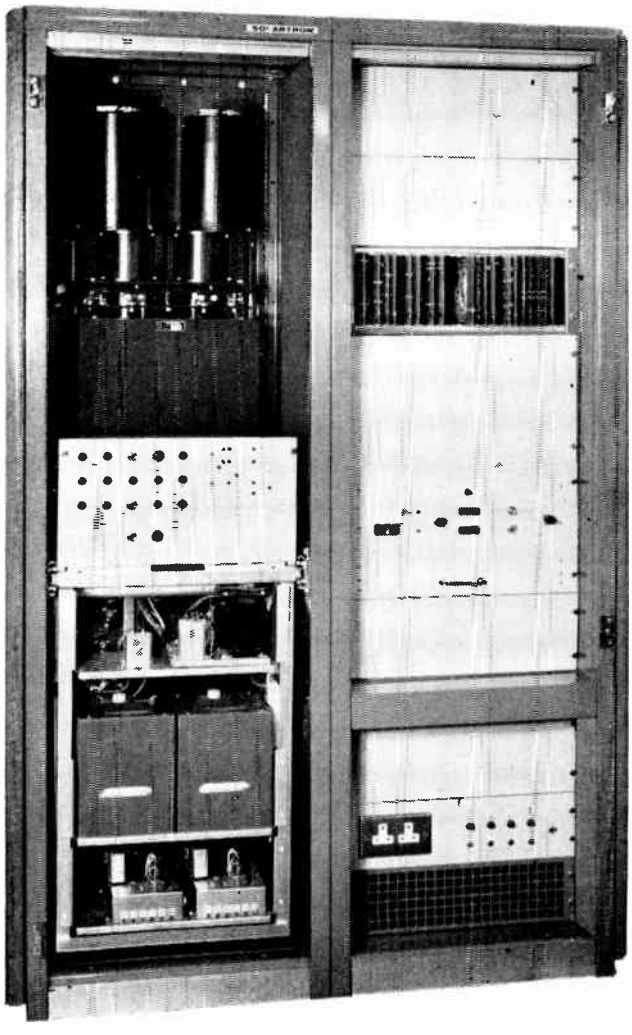
(c) Upper and middle airspace plates being fed in as separate video signals with the p.p.i. display at maximum expansion. The symbol and three-letter designation for Wagram coincide exactly

Properly developed, without agitation after the image has begun to appear, it produces lines with hard edges so that the transition from clear to opaque emulsion has no gradations.

The process of making a plate starts with a master drawing prepared to a scale which is perhaps seven or ten times that finally required. The drawing can be made either as a tracing of a chart on a suitable projection with other information added in latitude and longitude, or by the joining of calculated x and y co-ordinates. The latter is the system used by the Ministry of Aviation, and is based on the national grid system. As no tracing is required, the M.o.A. use white-coated zinc plates for their masters such as are used in preparing Ordnance Survey maps.

Where a tracing technique is used, the material on which the tracing is made must have great stability to avoid inaccuracies through distortion, and a surface which will take ink very smoothly. A Melinex or Mylar base material such as 'Permatrace' or 'Stabiline' is suitable.

With either a transparent or a metal base, the master drawing is laid out to the scheme shown in Fig. 1. The map to be reproduced occupies the circular area. In the exact centre, corresponding to the position of the radar head, is a small circle for alignment purposes. This circle is so small that even the original on the master drawing has to be prepared by photographic reduction. Also in the circular map area are two sets of scaling marks at 20% and 80% of maximum range. These are used in setting up



Solartron high-resolution video map type SY.2042

the map picture against a crystal-controlled or crystal-calibrated range-mark generator. The radar controller can also check them in day-by-day operation against his display range marks.

Either side of the map area are two alignment squares. These provide a hairline cross at each end of the plate. These crosses allow the plate to be roughly centred in the plate carrier, then aligned after accurate centring. Centring and alignment are done in a jig under a microscope. The jig has a calibrated orifice in the centre, and engraved studs to correspond to the alignment crosses at either end.

Line thickness on the plate, and in the drawing, is closely related to c.r.t. spot size. In the centre of the plate, lines are 0·0015 in. wide. Elsewhere the standard is 0·002 in. except where the line is within 15° of being a radial. For these, some thickening may be needed towards the circumference. The calculation of this depends upon the p.r.f. and rotational speed. The necessity for it is due to the fact that if the rotational speed is high enough, and/or the p.r.f. low enough, a radial scan does not provide complete coverage. It is in fact a series of spokes which towards the periphery of the scan may have gaps between them.

The master drawing is prepared using calibrated pens, the draughtsman checking line thickness with a calibrated magnifier as he works. Much of the drawing is continuous line, such as is used for the boundaries of airways and other controller airspace, but there is a requirement for broken line of various sorts for features such as Decca airways, or the borders of prohibited areas. There are also symbols to represent reporting points, airfields, etc., and these may or may not be marked with an alpha-numeric designation.

Improvements in video mapping have made it possible to display much more information than formerly, but no standard has yet been agreed on the symbols to be used. Fig. 2 gives examples of different symbols which may be used for airfields and reporting points. Standardization of symbols is currently under discussion in the U.K.: in coming to a decision it will be necessary to consider the possibility of the same symbol being used on a video map and for automatic tracking.

Photographing the master drawing is a specialist job. It is done with a large copying camera and closely-controlled illumination. Sharpness of focus over the whole area is essential, otherwise line thickness will be increased. The reproduction on the plate must be exactly to scale.

The test of a video map system, and the word in this case embraces drawing and photography as well as the equipment, is whether two transparencies can be matched at the display. The three photographs of Vienna airspace illustrate this point; 'a' shows the upper airspace map, out to 100 nautical miles. The reporting point at Wagram, marked by the letters WGM and an open triangle, is a mile or two north of the centre. At 'b' is the middle airspace map to the same range. The Wagram beacon, also a reporting point in middle airspace, is in the same position. Photograph 'c' is taken with the p.p.i. display at maximum expansion, and with both video maps being fed to it as separate video signals. The symbol and designation letters show complete coincidence.

Sima Form New Group

A Machine Tool and Production Equipment Group has been formed by the Scientific Instrument Manufacturers' Association, bringing together those member firms whose interests include instrumentation and control in this field.

Under its terms of reference the Machine Tool and Production Equipment Group will keep itself informed of the requirements of the users of instrumentation and control equipment in this field. They will make known the activities of the Group members to those concerned and they will establish liaison with users particularly through appropriate trade associations and research establishments.

A steering committee has been set up to give detailed consideration to action to be taken by the Group and to make initial contacts with relevant organizations. This steering committee consists of: P. H. Stephenson (Pye Laboratories), H. Ogden (Ferranti), H. E. Dohoo (Hilger & Watts), D. K. Young (Londex), J. Hann (Optical Measuring Tools), T. W. Clifford (Rank Taylor Hobson Division), D. W. Foscoe (S. Smith & Sons) and F. W. Allen (Sperry Gyroscope).

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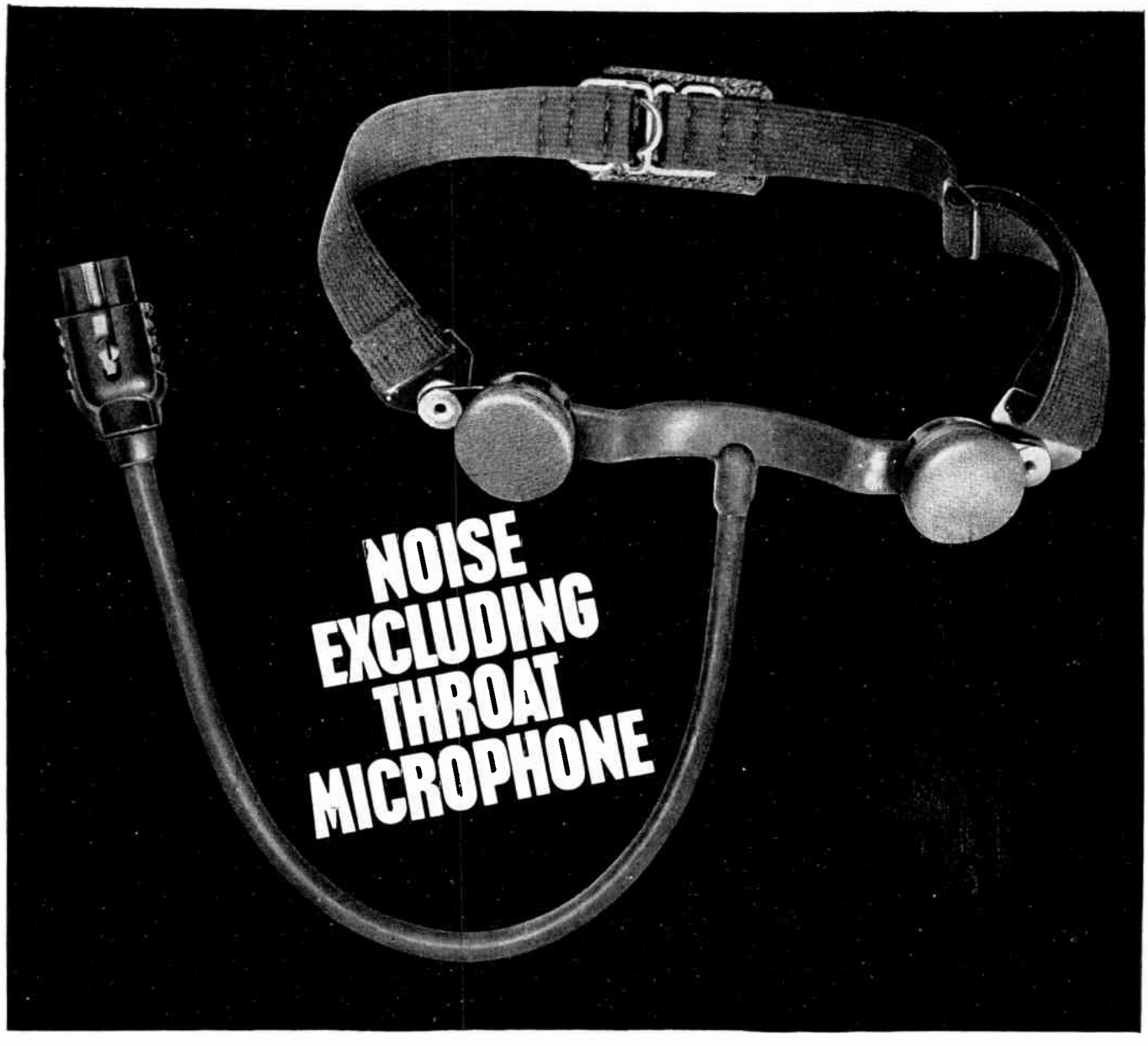

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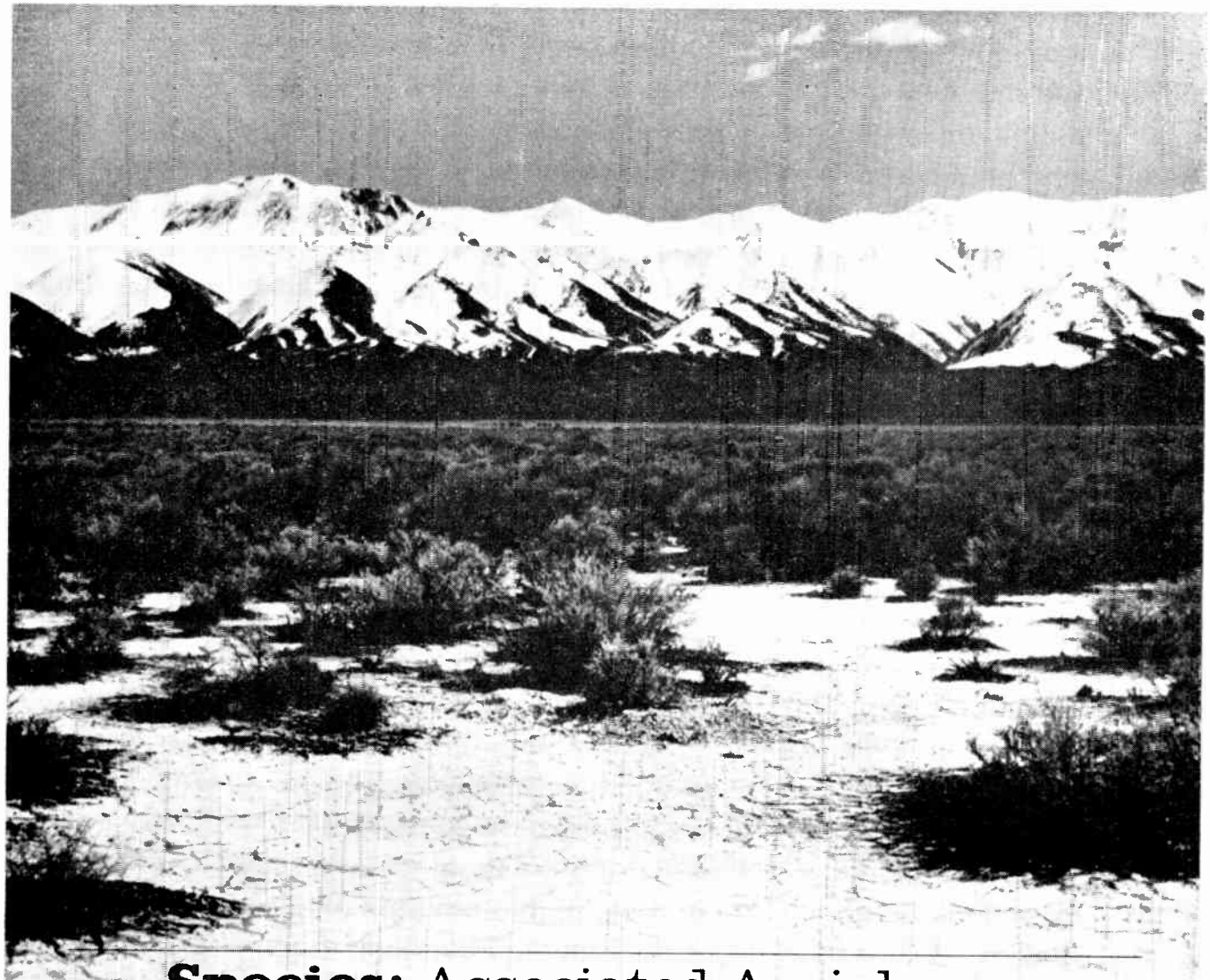

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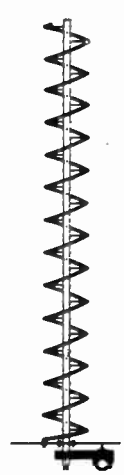

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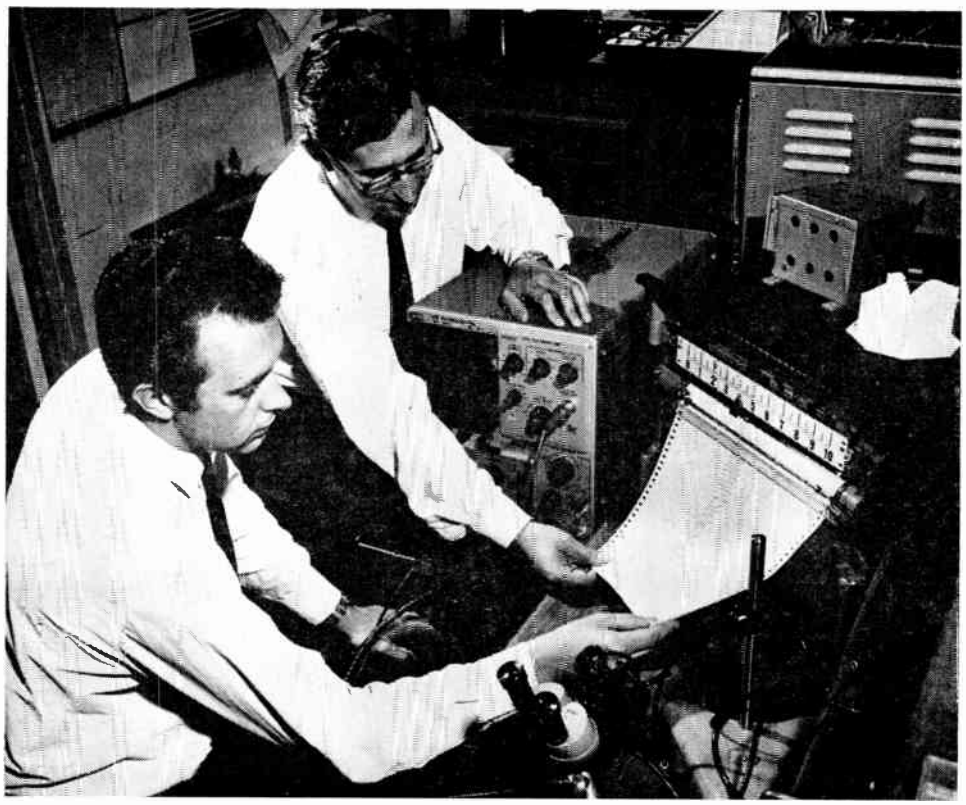


Engineers looking at the microwave output waveform from one of the new epitaxial devices. The trace was obtained by sampling techniques over a period of 5 minutes and shows good coherence and stability of oscillation

NEW MICROWAVE OSCILLATOR

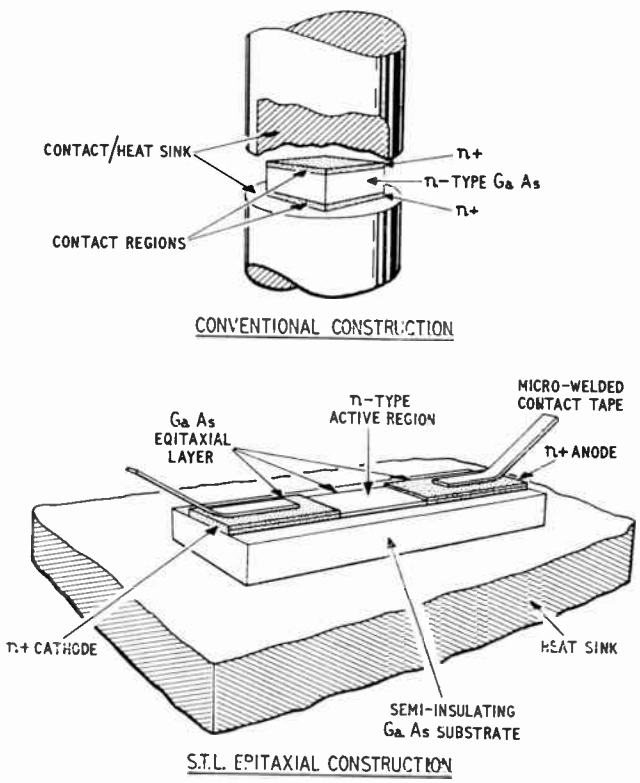


Fig 1. Details of the Gunn-effect generator compared with those of the conventional construction used to date. The epitaxial construction allows thermal and mechanical problems to be divorced from the electrical requirements

An experimental microwave oscillator with a volume of only 0·1 cu in. that produces several milliwatts of c.w. power at 1 Gc/s has been developed by a team at Standard Telecommunication Laboratories at Harlow.

It is the first Gunn-effect device to use epitaxial construction and shows promise for use as an amplifier as well as an oscillator.

Two years ago J. B. Gunn observed that the application of a steady electric field above a certain threshold level to low-resistivity gallium arsenide caused the charge carriers to break up into domains moving along the potential gradient at the carrier drift velocity. The transit time in short enough samples is such that the resulting currents are at microwave frequencies, but to date the development for c.w. operation in the Gc/s region has been restricted by the problem of removal of heat from the active area.

The epitaxial construction used in the STL device enables the frequency and the threshold power of the device to be determined independently of the resistivity of the active region or the mechanical and thermal properties. It uses a substrate of semi-insulating gallium arsenide about 100-microns thick on which is grown a 15-micron thick layer of gallium arsenide whose properties are optimum for the active region of the device. The effective cross-sectional area for the current path is determined by removing part of the layer to form a narrow track 100-microns wide. The

exterior of television and radio sets, tape recorders, instrument panels, telephones, etc. It will also clean plastics, chromium and glass surfaces, and experiments have shown that it will clean tape recorder heads, guides, pinch wheels, etc.

Bib Instrument Cleaner is antistatic, antiseptic, non-flammable, non-toxic and does not smear. It contains no abrasive, so therefore it cannot scratch.

The cleaner contains a blend of surface active agents which leave a layer on the surface and this not only discharges static, but keeps the surface polished as well.

It is available in small bottles of 4-oz capacity, for home maintenance use, and in five-gallon drums for factories and other bulk users.—*Multicore Solders Ltd., Hemel Hempstead, Herts.*

For further information circle 3 on Service Card

ELECTRONICS

4. Pencil Follower Trace Analyser

The problem of feeding computers with information relating to traces, two-dimensional shapes and positioned points has been simplified by the development of a pencil follower trace analyser by d-mac ltd.

Paper-chart and film records, maps and drawings, engineering and architectural designs, all may be converted, by suitable coding, into data suitable for a digital computer and then stored for future reference, analysis and interpretation.

The apparatus consists of a worktable (on the left in the picture), with its associated equipment for projecting images, instructing the system and tracing, and an electronic data-handling console (right). Special pencils are used for tracing and a servo-mechanism tracks their movement, which may be presented either on a typewriter or in tape-punch or card-punch form. Position-readout resolution is 1·0 or 0·1 mm/digit, depending on the digitizer fitted, and servo-positioning accuracy is ±0·1 mm. The maximum permissible pencil speed is 25 cm/sec. — *d-mac ltd., 4 The Mount, Guildford, Surrey.*

For further information circle 4 on Service Card

5. Wide Range Timing Unit

The Type 5T3 wide range timing unit now being manufactured by Tektronix is for use with their Type 661 sampling oscilloscope. It incorporates both real-time and equivalent-time sampling to provide a range of calibrated sweep speeds from 0·01 nsec/cm to 5 sec/cm. Triggering capabilities extend from d.c. to above 5 Gc/s at mV sensitivity levels.

When operating in the equivalent-time sampling mode the sweep speeds range from 0·01 nsec/cm to 100 μsec/cm. Any part of the display may be horizontally magnified up to ×100 without the display spot size being affected. The actual sweep is read out directly on a single control even when the display is magnified.

The sweep speeds in the real-time sampling mode range from 200 μsec/cm to 5 sec/cm. A real-time sweep is used on the X-axis providing a high display rate. For both real-time and equivalent-time sampling the display is in the form of dots.

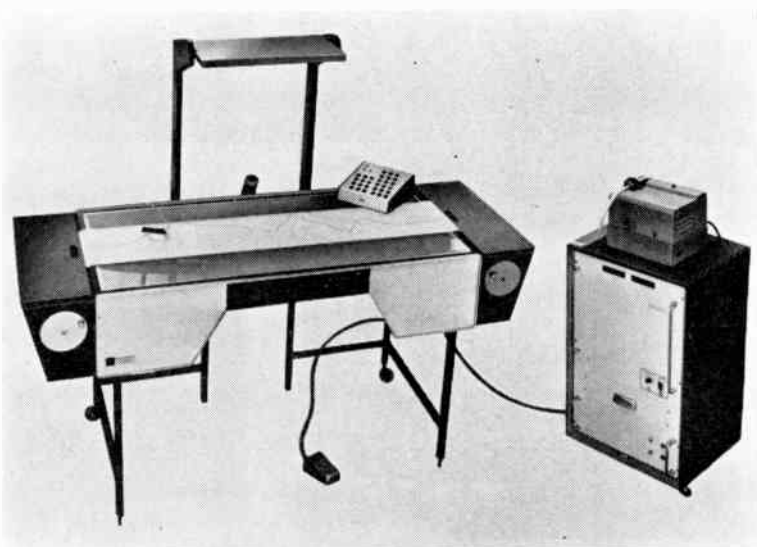
Both 50 Ω and 1-MΩ external trigger inputs are provided, the 1-MΩ input being used with a conventional high-impedance probe to facilitate triggering between d.c. and 20 Mc/s.—*Tektronix U.K. Ltd., Beaverton House, Station Approach, Harpenden, Herts.*

For further information circle 5 on Service Card

6. Solid-State Marker-Sweep Generator

The Kay Electric Model 154-A is an all solid-state sweep generator that extends the range of video sweeping to 100 Mc/s at the same time maintaining the low-frequency end, giving a single sweep display from less than 50 kc/s to 100 Mc/s. The output voltage is 1 V r.m.s. into a 50 or 75-Ω load and is held flat to ±0·25 dB over the widest sweep. Sweep widths are continuously variable from 50 kc/s to 100 Mc/s. There is a choice of up to eight plug-in crystal markers which can be individually switched in. The marked points stay sharp, clear and precise even on the most narrow sweeps.

Operation modes are line-locked, variable 5–50 c/s, manual or c.w. The sweep output is a triangular wave synchronized with the sweeping oscillator with an amplitude of approximately 10 V peak-to-peak. High repetition rates are possible with external modulation up to more than 15 kc/s. Other standard features include a variable-marker provision



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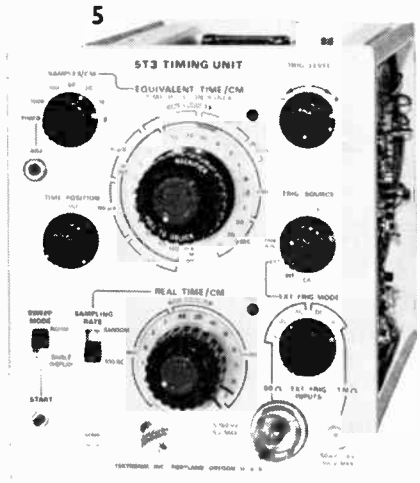

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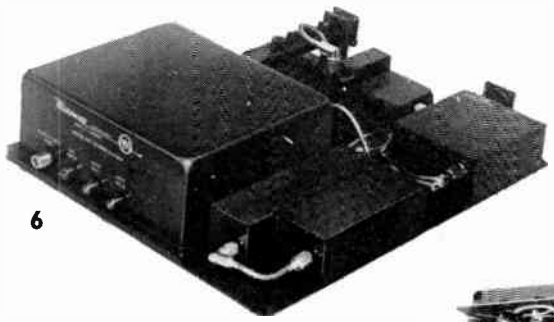
and individually-switched attenuators at 20, 20, 20, 10, 6 and 3-dB steps, plus a 3-dB variable.—*Wessex Electronics Limited, Royal London Buildings, Baldwin Street, Bristol* 1.

For further information circle 6 on Service Card



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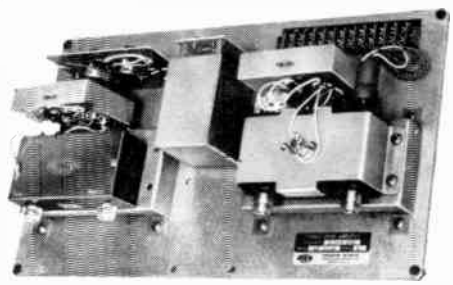
7. Tunnel Diode Amplifier

The Micro State Electronics Corporation have now made available in Europe their model NC-2209 Tunnel Diode Amplifier. This provides a gain of 30 dB in the frequency range of 2·2 Gc/s–2·3 Gc/s. Over this range the noise figure is less than 3·5 dB and the input v.s.w.r. is less than 1·5.

This amplifier uses gallium antimonide tunnel diodes and has been designed for use in telemetry systems. Available in the U.K. from: *Ad. Auriema Ltd., 125 Gunnersbury Lane, London, W.3.*

For further information circle 7 on Service Card



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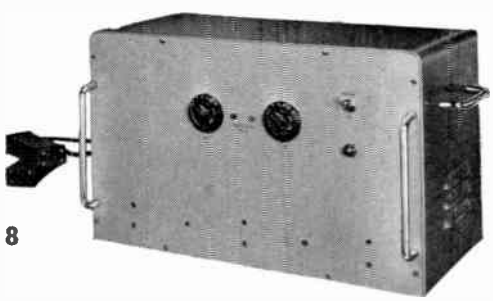
8. Photo-Registration Device

Benson-Lehner Ltd. have introduced a photo-registration device (type 2C5A) for use primarily in packaging, wrapping and bagging machines. The unit is completely transistorized and has no moving parts, thus allowing maximum operating speeds to be employed.

It responds immediately to any variation in the normal state of registration and, depending on the position of the registration marks, either advances or retards an auxiliary electric motor or other device to be controlled. Power supply is 200, 220 or 240 V a.c. (50 c/s), maximum operating rate is 600 c.p.s. (at a maximum ambient temperature of 110 °F), and the maximum power demand from the a.c. mains is 1,300 W.—*Benson-Lehner Ltd., West Quay Road, Southampton.*

For further information circle 8 on Service Card



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9. Solid-State Pulse Sources

The 0·3-μsec pulse rise time is a feature of a series of solid-state pulse sources manufactured by Micromega of America and available in this country through Microwave Systems.

For pulsed applications the sources have a rise time of less than 0·3 μsec and a carrier-on to carrier-off ratio greater than 140 dB. Outputs range from 4 W at 100 Mc/s to 200 W at 9 Gc/s. Circuitry includes transistors, varactors, step recovery diodes and a crystal-controlled oscillator with short-term stability of 1×10^{-9}.

Spurious signals are over 60 dB down and harmonic rejection is greater than 40 dB. Maximum d.c. power input to the circuits is 30 W ; the oven power input is 15 W peak and 4 W running. All units are shielded to meet −100 dBm r.f. leakage specifications.—*Microwave Systems Ltd., 9-10 River Front, Enfield, Middlesex.*

For further information circle 9 on Service Card

10. Doppler Navigator

A Doppler navigator, employing a small lightweight aerial, has been developed by the Marconi Company. Precise measurements of aircraft ground speed, drift angle and distance flown can now be made with the system, which has a transmitter fre-

NEW

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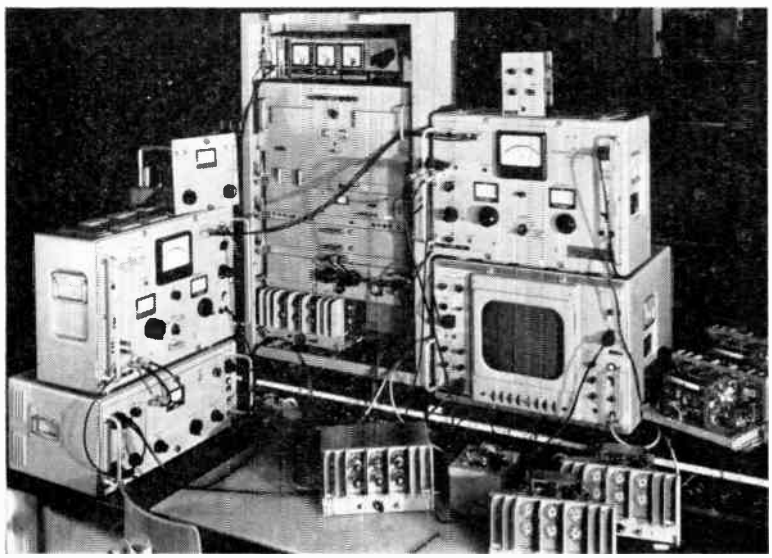

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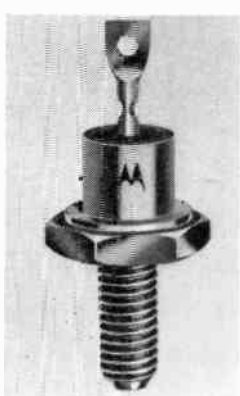

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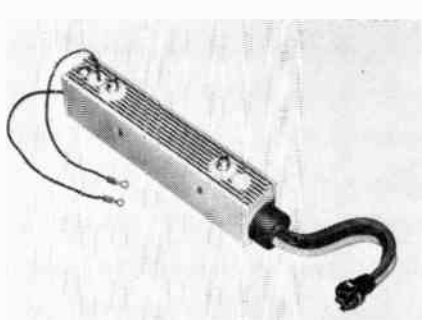

quency of 13,300 Mc/s (+30 Mc/s).

Fully automatic in operation, the equipment is completely transistorized (except for the klystron output valve) and uses sealed modular construction techniques.

The Doppler stabilized moving aerial, into which all the servo-mechanisms have been incorporated, contains a linear array of slotted waveguides which produce four separate beams. The transmitter has a frequency-modulated continuous-wave output of 1 W which is time-shared to each of the four beams in turn, thus ensuring that maximum energy is radiated by each of them.

The unit weighs only 12 lb, measures 17½ in. by 11 in. by 5$\frac{9}{16}$ in., and reduces the effect of 'water bias' to an average of 0·25%. Standard speed range is 90 to 1,000 knots and the maximum operational height is 50,000 ft over land or sea. — *The Marconi Company Ltd., Chelmsford, Essex.*

For further information circle 10 on Service Card

COMMUNICATIONS

11. Sweep-Frequency Measuring Equipment

A complete set of equipment for sweep-frequency measurements of voltage levels and attenuation characteristics is manufactured by Siemens and distributed in this country by R. H. Cole Electronics. It was designed for the development and testing of multi-band radio relay equipment as well as the setting-up and operational supervision of radio links.

There are four basic units of the equipment: a level oscillator, a sweep attachment, a level meter and a level-tracing receiver. The oscillator used is a crystal-controlled beat-frequency oscillator. This provides coverage of the entire frequency range, 10 kc/s–17 Mc/s, without range switching. Two sweep attachments allow sweep widths of ± 500 c/s to ±7·5 Mc/s and the oscillator can be used as either a manually-tuned or a sweep oscillator. The high performance and frequency accuracy of the oscillator are maintained during the sweep, the crystal control allowing selection of narrow sweep widths with uniformly high resolution over the entire frequency range. For all sweep widths the output level of the oscillator is stable, and the sweep width remains practically stable when the centre frequency is changed and the centre frequency remains constant with the sweep width.

The level-tracing receiver incorporates a cathode-ray display tube with a 26-cm screen which displays a trace representing the frequency response of the circuit under test. Responses can be evaluated with the aid of eight adjustable horizontal traces representing attenuation levels and vertical traces which act as frequency markers. A sensitivity of 0·1 dB/cm is possible and, with a trace width of 0·5 mm, a clear reading of level variation of 0·01 dB (0·1%) can be obtained. The measuring range is switched in increments of 5 dB from −5 dB to −40 dB. The input impedance is 75 Ω and the reflection coefficient is less than 1% throughout the entire frequency range. The receiver is built as a basic unit with slide-in units for adaptation to the various measuring and frequency ranges within the overall range of the receiver.

The equipment is used primarily for attenuation measurements including measurements of reflection coefficients and all other measurements that can be reduced to an attenuation measurement. It can also be used as a frequency analyser for the analysis of waveforms into their component harmonics. — *R. H. Cole Electronics Ltd.*, 7-15 *Lansdowne Road, Croydon, Surrey.*

For further information circle 11 on Service Card

12. S-Band Amplifier

The QKS 1194 Amplitron recently introduced by Raytheon has a 12-dB gain and requires a 48-kW input for a peak power output of typically 750 kW. The tube is capable of operating at 3-MW levels. The average power output is 15-kW with a 0·02 duty cycle and 40-μsec pulses. The efficiency is 65%.

When used with a modulator having proper load-line characteristics, the QKS 1194 covers its frequency range of 2·8–3·2 Gc/s in the S-band without electrical or mechanical adjustment.

The 115-lb tube employs integral magnets and waveguide with UG54A/U couplings for both input and output. It is cooled by forced liquids. — *The Raytheon Company, International Sales and Services, Lexington, Massachusetts, U.S.A.*

For further information circle 12 on Service Card

13. 500 W Aerial Switch

A high-power solid-state switching diode (type MV 1892) has recently been introduced by Motorola. Its low insertion loss (0·1 dB) and high breakdown voltage (700 V) make it suitable for instantaneous send/receive (or similar) functioning in aerial switching of mobile communications equipment.

Claimed to be much faster than any electromechanical switch, the device can be self-biased to operate effectively at low-bias voltages and is compatible with fully transistorized equipment; it also has a low holding power requirement of 100 mW.

At 500 W, switching capability is effective up to 50 Mc/s and the isolation factor is 30 dB at 50 c/s.— *Motorola Semiconductor Products Ltd., York House, Empire Way, Wembley, Middlesex.*

For further information circle 13 on Service Card

14. Bi-Directional Power Monitor

Wessex Electronics have made available the Sierra Model 164B bi-directional power monitor. These instruments give continuous or intermittent indications of incident or reflected power during transmission. They can be used for monitoring the reflected power so that aerials or loads can be matched to transmitters or other power sources. The instrument is switched from incident to reflected power measurements by turning a knob on the top of the unit.

Ten plug-in elements allow selection of frequency ranges of 2 Mc/s–1 Gc/s and power ranges of 100 mW–5,000 W. Power is read on a direct linear scale and a v.s.w.r. scale is provided.

The meter movement is damped regardless of the position of the instrument allowing for ease of transit.— *Wessex Electronics Limited, Royal London Buildings, Baldwin Street, Bristol* 1.

For further information circle 14 on Service Card

15. X-Band Travelling-Wave Tube

A 1-kW X-Band travelling-wave tube has been produced by the Raytheon Co.

The new QKW1132 has a unifilar, helix-type wave-propagating structure and employs an integral permanent magnet. The rated 1-kW output with an average gain of 40 dB applies over the tube's frequency range of 7–11 Gc/s. The conduction-cooled t.w.t. is designed for pulsed operation with a maximum duty cycle of 0·01. The output v.s.w.r. is 2 : 1.

The r.f. input impedance is 50 Ω and both connectors are TNC female type. The Raytheon QKW1132 is of rugged ceramic-metal construction permitting operation in hot, cold and high altitude environments. — *Raytheon Company, International Sales & Services, Lexington, Mass., U.S.A.*

For further information circle 15 on Service Card

16. Tunable UHF Circulators

Microwave Systems Ltd. have made available a new range of 3-port coaxial ferrite circulators manufactured by Micromega. The circulators are mechanically tunable over frequency ranges which lie between 350 Mc/s and 1 Gc/s and a calibrated dial permits tuning within seconds.

With a built-in load the units can be converted into compact u.h.f. isolators with high isolation and insertion loss ratios. The mid-band insertion loss is 0·2 dB.

The size of the unit is 3¼ × 4 in. and they have magnetic shielding and good temperature characteristics.— *Microwave Systems Ltd.*, 9-10 *River Front, Enfield, Middlesex.*

For further information circle 16 on Service Card

17. Portable R.F.I. System

A hand-portable, precision radio frequency interference (R.F.I.) measuring system covering the full frequency spectrum from 10 kc/s to 10 Gc/s is available through Aveley Electric.

Manufactured by Stoddart Electric

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NEW

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Systems, and designated type LF-SHF-2T, the new system performs essentially the same function as a system comprising 6 instruments of previous designs and measures only 17 × 17 × 11 in. and weighs 55 lb.

Basically modular and expandable, the LF-SHF-2T provides for four tuner units. These cover the low frequency range from 10 to 160 kc/s, the medium/high frequency range from 150 kc/s to 32 Mc/s, the very high/ultra high frequency range from 31 Mc/s to 1 Gc/s, and the upper ultra high frequency range from 950 Mc/s to 10 Gc/s. Depending on measurements required, the user may start with one or more tuner units, and expand the system for full-frequency coverage. The specific tuner used in a given application is selected with a four-position tuner control.

For simplicity of operation, the instrument has only two functional modes—average signal measurement, and peak measurement. To facilitate calibration and permit substitution measurements to be made, an impulse generator forms an integral part of the instrument.

The sensitivities for the equipment range from −146 dB at 10 kc/s to −81 dB at 10 Gc/s. In order to maintain complete portability, the instrument contains a rechargeable battery pack, providing 100 mA at 14·4 V d.c. The unit may also be operated from 115/230 V a.c., 50–400 c/s power. Applications include determination of the source and characteristics of radio interference, radar site selection surveys, aerial pattern measurements, specification testing, telemetry studies, and satellite communications monitoring.

The instrument incorporates miniature low-loss microwave circuitry, solid-state etched circuit modules, thin-film modules, and integrated circuits meeting stringent specifications. — *Aveley Electric Ltd., South Ockendon, Essex.*

For further information circle 17 on Service Card

18. R.F. Phase Detector

Teltronics of America have produced a precision instrument for accurate measurement of phase shift in r.f. components and which is available in the U.K. from Microwave Systems. Designed to operate in the frequency range of 15–100 Mc/s, the unit will measure the phase shift in r.f. amplifiers, i.f. strips, wideband amplifiers, narrowband amplifiers, networks and delay lines. Comparative or relative phase between similar or identical stages can also be measured.

The phase detector is a dual-channel amplifier which algebraically sums two r.f. inputs and detects the phase difference between the two by displaying nulls when they are in phase with each other and of the same amplitude. The minimum input voltage is 250 mV r.m.s. and the unit will stand a d.c. voltage of 500 V maximum. The unit has a v.s.w.r. of 1·1 and the gain can be adjusted from +5 dB to −15 dB. The accuracy of the meter reading is better than ±0·5°. — *Microwave Systems Limited, Enfield, Middlesex.*

For further information circle 18 on Service Card

19. Broad-Tuning Cavity Amplifier

A new broad-tuning cavity amplifier operating over the 150 Mc/s–1 Gc/s range with 100 W c.w. minimum power output has been developed by Eitel-McCullough Inc. The EM 4547 amplifier is the latest addition to Eimac's cavity line, and incorporates the company's new X843D ceramic-metal planar triode. It is particularly applicable for use in test equipment consoles and special transmitters.

Operating characteristics include 3-dB bandwidth at 5 Mc/s, and 50-Ω nominal load impedance. The maximum load v.s.w.r. is 1·5 : 1 in any phase and the minimum gain is 10 dB, 10-W nominal r.f. drive power being required. The unit is designed for installation in conventional 19-in. relay racks and has the overall dimensions of 11 × 19 × 42 in. and a net weight of 50 lb. Cooling is by a self-contained circulating liquid system. Complete front-panel tuning controls are provided and a power supply, model EM 4580, is also available for use with the EM 4547 amplifier. Distributed in the U.K. by *Walmore Electronics Ltd., 11-15 Betterton Street, Drury Lane, London, W.C.2.*

For further information circle 19 on Service Card

20. Inter-comm Master Station

To complement the Deltaline Interphone System of inter-office communication, S.T.C. have introduced the Deltaline Master Station. This is a loudspeaking station which can be connected to 15 Deltaline interphones.

It is fitted with 20 piano-type keys, 15 of which are three-position switches for connection to the interphones, the other five being for special applications. The central position of the key is 'off' while a depressed key calls up the required extension. If this extension is engaged a light comes on and if the key is put to the up position a light is switched on at the extension to show that it is being called. When the extension is free the master station is called, a buzzer sounds and a light associated with the appropriate key

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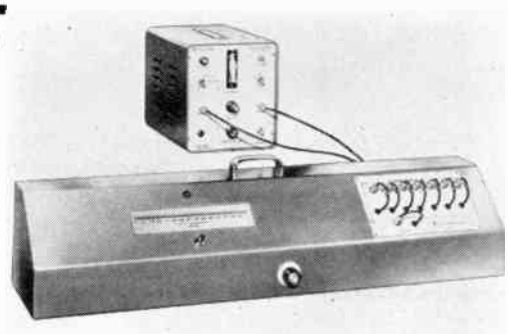

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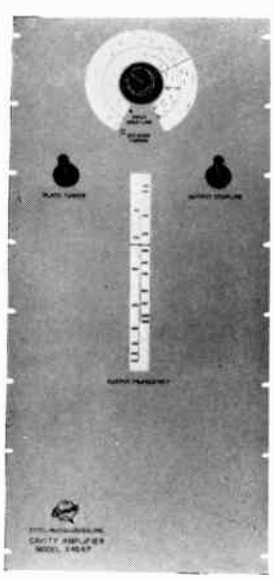

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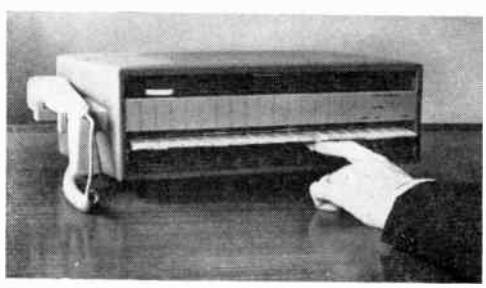

Electrosil **triple rated** glass-tin-oxide resistors receive **qualification approval** to DEF5115-1 **multiple rated** pattern RFG-5

In establishing a concept of multiple rating, R.C.S.C. have pointed the way to economy. This means that one type of resistor can perform three roles of operation, according to the stability required. These are equivalent to the semi-precision oxide of DEF 5114A, the grade one carbon of DEF 5112A, and the general purpose oxide of DEF 5114A. All three types can now be replaced by one resistor—Pattern RFG5 of DEF5115-1, stocks and expenditure are thus greatly reduced and the discrete component situation vastly simplified. DEF5115-1 also include Pattern RFG2, which covers general purpose metal oxide only. Needless to say the Electrosil TR range has also received approval to this Pattern.

Electrosil Type	DEF5115-1 Reference	Ratings (Watts 70°C)	Approved Range
TR4	RFG5-F	$\frac{1}{16}$, $\frac{1}{8}$, $\frac{1}{4}$	51 ohms-47K
TR5	RFG5-E	$\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{2}$	20 ohms-470K
TR6	RFG5-D	$\frac{1}{4}$, $\frac{1}{2}$, 1	20 ohms-1 meg

Pattern RFG5 includes 1%, 2% and 5% selection tolerances, and is therefore the only pattern in DEF 5115-1 available to 1% selection tolerances.

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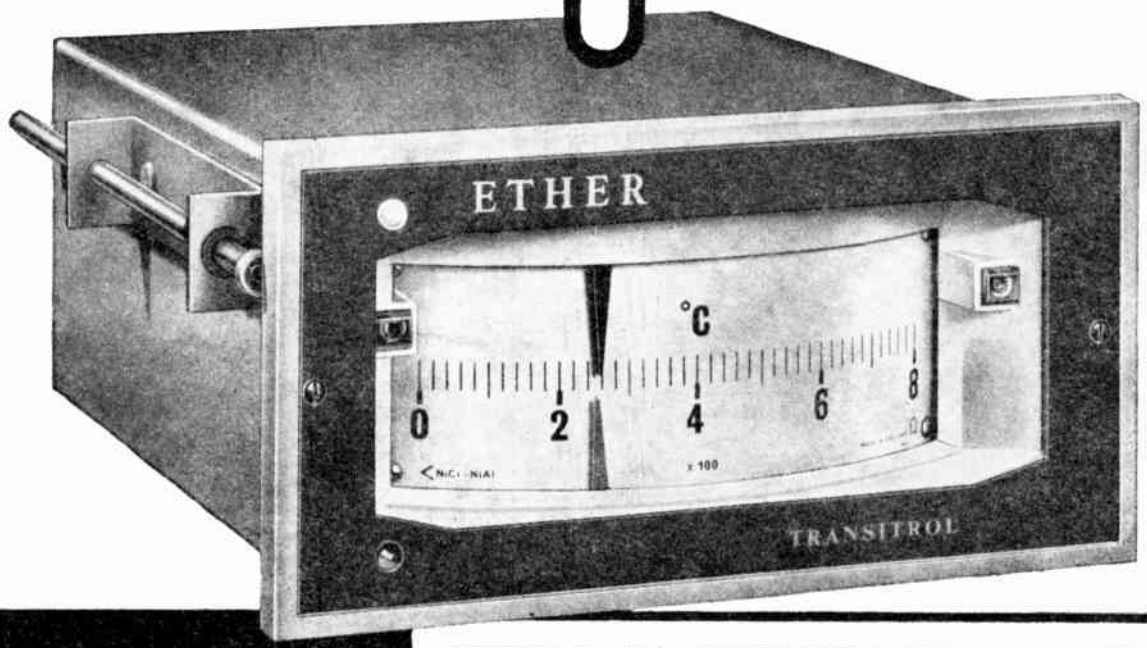

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comes on so that the extension may be called by depression of the key. The other five keys provide for calling a secretary and another master, for cutting off the microphone so that the extension is held without a private conference being transmitted during a conversation, for controlling 'enter/engaged' signals on the office door and for controlling a paging system. A handset is provided which, when lifted, comes into operation and cuts off the microphone and loudspeaker.

The master unit measures 17 in. wide by 10½ in. deep by 6 in. high. It is supplied from the 9–12 V mains unit used to power the complete Deltaline system. —*Standard Telephones and Cables Ltd., Private Communications Division, Footscray, Sidcup, Kent.*

For further information circle 20 on Service Card

INSTRUMENTATION

21. Bipolar Pulse Generators

A new range of bipolar pulse generators, manufactured by Intercontinental Instruments, is available in this country from Claude Lyons. There are three models, the P.G. −31, the P.G. −32 and the P.G. −33.

The frequency range of the P.G. −32 is 0·1 c/s to 10 Mc/s for square-wave and single-pulse operation and for single-shot and double-pulses. Two channels are provided and by combining their outputs an effective pulse rate of 0·2 c/s to 20 Mc/s is obtained. Gating and external drive and external synchronization facilities are provided with adjustment of sensitivity, slope and level. For double-pulse operation the amplitude, slope and width of each pulse and the delay between pulses are independently variable. The pulse configuration common to both channels consists of double pulses and each channel can be set to choose either one pulse or the other, both pulses together or a square-wave.

The rise time and fall time for each channel are independently variable from 10 nsec to 1 sec linear with a 100 : 1 ratio. As a current source the output is 10 mA to 400 mA with a source impedance greater than 1 kΩ, and as a voltage source the output is 20 mV to 20 V with an impedance of 50 Ω.

The P.G. −31 model is the same as the P.G. −32 above but there is no adjustment of rise and fall time. The P.G. −33 is also similar except that the current is limited to ±200 mA and the rise time is improved to 5 nsec.

Silicon transistors are used throughout the instruments and each unit requires 3½ in. of rack space when used with rack adaptors. — *Claude Lyons Ltd., Instrument Division, Hoddesdon, Herts.*

For further information circle 21 on Service Card

22. Range-Expansion Unit

Comark Electronics Ltd. have produced a range-expansion unit type 164C. When used with the thermocouple meter Type 160C it will measure temperatures from 0 °C to 1,200 °C with one-degree resolution throughout the entire range.

The output from a thermocouple type Cr/Al is fed via the unit to the meter and a precision potential divider provides an input to the meter in steps equivalent to 100 °C. Intervals between the steps are covered by the meter set to the 0–100 °C scale. The 160C meter also incorporates a search range of 0–1,000 °C and direct-reading ranges for Cr/Al and other thermocouples.

On the lowest range the sensitivity is 30°C f.s.d. The Type 160C alone has an accuracy of ±2% of f.s.d. but when used with the expansion unit the accuracy is increased to ±1% of f.s.d. or 2 °C.

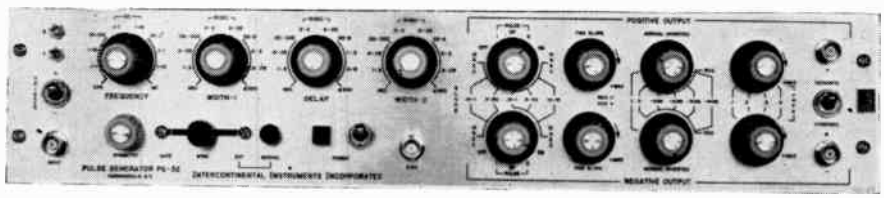
NEW ELECTRONICS COMMUNICATIONS INSTRUMENTATION CONTROL

The range-expansion units are powered by internal mercury batteries and have built-in facilities for cold-junction compensation and for calibration of a reference cell. An output suitable for a recorder is available.— *Comark Electronics Ltd., Gloucester Road, Littlehampton, Sussex.*

For further information circle 22 on Service Card

23. Heterodyne Voltmeter

Fully transistorized, this battery operated instrument can give selective measurements of all commonly used a.m., f.m. and television frequencies. Not only amplitude, but also frequency and percentage modulation can be determined, a loudspeaker giving an audible signal check. The voltmeter is provided with a direct input terminal (at which the impedance is 75 Ω), but a special probe may be fitted to this to obtain a high impedance input. To extend the voltage range the probe is supplied with a voltage divider of 60 dB attenuation, and a stabilized reference oscillator is incorporated for calibrating the instrument. The fre-



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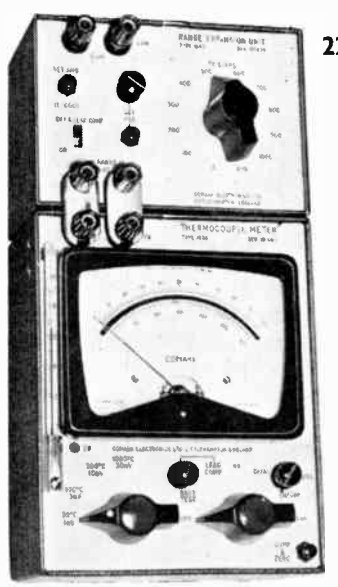

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quency range is 40 kc/s to 260 Mc/s, in six ranges, with a frequency accuracy of 2% ±10 kc/s. Voltage ranges with the attenuator are 50 mV, 500 mV, 5 V and 50 V f.s.d., with a voltage accuracy of ±0·5 dB from 40 kc/s to 170 Mc/s and ±1·0 dB from 170 Mc/s to 230 Mc/s. —*B and K Laboratories Ltd., 4 Tilney Street, Park Lane, London, W.1.*

For further information circle 23 on Service Card

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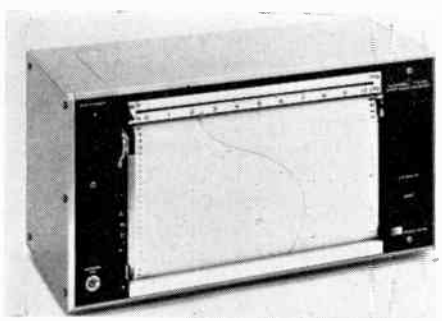
24. Industrial pH Monitor

Developed principally for effluent treatment, this hermetically sealed pH meter/controller contains a highly stable amplifier circuit and has a sensitive, pivotless indicating meter which is free from any errors caused by hysteresis, friction or deterioration. Two reliable independent transistorized alarm/control systems are incorporated which will operate alarms or simple on-off control devices and are rated at 5 A, 250 V. The standard range of measurement is 2–12 pH with discrimination on the panel meter to within ±0·1 pH. Automatic temperature compensation for shift and slope is provided throughout the range 0–100 °C.—*W. G. Pye & Co. Ltd., P.O. Box 60, Cambridge.*

For further information circle 24 on Service Card



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25. Strip Chart Recorders

Two 10-in. single-span models are available for one or two channel recording at a single chart speed. The standard instrument has a 5-mV full-scale span and a 4-in. per min chart speed. However, 124 different combinations of sensitivity (from 1 mV to 1 V full scale) and speed (1 in. per hour to 4 in. per min) are offered.

The recorders provide high accuracy, fast balance speeds, 1 MΩ input resistance at null, and zener controlled electronic reference. Event markers, retransmitting potentiometers, remote electric pen lift and chart control and a 10 to 1 chart speed reducer are available extras.—*Hewlett-Packard, Dallas Road, Bedford.*

For further information circle 25 on Service Card

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26. Probe Accessory for Counters

Racal Instruments announce the availability of a counter accessory, the active probe unit type SA. 544. This fully transistorized probe is for use with the Racal direct-reading digital counters types SA. 540 and SA. 550 for 10 Mc/s and 100 Mc/s frequency measurement.

Use of the active probe enhances counter performance, typically increasing counter input impedance to 10 MΩ in five ranges and sensitivity to 5 mV, making possible many measurements over the 100-Mc/s frequency range which were hitherto only possible using special external amplifiers and impedance-matching devices. The high inherent accuracy of the counter is retained for all measurement functions.

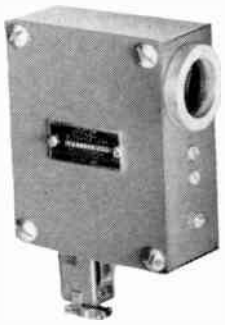
The probe, which makes exclusive use of semiconductor devices, is powered directly from the associated counter. It is of rugged construction and designed to withstand the severe environmental operating conditions imposed by military applications.—*Racal Instruments Ltd., Crowthorne, Berkshire.*

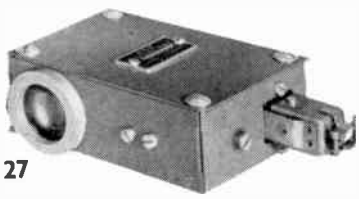
For further information circle 26 on Service Card

CONTROL

27. Lift-Door Control Switches

Photoelectric lift-door control equipment (type WK 525/526) is now available from the Witton-Kramer division of G.E.C. (Engineering) Ltd. It uses infra-red light, which has the advan-





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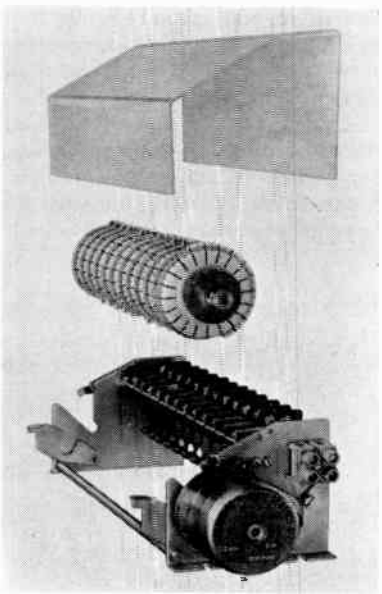

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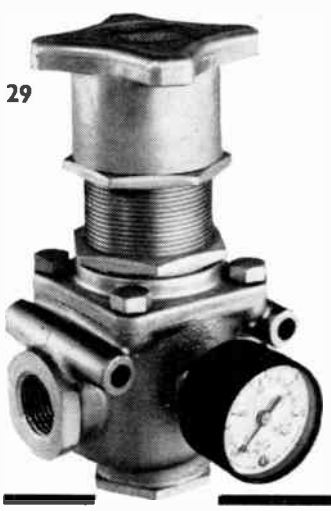

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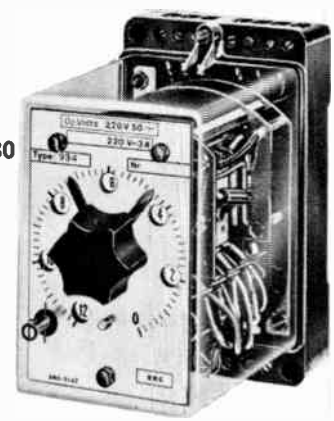

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tages of being invisible and preventing switch activation by ordinary light.

A projector throws a beam across the doorway to the receiver/switch unit and, if the beam is broken when the doors are closing, the switch operates to reverse the travel of the doors. Once the beam has been re-established, the doors remain open for the usual set time-interval before closing.

The standard equipment is designed to operate from a 12 V a.c. or d.c. supply, but switches suitable for 6 and 24 V a.c. or d.c. operation can be provided. Maximum beam length is 20 ft and the relay-contact load rating is 4 A at 230 V a.c., on a non-inductive load. Each unit measures 3 in. by 4 in. by $1\frac{3}{4}$ in. and weighs 1 lb.—*G.E.C. (Engineering) Ltd., Witton-Kramer Division, Birmingham 6.*

For further information circle 27 on Service Card

28. Removable-Camshaft Timer

For rapid change of the timing sequence in control processes Elremco have produced a cam-timer with a removable camshaft. Two snap-action levers are operated to release the camshaft, which may be replaced by another (previously programmed) within seconds. The associated miniature synchronous motor and gear assembly can also be exchanged.

The timer has moulded cams, 6·56 in. in circumference, each one being calibrated and friction held to the shaft; a secondary and tertiary camshaft may be fitted if necessary and snap-action, independently removable, changeover microswitches are supplied as standard. Units with 1, 2, 3, 4, 5, 6, 9 or 12 cams are available, each with a transparent dust cover.—*Electrical Remote Control Co. Ltd., The Fairway, Bush Fair, Harlow, Essex.*

For further information circle 28 on Service Card

29. Pressure Regulators

A range of $\frac{1}{8}$, $\frac{1}{4}$ and $\frac{1}{2}$-in. BSP pressure regulators for panel mounting has been announced by Martonair Ltd. They incorporate a self-exhausting feature which reverses the flow when the upstream pressure is reduced to below that of the downstream pressure setting; this is of particular value when it is required to exhaust the downstream pressure by exhausting the supply pressure.

A standard built-in automatic relief valve enables downward adjustment of the secondary pressure to be made without bleeding the circuit; it will also automatically relieve the downstream pressure if this should rise above the pressure setting.

The units reduce primary pressures of up to 250 p.s.i. to a steady secondary pressure of from 0–100 p.s.i., and their operating temperature range is 5–90 °C.—*Martonair Ltd., St. Margaret's Road, Twickenham, Middlesex.*

For further information circle 29 on Service Card

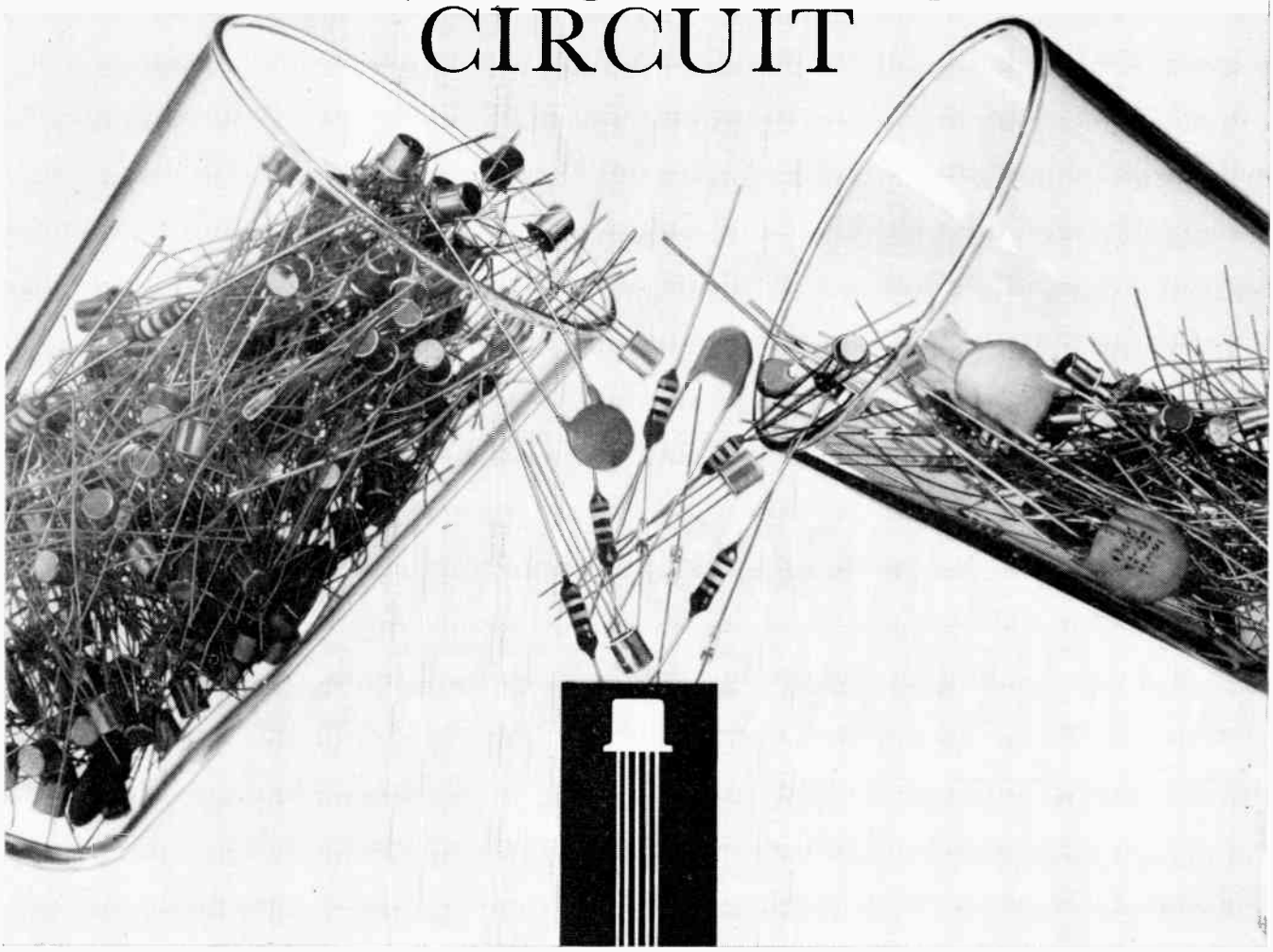
30. Industrial Timer Unit

A synchronous-motor-driven process timer, series 934, has been introduced by Magnetic Devices. It incorporates a special feature which, if the supply fails, allows the timer to be set either to return to its initial position or to remain in its interrupted position until the resumption of the supply, when it will complete the unelapsed time.

The timer can perform most of the functions required in process control and automation and has three selectable time ranges, within the scale of which the delay can be infinitely adjusted. Control is by means of an external impulse switch, or on/off switch, and is adjustable for time-delay ranges of 0 to 12, 60 and 120 sec; 0 to 24, 120 and 240 sec; 0 to 6, 30 and 60 min; and 0 to 3, 15 and 30 hours. Four microswitches are used, two operating instantaneously and two after the time-delay period.

Setting accuracy is about 1.5% of complete cycle, with repetitive accuracy better than 1%. Operating voltage is

A GLASS AND A HALF OF COMPONENTS GO INTO EVERY INTEGRATED CIRCUIT



Roughly speaking. More precisely, Semiconductors Ltd. integrated circuits offer a range of sophisticated elements which by their versatility, compact form and low cost permit a completely new approach to many common requirements in circuit design.

The SL 700 Series, for example, are high-gain d.c. operational amplifiers, extremely tolerant of supply line variations. Input d.c. offset voltage is typically 10 mV and offset current 0.3μA. High gain versions have open loop gains of approximately 70dB, while alternative versions from the same basic chip enable gain to be traded for stability.

The SL 500 Series is a 100 Mc/s wideband amplifier, primarily intended for use in linear I.F. strips operating at centre frequencies between 10 and 60 Mc/s.

The amplifier gives a current gain of 26dB between 5 Mc/s and 100 Mc/s and the circuit incorporates AGC giving at least 40dB gain control range.

These are just two of the many advanced, monolithic, silicon integrated circuits available.

It will always pay you to check with Semiconductors Limited before initiating new equipment designs.

PLESSEY COMPONENTS GROUP

Semiconductors Limited

Cheney Manor, Swindon, Wilts. Tel: Swindon 6251

and motor-operated models are available.—*The British Electric Resistance Co. Ltd., Queensway, Enfield, Middlesex.*

For further information circle 35 on Service Card

36. Solid Tantalum Capacitors

S.T.C. have introduced into the U.K. a new range of low-cost, solid tantalum capacitors having the advantages of small size and long life including a long shelf life without reforming. A moisture-resistant resin coating gives mechanical protection.

The values of these capacitors are 0·1 μF to 50 μF at working voltages of 3 V to 35 V d.c. A capacitance tolerance of −20% to +50% is offered and the temperatures at which the components can be used are between −40 °C and 85 °C.—*Standard Telephones and Cables Ltd. London Sales Office, Footscray, Sidcup, Kent.*

For further information circle 36 on Service Card

37. Subminiature Microswitches

Erg have announced commencement of full British production of their no-bounce subminiature microswitches series M.S.M. The type illustrated has an aluminium body to provide electrostatic screening of the contacts and is available with actuators to suit linear or cam operation.

Rated at speeds up to 1,000 c/s, it is claimed that there is no contact bounce at operating speeds up to 500 c/s. Electrical noise is <1 μV.

Contacts are single-pole single-throw and rated at 28 V d.c. ¼ A resistive (max.). Lift expectancy is 1,000 million c/s minimum and operating pressure is 18 to 30 gm.—*Erg Industrial Corporation Limited, Luton Road, Dunstable, Beds.*

For further information circle 37 on Service Card

38. Standard Reference Magnets

A range of fully-screened standard reference magnets designed for the calibration of search coils, fluxmeters, Hall-effect and similar gaussmeters is now available from Preformations Ltd. These magnets are suitable for the calibration of search coils or Hall-effect probes with a maximum diameter of 10 mm and a maximum thickness of 4·75 mm.

During production they are fully stabilized, both magnetically and by temperature cycling, to guard against irreversible losses resulting from temperature changes and external magnetic fields. Magnets with either transverse

NEW

ELECTRONICS
COMMUNICATIONS
INSTRUMENTATION
CONTROL

or axial fields are available with flux densities of, for axial fields, 300 and 500 gauss and, for transverse fields, 1,000, 3,000, 5,000, 10,000 and 15,000 gauss.

Accuracy is within ±0·5% of marked flux density at 20 °C and the magnetic stability is such that the magnets will not be permanently affected by stray fields below 150 oersteds. Temperature stability is of the order of 0·2% per degree C between −10 °C and +90 °C, the maximum operating temperature being 100 °C.—*Preformations Ltd., Cheney Manor, Swindon, Wilts.*

For further information circle 38 on Service Card

PRODUCTION AIDS

39. Infrared Camera

Developments in infrared thermography have made it possible to use the process both for non-destructive

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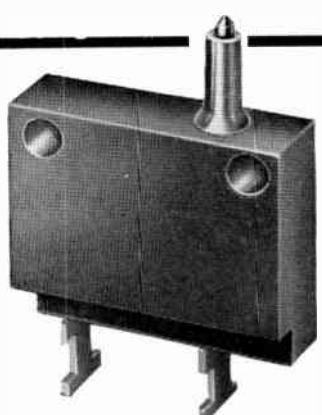

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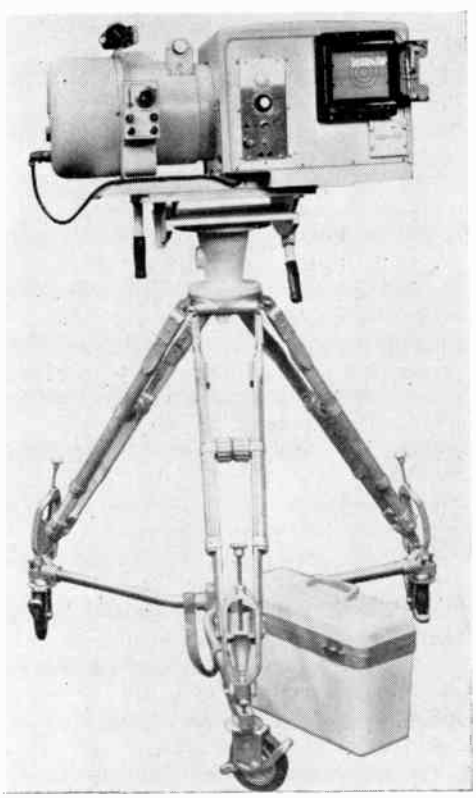

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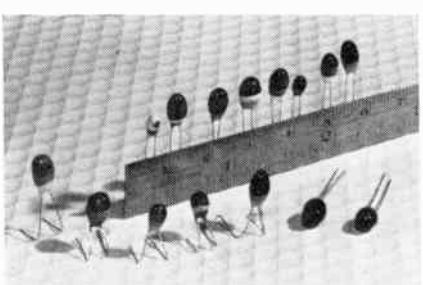

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testing of miniature circuit boards and for predicting component performance before installation. To this end, Barnes Engineering Co., of Connecticut, have introduced their model T-4 Infrared Camera for thermal studies of extended areas.

The camera will produce a thermographic picture (thermogram) of temperature distribution, the prints and negatives being available 10 sec after scan ; high temperatures appear white, while progressively cooler details show greys of increasing density.

The target temperature range is −170 to +250 °C and, within this region, a black and white thermal image can be obtained over temperature ranges of 1·0 °C (minimum) rising to 250 °C (maximum) ; these ranges are selected by electronic controls on the camera and the smallest detectable temperature differences in them are 0·1 °C (minimum) and 20 °C (maximum), the instrument having an absolute accuracy of ±5%.—*B & K Laboratories Ltd., 4 Tilney Street, Park Lane, London, W.1.*

For further information circle 39 on Service Card

40. Electrostatic Spraygun

Hursant Electronics recently announced their 'Weathermaster' spraying equipment (mobile and/or portable), which will operate satisfactorily into a head-on wind of up to 20 m.p.h. without any detectable blow-back. In cross winds there is a slight shift of the spray pattern in the direction of the wind, but the process is always completely under control.

The apparatus consists of a gun unit, which atomizes and electrostatically charges the coating material positive with respect to earth and directs it on to the unit to be sprayed, which is earthed. The weather-protected equipment requires a source of compressed air (consumption varies from 9 to 14 cu ft/min) and an electrostatic generator is available for either mains or 12–24 V battery operation.—*Hursant Electronics Ltd., Central Way, Feltham, Middlesex.*

For further information circle 40 on Service Card

41. Digital Instrumentation Systems

The Westinghouse digital instrumentation systems provide complete equipment for measurement of speed, speed differential and linear footage in the continuous process industries.

The systems, available with or without control initiating provisions, will immediately localize process variations. Improper speed, which results in poor product quality and equipment malfunction, can be determined. The data-logging equipment provides operating records for analysis and determination of operational improvements.

The various systems are composed of basic building-block units assembled into complete systems to perform particular functions. These units include the master control, which houses all logical programming modular circuitry, the pulse generating equipment and auxiliary units. The accompanying illustration shows the master control unit.—*The Westinghouse Electric International Co., P.O. Box 1133, Grand Central Station, New York, N.Y. 10017, U.S.A.*

For further information circle 41 on Service Card

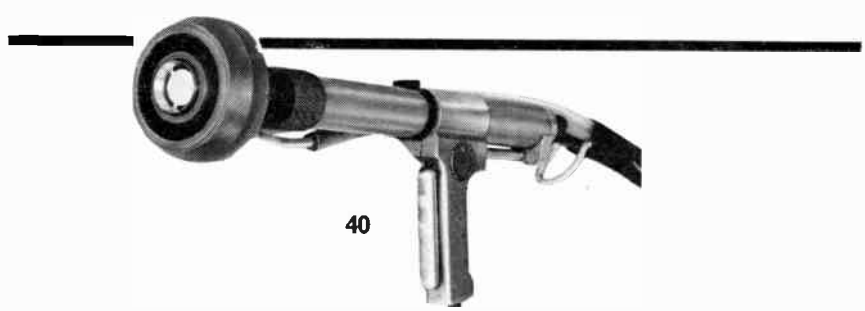
42. Transfer-Tape Coating Machine

Vitta Corporation have announced a laboratory model tape transfer machine for small-scale production of metallizing, glazing or any other type of flat-surface or butt-ring end-coatings. It is designed to replace 'wet' techniques such as painting, spraying, silk-screening, etc., by the use of transfer tapes. This provides a completely dry and accurately-controlled coating operation combined with high speed and convenience of handling.

The unit is hand operated or motor driven and can handle flat or ring surfaces from 0·02 to 4 in. in diameter. The capacity of the machine varies from 1,000 2-in. diameter pieces (for an 8-hr period with one operator) up to 10,000 0·2-in. or smaller diameter pieces. Pattern coatings can be performed with a stencil which shields the surface areas to be left uncoated. Extremely thin and delicate pieces (e.g., silicon wafers) can easily be coated, even if very low thickness coatings are required.

The machine performs the coating operation by two pressure rollers which apply a closely-controlled pressure to the pieces and thus accomplishes the transfer of the coating. After the pressure is applied, the coated pieces are released from the tape by the release edge of the machine and are immediately ready for further processing without the necessity for any drying procedure.—*Vitta Corporation, 382 Danbury Road, Route U.S.7, Wilton, Connecticut, U.S.A.*

For further information circle 42 on Service Card



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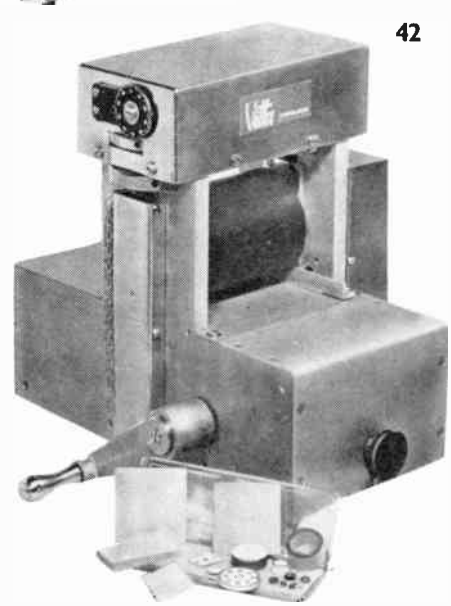

Extended range of EEV Ignitrons now available with coaxial construction

All Ignitrons with the International size letters A to D in the range manufactured by
English Electric Valve Company Limited
at Lincoln, can now be supplied in co-axial construction form. This range, already established as the most comprehensive in Europe, is now extended to incorporate those Ignitrons previously available from The English Electric Company at Stafford: these will continue to be available under their original type numbers. (AR10T, AR14T and AR31).

INTERNATIONAL SIZE LETTER	EEV TYPE NO.	AMERICAN† EQUIVALENT	APPLICATION
A	BK66 (AR31)	5550	A.C. resistance welding
B	BK42 (AR14T)	5551A	
	BK442 *	7669	
C	BK24 (AR10T)	5552A	
	BK168	5822A	
	BK444*	7671	
D	BK146	5553B	
C	BK44	5554	Power rectification and control
D	BK46	5555	
A	BK416	7703	Capacitor discharge
	BK428	—	
D	BK178	—	
E	BK194	—	

† These equivalent type numbers are usually prefixed with the identifying code letters of the manufacturer concerned.

* Co-axial construction.

Full information on the complete range of Ignitrons available from EEV may be obtained from the address at the foot of the page. Enquiries from Government departments and overseas customers should be directed to the Sales Department, Chelmsford, Essex, England, Telephone: Chelmsford 3491 (Ext. 262) Telex: 99103, Telegrams: Enelectico, Chelmsford.

ENGLISH ELECTRIC VALVE COMPANY LIMITED
CARHOLME ROAD, LINCOLN, ENGLAND. Telephone: Lincoln 26352
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EEV

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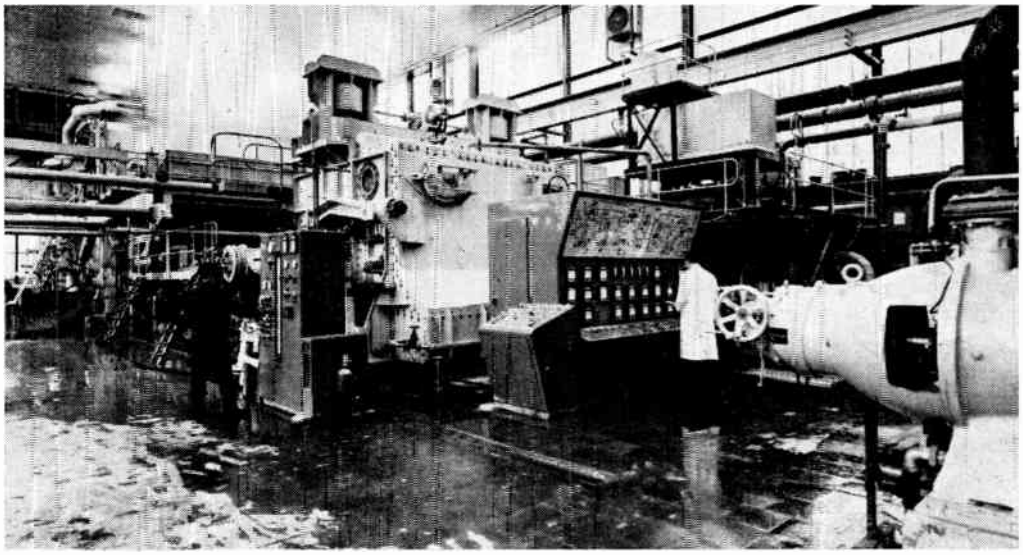


This view of the plant shows the largest of the two main control consoles. All continuous recording and control functions are centralized on this. A mimic-type diagram, just above the operator's eye level, indicates clearly the parts of the plant being monitored and controlled.

Pneumatic and Electronic Control in Dixon's New Paper Mill

THE £2 million expansion scheme for the Oughtibridge, Sheffield, Paper Mill of Peter Dixon and Sons is now completed.

The Walmsley machine in the modernized mill is the latest of its type in Europe. Its ability to produce both wet and dry crepe products at speeds of up to 3,000 ft/min is dependent to a great extent on the pneumatic and electronic control systems. The pneumatic control instrumentation was installed by Honeywell Controls and the control for the sectional electric drives was produced by Harland Engineering.

The Honeywell pneumatic 'Tel-O-Set' instrumentation monitors stock preparation, proportioning, drying and ancillary systems throughout the mill. All continuous recording and control functions are centralized on a semi-graphic control panel which gives remote regulation of consistency, level, stock proportion and flow in the preparation plant. Other panels give localized supervision of pulping, broke handling and paper drying, including a closely controlled warm-up programme for the main (M.G.) cylinder.

Electronically-Controlled Sectional Electric Drive

In a paper-making machine there are many rollers and drive motors each of which must be accurately controlled in speed to maintain the required tension on the paper being produced.

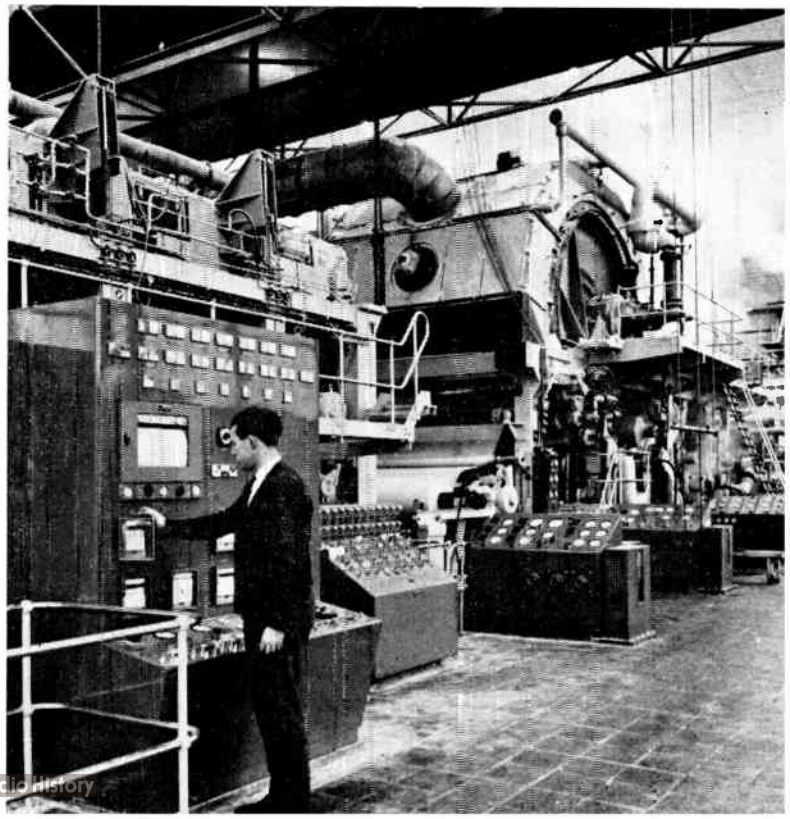
The tissue machine is powered by a drive which incorporates silicon rectifiers and magnetic amplifiers for the production of direct current power for the 16-motor sectional electric drive. This drive is a development by the Harland Engineering Co.

The direct current motors derive their electrical supply from the entirely static silicon rectifiers for the conversion of the mill a.c. supply to variable voltage direct current. Each section motor or group of motors is provided with a separate bank of these rectifiers and extreme accuracy of control of the speed of each section is achieved by use of rapid response power magnetic amplifiers operating in the a.c. supply circuits to each rectifier bank. The magnetic amplifiers range in size from 360 kW to 30 kW.

Section motor speed signals are derived from high stability tachometer generators which accurately represent the speeds of the various sections in terms of a signal voltage which is compared with that of a highly stabilized transistorized reference source, any departure from the preset speed being detected and made to operate on the magnetic amplifier control system to correct the error.

One feature of this type of drive is the exceptionally high rate of response of the control system that can be obtained and the input to the section motors can be swung, if required to do so, from zero to its maximum value in 7 msec.

Accuracy of speed holding of this type of drive is very good and it is claimed that a load change of as much as 50% of the rated output can be so closely and rapidly controlled that the departure from the preset speed can be limited to 0·0125% of the top machine speed.



Illustrated here is the second of the two main control consoles. This provides localized supervision of the complete drying system, including a closely-controlled warm-up programme for the M.G. cylinder

ddc

direct digital control

DIRECT digital control (d.d.c.) is the use of digital computing equipment to carry out the functions of conventional electronic two- and three-term controllers.

So-called conventional control implies the automatic regulation of a process variable, for instance a flow, to a set value, despite any changes in plant conditions. This is achieved by measuring the variable and computing the variance from the set value and then applying feedback to modify the control valve. Fig. 1 illustrates in simple form conventional control as is applied at present. In order to get smoother and more accurate control, proportional, integral, and derivative terms are introduced into the calculation of the feedback signal. Until recently these computations have been carried out in analogue form, either electronically or pneumatically.

Advances in transistor technology and simplifications in computer design have now made it possible to take advantage, at economic cost, of the greater speed and accuracy of digital computing equipment and to replace a large number of individual instrument loops by one central digital control unit. Fig. 2 shows a simple schematic diagram of a system of control using central digital control. This can either be an equipment designed exclusively for d.d.c., such as the Elliott Arch 101 Direct Digital Controller, or an all-purpose computer, such as the Arch 9000 System, programmed to spend a proportion of its time on d.d.c. calculations and the remainder on higher level control functions.

Although the first d.d.c. installations are to be found in the chemical and petroleum industry, these new techniques are rapidly gaining ground in other industries as processes become more complex. More and more control loops have to be interrelated, increasing the demand for multi-ratio and multi-cascade control.

The Arch 101 Direct Digital Controller, which is one of the two d.d.c. equipments, recently introduced, is designed to provide proportional or proportional-plus-integral non-interacting control functions on up to 30 control loops. It can also be expanded in modular form to provide control facilities for up to 100 loops or functions. Cascade control facilities and high and low limit alarm scanning are standard features. The programmes for these functions are wired into the machine on plug-in cards which can be replaced by other cards for solving additional control functions.

The Arch 9000 system, which is based on a stored-programme computer, the Elliott MCS 920, is designed to provide, in addition to the standard control functions, facilities for data logging, data reduction and for solving complex control problems.

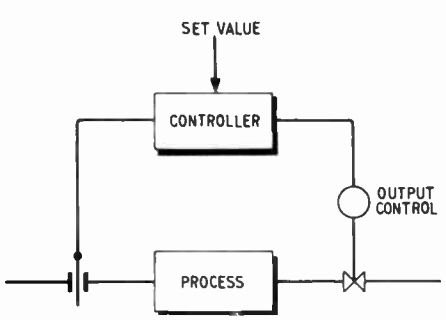


Fig. 1. A simple schematic diagram for a conventional controller and the associated system

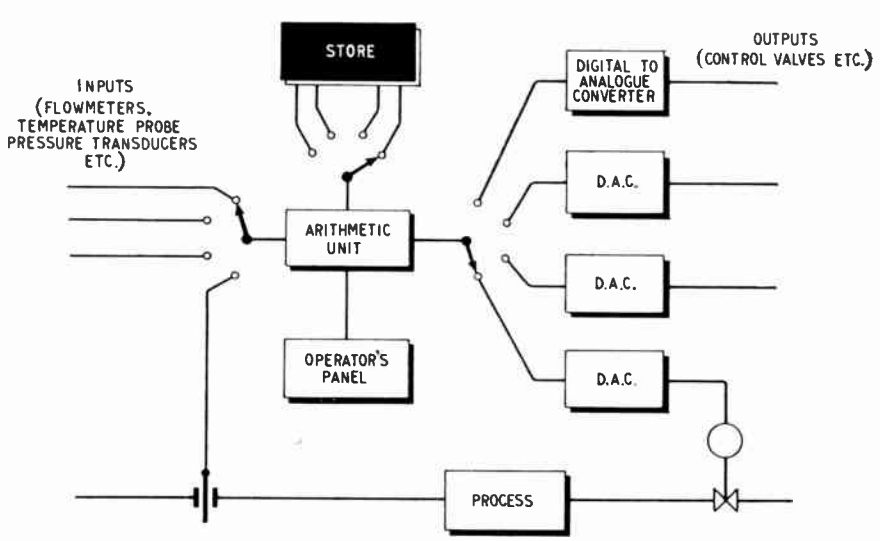


Fig. 2. In a simplified way this shows the direct digital control system

This standard Arch 101 direct digital controller can handle up to 30 control loops or functions

It has been estimated that the average total cost using conventional electronic controllers is about £400 per loop or single process to be controlled. Therefore, at £12,000 for a typical Arch 101, which can handle up to 30 loops, a 'break-even' point is reached.

The main advantages using this direct digital control approach are: (1) the control system is designed in module form and can be readily expanded to meet future needs and (2) with digital control signals already available the 101 d.d.c. can more readily be incorporated into an overall computer-controlled system.

New Technique for Depth Recording

The application of digital computer techniques to echo-sounding and depth recording has made possible the 'Contour', the latest addition to the Marconi Marine range of echo-sounders. Based on an amplifier-integrator (a simple form of computer which selects the signal received back from the seabed and applies an appropriate voltage to the recorder circuit) the 'Contour' records depths with an exceptional precision by means of a very fine marking on smudgeless paper. It is now being introduced after extensive trials by Shell International Marine, who have been using the first models in a series of experiments during recent months.

The recorder employs a heat-operated 'pen' to draw a continuous line on paper to produce a faithful reproduction of the contours of the seabed. At the same time a pointer above the chart aperture shows the depth against a fixed scale to provide a quick visual check at any moment. The 'Contour's' amplifier-integrator unit automatically rejects all echoes except those from the seabed, ensuring that only seabed echoes reach the recorder and that all other intervening targets, such as fish shoals, are ignored.

The requirement of Shell International Marine was for an echo-sounding installation that would enable them to carry out tests to determine under what conditions of trim, draught, speed, and ship's motion due to sea, large tankers could safely use shallow or restricted waterways. Such an installation would have to provide very precise depth measurement, demanding an echo-sounder of sharp discrimination, particularly at the shallow end of the depth scale.

After discussions with Shell International Marine Ltd., a special Marconi Marine installation was devised and fitted in the tanker 'Philine'. This was required to serve two purposes: (1) normal navigational echo-sounding, and (2) 'survey', the latter to give precise soundings not only at one point beneath the hull, but forward, aft, and on either side amidships. Four 48-kc/s projectors were therefore fitted, one towards each end of the 'Philine's' 725-ft length and one out towards each side of the bottom.

For normal navigational use one 'Contour' recorder, with a 'Metron' depth indicator also working from its amplifier-integrator unit, can be operated with either the forward or after projector. This installation operates on the standard 'Metron' depth ranges—2½ ft to 300 fathoms in three ranges—and sounds at the rate of 40 per minute.

Four more 'Contour' recorders are installed for 'survey' sounding, each connected to its individual projector—fore, aft, port, and starboard. These operate simultaneously on a single, specially shallow range of 1 ft 6 in. to 30 ft, with a discrimination of 0·2 in. per foot and at a rate of approximately 100 soundings each per minute. Their records show very precise soundings of the depth under each end and each side of the ship, giving under-keel clearances at the extremes of both the transverse and longitudinal axes of the vessel.

The 'Contour' readings are, of course, presented visually, but they are also fed into a 7-channel recorder which at the same time records the amounts of pitch, roll and heave so that these measurements can be correlated with those of depth beneath the four projector positions.

Electronic Sand Allocation

A NEW electronic sand control system, developed by Scientific Systems, has been installed in the foundry of Newman Industries. It eliminates production hold-ups by automatically working out priority of sand allocation to moulding machines.

At Newmans the moulding machines are supplied from a number of hoppers, each of which has an associated plough on a common sand feeding belt. When a plough is down it diverts all the sand from the belt into its associated hopper.

The problem in the past has been to keep all hoppers from running out of sand and to balance the sand supply with the random demands of the moulding machines.

This new equipment incorporates a scanning system, and probes and associated detectors in each hopper will indicate 'full' and 'below half-full'.

In operation the scanner rapidly interrogates each hopper in sequence until it finds one indicating 'below half-full'. The appropriate plough is then lowered for pre-set feeding period of time. At the end of this period the scanner proceeds with sequential interrogation, seeking the next hopper in need of sand as defined by the lower probe. In this way supplies to hoppers are automatically balanced with their demands, the more heavily used hoppers receiving more frequent feeding periods.

The feeding period is adjustable to suit the installation and is set large enough to prevent long sequences of re-iterative demands from the same hopper, but not so large as to make the scanning cycle too long should several hoppers be calling for sand.

Whenever the scanner completes a cycle of interrogation and finds no hoppers calling for sand the Priority Control adopts the 'bonus mode'. It then feeds the hopper last interrogated for a pre-set period of time, providing this was not signalling 'full'. The 'bonus-mode' persists until any hopper signals 'below half-full' or all hoppers are full.

Whenever a hopper signals 'full' during a feeding period, feeding stops immediately and the scanner proceeds.

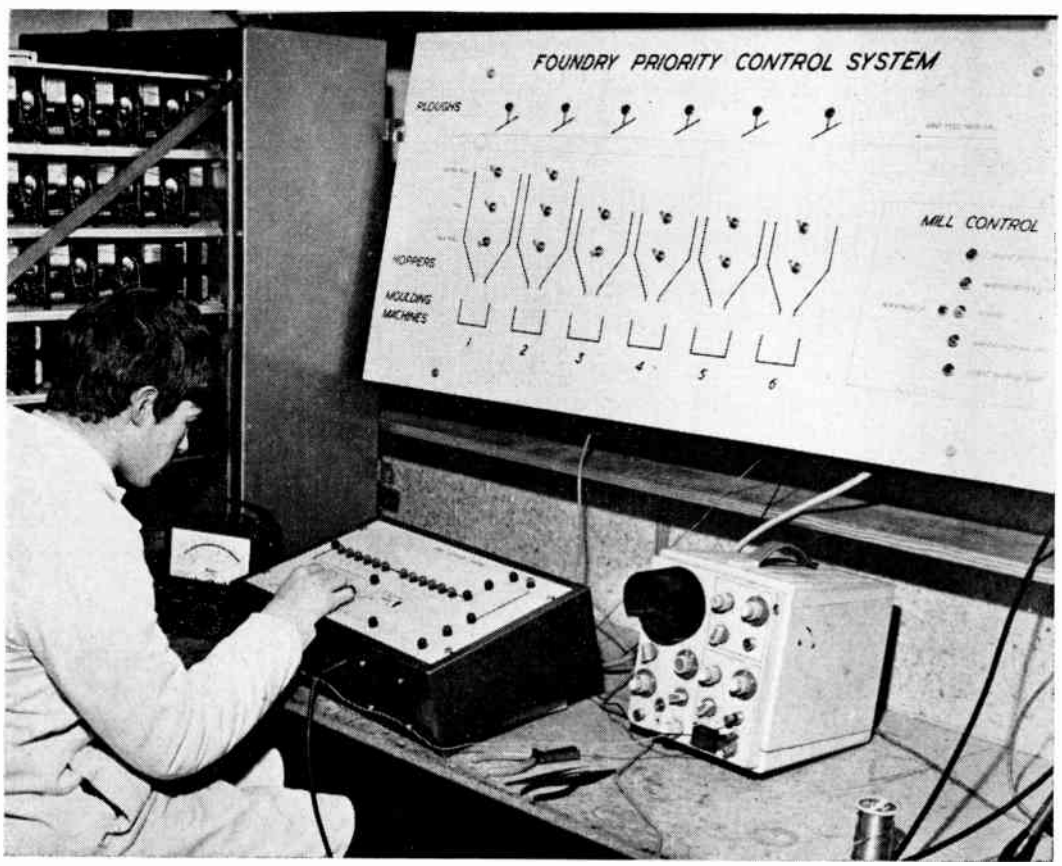
Thus the distribution of sand is optimized and priority of feeding is given on a time-sharing basis to all hoppers at or below half-full.

The installation can also be readily adjusted to accommodate more or less hoppers and hoppers can be temporarily switched out for cleaning or maintenance without interfering with normal operation of the rest of the system.

A visual summary of the state of the entire sand system is shown on a 'Mimic' panel in the manager's office. The panel incorporates warning lamps which give prior indication of impending breakdown or blockages at key points on the foundry conveyor layout. A counter, which derives signals from a photoelectric detector, also gives a running total of moulds produced.

The same basic system can be applied to many other industries where the distribution of granular products is involved.

For further information circle 43 on Service Card



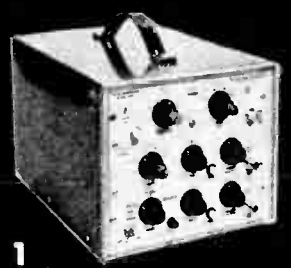
This shows the system undergoing the final test in conjunction with a specially constructed foundry simulator

A large part of the

WORLD'S MOST ADVANCED INSTRUMENTATION

is available in the U.K. — from one source.

We are showing here a very small part of that large part!



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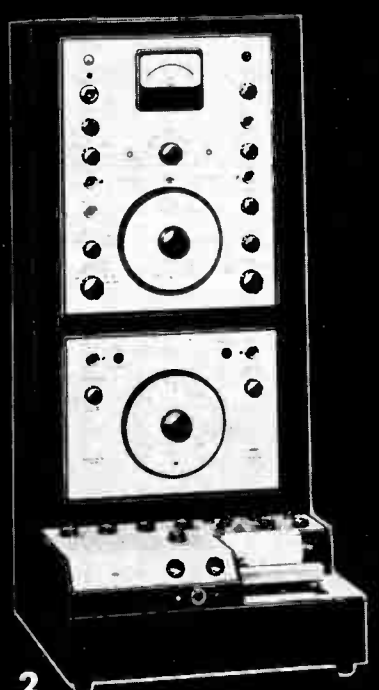

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If British electronic engineers are to keep pace with international competition, their most important need is for the type of equipment which is not only of the highest possible quality in design and construction, but also the most advanced of its kind for any given application.

B & K Laboratories, long aware of this fact, have specialized for many years now in seeking out such equipment in whatever part of the world it may be found, and making it available through one convenient source to British industry.

Hence today, a great many of the world's leading manufacturers of electronic apparatus are making use of this facility and we are showing here a small selection of typical types available.

1. The latest TEXAS INSTRUMENTS British Made pulse generator, an exceedingly versatile instrument.

2 & 6. BRUEL & KJAER automatic Spectrum Recorder and Sound Level Meter, built to a standard by which others are judged.

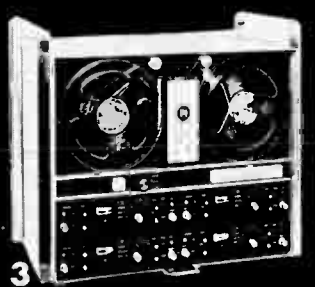
3. PRECISION INSTRUMENT's 6100 portable instrumentation tape-recorder—in a field of its own.

4. The DANA Digital Voltmeter, fastest reading, most versatile and most accurate in the world.

5. The PEEKEL portable Strain Gauge instrument, in use everywhere in modern industries.

7. DYTRONICS unique wide-range Phase Shifter and Generator.

8. LYREC special 7 channel Tape Recorder for Auto-correlation.



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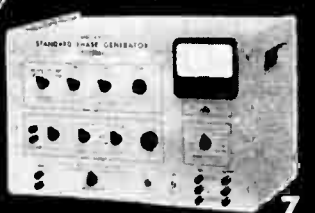

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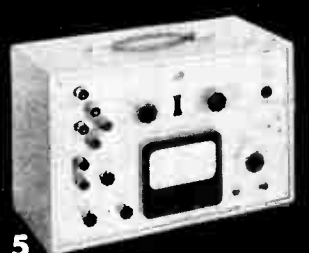

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INSTRUMENTATION · MEASUREMENT · TESTING & CONTROL EQUIPMENT

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Industrial News

Personal News

Following the recent take-over by Marconi Instruments Ltd., the W. H. Sanders (Electronics) Ltd. board is now completed with the appointment of **Prof. H. M. Barlow, Ph.D., B.Sc., F.R.S., M.I.Mech.E., M.I.E.E.** and **E. Eastwood, C.B.E., Ph.D., M.S.C., M.I.E.E.** Professor Barlow is Pender Professor of Electrical Engineering at University College, London, and is a member of the University College Committee. Dr. Eastwood is chief scientist and director of research for the English Electric Co. Ltd.

Three executive changes have been announced by Standard Telephones and Cables Ltd. With these changes **Alister D. Mackay** becomes managing director of the company and in this capacity, he will also function as chief executive officer of S.T.C. **Sir Thomas Spencer** has been appointed the first honorary president of S.T.C. and has resigned as chairman of the company. He is succeeded as chairman by **Rex B. Grey,** who moves from the post of managing director.

Dudley Saward, O.B.E., has been appointed the new general manager of S.T.C. consumer products division. Until recently he was managing director of Rank-Bush-Murphy Ltd.

In his new capacity as manager, Engineering Services, at the Witton, Birmingham, works of G.E.C., **K. C. Parton, B.Sc.(Eng.), A.M.I.E.E.,** will retain responsibility for engineering computer services and will also assume responsibility for the consultant's and commercial computer departments and for the Witton development laboratories and chemical and metallurgical laboratory.

I.B.M. United Kingdom Ltd. have announced the following appointments to the board of directors of I.B.M. United Kingdom Rentals Ltd. **G. van der Woude** is the sales manager, data processing division, and **N. E. Hearson** becomes divisional manager, office products division. **D. J. N. Stirten** and **M. A. Hynes** are appointed director of staff services and director of finance and administration respectively, with **J. R. Bache** as director of data processing manufacturing and service. The new field sales manager, data processing division, is **E. R. Nixon.**

David Mortimer, manager of public relations of IBM United Kingdom Ltd. for the last three years, has been appointed manager of internal communications at the Paris headquarters of IBM World Trade Europe Corporation. He has been succeeded as IBM's manager of public relations in the U.K. by **David Farrow.**

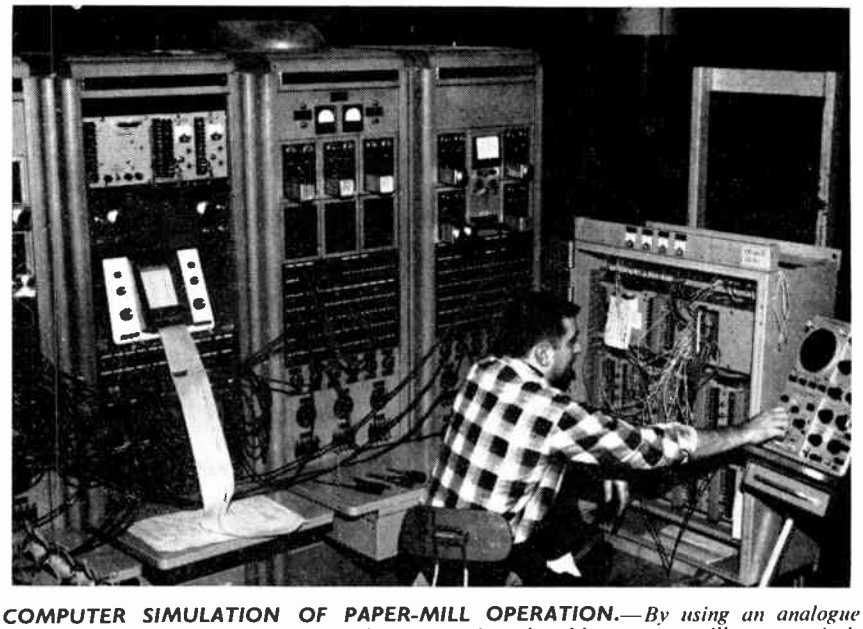
Among four new vice presidents elected by the board of directors of I.T.T. Europe Inc. are **J. David Barker,** public relations director, and **John D. Clare,** technical director. The election has also been announced of **Frank W. Stoneman** as a director. I.T.T. Europe Inc. is the European headquarters of I.T.T. in Brussels.

Westool Ltd., of Bishop Auckland, have announced the following senior managerial appointments. **A. C. Stewart** and **D. Ridell** become joint assistant managing directors. **A. G. Why** assumes the post of secretary and financial controller. Two former assistant chief engineers, **B. Baglee** and **B. Barton** have been appointed chief engineer and deputy chief engineer respectively. Promotion to marketing and sales manager has been given to **T. C. Walker.**

Two new appointments to the Board of The Chloride Electrical Storage Co. Ltd. are **E. Honey, M.B.E., B.Sc.,** and **J. A. Hunt, M.B.E.** Both have served the Chloride Group for many years and are directors of some of the subsidiary companies.

On the resignation of **Mr. Jean Riboud,** who has been appointed president of Schlumberger Ltd., **E. R. Ponsford** takes the post of chairman and managing director of the Solartron Electronic Group Ltd. E. R. Ponsford is one of the founders of Solartron.

Rank Taylor Hobson has appointed **F. Cooper** as marketing manager of precision instruments and **T. Schofield** is promoted to marketing manager of optics.



COMPUTER SIMULATION OF PAPER-MILL OPERATION.—*By using an analogue computer to simulate every aspect of an operating closed-loop paper-mill system, it is now possible to test process-regulating equipment before installation.*

The T-100 regulator, manufactured by the Westinghouse Industrial Systems Division and shown facing the operator, provides control of speed, voltage, torque, tension or position (as required by the process). The simulator (on the left) is adjusted to represent such quantities as tachometer voltage, load inertia and friction, sheet tension, swing roll position and the electrical equivalents of the power supply, motors and generators. These variables are then fed, as electrical analogues, into the regulator to check its performance

S. Gibson and **Ray Taylor** have joined the Sales Engineering Department of The M-O Valve Co. Ltd. Mr. Gibson will cover the sale of transmitting and general industrial valves, and Mr. Taylor microwave valves and components.

D. Bates has joined the Small Transformer Division of Gresham Transformers Ltd., as production manager. His first responsibility will be to supervise the reorganization of Gresham's Hanworth factory.

Baldwin Fluid Power Ltd. announce the appointment of **R. A. Moule** as technical sales representative. He will be responsible for sales in Warwickshire, Staffordshire, Worcestershire, Shropshire and part of Wales.

Now assuming overall responsibility for Sales, **J. D. Hayden** becomes sales director of Electrosil Ltd. Formerly he was with Plessey as sales manager of electronic components.

G. R. Ireland is the new general manager of Ultra Electronics (Components) Ltd. Since 1963 he had been project manager for Ether Langham Thompson, a position he is relinquishing to take up his new duties with Ultra.

P. N. Delves Broughton has succeeded **Dr. M. C. Field** as manager, rubber and plastic cable division of S.T.C., Newport. **G. E. Sparkes** has been appointed site manager.

John Waller has been appointed publicity manager of Decca Radar Ltd. He succeeds **H. L. A. Foy,** who is to take up a senior position in connection with the marketing of the company's industrial electronic products.

R. Lomas has been appointed manager, sales and contracts, of The English Electric Company's fusegear division, Liverpool. Prior to this he was manager of English Electric's Ipswich branch office, holding this post up to his recent appointment

R. W. Atkinson has been appointed general manager at R. & J. Beck Ltd. Formerly he was with Rank, Taylor, Hobson, Kershaw, where he held the position of general works manager.

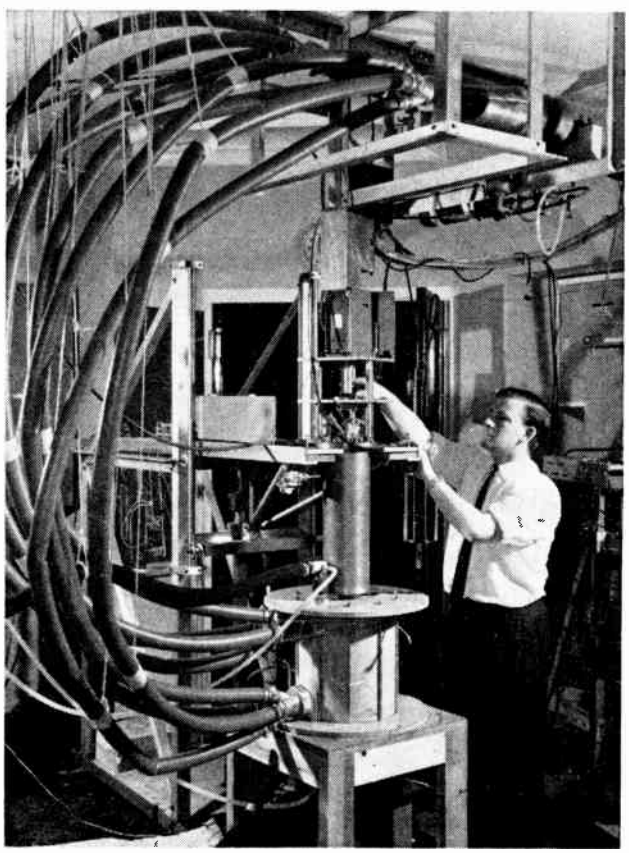
J. W. Clift, A.F.R.Ae.S., has been appointed general sales manager, Vactric Control Equipment Ltd. He will be co-ordinating both the internal and external sales activities for the additional ranges of servo and other components which the company is now marketing.

International Rectifier Europe S.A. at Brussels have appointed **E. Strauss** as general sales manager. Mr. Strauss was previously director and general manager of one of MI's wholly-owned subsidiaries, Taylor Electrical Instruments, of Slough. **John Minister,** sales manager, has succeeded him as general manager at Slough while retaining his sales responsibilities.

R. D. Gardiner has been appointed assistant managing director of Evershed & Vignoles Ltd., a subsidiary of George Kent Ltd. Mr. Gardiner joins the Evershed & Vignoles board after holding a senior appointment with Central Electricity Generating Board for the past six years.

The Manufacturers Equipment Co. Ltd. (a J. H. Fenner company) announce the appointment to their board of **J. I. Davies** who will be works director. Mr. Davies joined the company in 1960 as works manager.

J. R. Humphreys is now the general manager of the industrial products group of A. C. Cossor Ltd. Mr. Humphreys will be responsible for the operations of the Cossor Instrument Company, Cossor Communications Company, Best Electrics and Cossor Valve Company. He succeeds **J. F. Eldredge** who is returning to the United States.



THE MULLARD CRYOMAGNETIC LABORATORY AT OXFORD.— *Recently inaugurated at Oxford University's Clarendon Laboratory, equipment financed by the Mullard Company and the D.S.I.R. (now the Science Research Council) will enable research to continue into the study of nuclear orientation and nuclear cooling in magnetic fields of up to 140 kilogauss.*

The name 'cryomagnetic' means cold and magnetic. With strong magnetic fields, low temperatures can be produced (magnetic cooling, nuclear cooling); with low temperatures, strong magnetic fields can be achieved more easily (e.g. super-conducting solenoids); and finally, low temperatures and high magnetic fields combine to remove molecular disorder.

The picture shows apparatus for optical studies being adjusted, using one of the 80-kilogauss magnet coils

Company

Semtech Inc., of Newbury Park, California, and **Bourns Inc.,** of Riverside California, have jointly announced the conclusion of a marketing agreement providing the promotion, sales and distribution of the full line of Semtech products in Western Europe and Israel by Bourns A.G., of Zug, Switzerland. Semtech specialize in the production of silicon rectifiers and bridges.

Ferranti Ltd. have entered into an agreement with **SAGEM (Société d'Applications Générales d'Electricité et de Mécanique),** of Paris, whereby the two firms will pool their knowledge and experience in the design and development of aircraft navigation systems and components. An inertial system, developed and manufactured by SAGEM and Ferranti, has been chosen by Sud Aviation (joint constructor of the Concorde with B.A.C.) for equipping the Concorde.

Simmonds Relays Ltd. have now completed their move from Harlow, Essex, and their new address is St. Asaph's Avenue, Kimmel Bay, Nr. Rhyl, Flintshire, N. Wales (Phone: Rhyl 895).

The Plessey Co. Ltd. is to set up a new Automation Group at Poole, in Dorset. H. E. C. Nash is the director of the Group, which is expected to comprise the four main divisions of data handling, data processing, traffic management and automation accessories.

B & K Laboratories Ltd. have opened an additional sales and service department on the Bradshaw Trading Estate, Manchester (Phone: Middleton 7109). Alan Gibson, B & K's Northern representative, will be in charge of the new branch.

Multicore Solders Ltd., have now changed their telephone number from Boxmoor 3636 to Hemel Hempstead 3636.

The two major close-circuit television marketing organizations in the Pye Group—the Industrial Division of Pye Telecommunications Ltd. and the H.D.T. Co.—have been merged into one company, **Pye H.D.T. Ltd.** This company, whose initials stand for high-definition television, will plan, manufacture and sell c.c.t.v. equipment for industry, commerce and education.

The A.E.I. Telecommunications Group are soon to start building two new factories in Scotland to meet the increase in purchases by the G.P.O. and general world-wide demands in the telecommunication field. The Group expects to double its manufacturing capacity for telephone-exchange equipment by 1966/67.

Painton & Co. Ltd., the electronic component manufacturers of Northampton, have acquired the whole of the issued share capital of **Elcom (Northampton) Ltd.**, manufacturers in the same field. C. M. Benham continues as chairman of the Painton Group, while W. S. Cator remains a director of Elcom.

An agreement has been concluded between **E. & M. Laboratories**, of North Hollywood, California, and **James Scott (Electronic Engineering) Ltd.**, Glasgow, Scotland, for the sale in the U.K. of the microwave components produced by E. & M. Laboratories. These components include ferrite modulators, circulators, multiplexers, couplers, switches, filters, isolators and attenuators, etc., both coaxial and waveguide.

The new address of **D. Robinson and Co. Ltd.**, distributors of Rodene Timers and C. and S. Relays, is Victoria House, 44 Park Street, Camberley, Surrey. Telephone: Camberley 25501.

***SOLID-STATE S.H.F. TELEVISION LINKS.**—The B.B.C. will soon be using all solid-state portable television-link equipment, operating in the 7-Gc/s band, for outside broadcast purposes. Designed by Microwave Associates Ltd., of Luton, the new microwave equipment (type MLV 7000) is the first of its kind to be manufactured in the U.K. and meets the requirements of B.B.C. specifications.*

It provides main and standby facilities into a single aerial system and non-demodulating repeaters may be used at intermediate points. The transmission characteristics of the link equipment enable either monochrome or colour television signals to be satisfactorily transmitted

Benson-Lehner, of West Quay Road, Southampton, has announced the formation of a new division, known as the Digital Systems Division and operating from their head office. It comprises a technical advisory and design team, integrated with technical sales. Products currently being handled are high-speed data-acquisition systems, a range of high quality d.c. amplifiers, analogue-to-digital converters, digital-to-analogue converters and multiplexers.

Scientific Systems Ltd., a subsidiary of Educational and Scientific Developments Ltd.—the new Group recently formed as a branch of the Imperial Tobacco Co.—has taken over the electronics division of Newman Industries Ltd., the Yate electric motor producers. The company uses standardized plug-in units to produce a range of special-purpose electronic instruments which cover the whole field of supervisory and control systems, industrial process control and computers.

Remington Rand have opened a new bureau in London to provide a complete service for the microfilming of engineering drawings and office documents. The address of this bureau is Remington House, 65 Holborn Viaduct, London, E.C.1. Telephone: Central 1010.

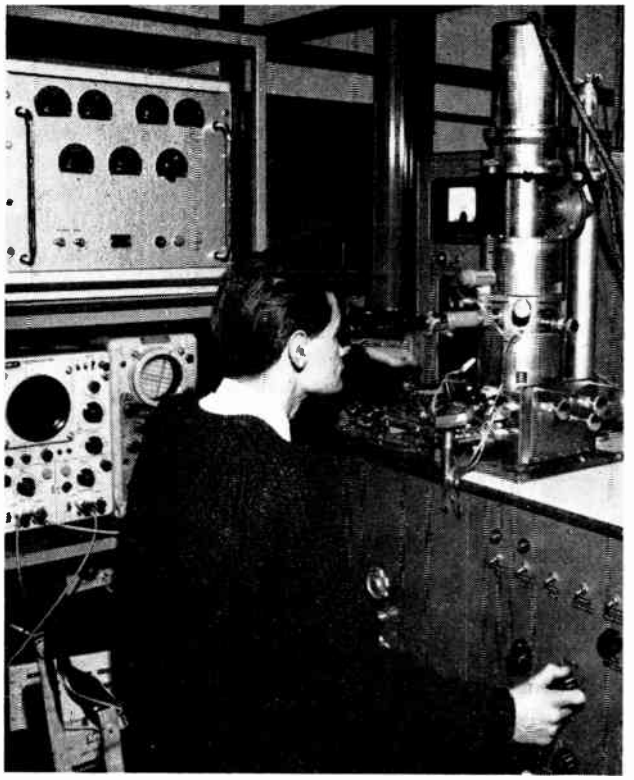
Redifon Ltd., of London, and **Astrodata Inc.**, of California, have announced the formation of a new company to be known as **Redifon-Astrodata Ltd.** Its object will be to manufacture specialized computing and other electronic devices at an extension of the Redifon flight-simulator plant in Crawley, Sussex.

J. Hengstler Co. Great Britain Ltd. have moved from Highbridge Street, Waltham Abbey, Essex, to a new factory at Brooker Road, Waltham Abbey. The telephone number remains the same, Waltham Cross 26166.

Anglo-French Computer Project

A proposal for a joint Anglo-French project for a large computer has been submitted to the Minister of Technology by English-Electric-Leo-Marconi Computers Ltd. and International Computers & Tabulators Ltd. A similar proposal is being submitted to the French Government by the Compagnie pour l'Informatique et les Techniques Electroniques de Controle (CITEC).

The aim of the project is to develop a large computer system which is capable of handling the largest computations (in, for example, astronomy



ELECTRONICALLY-CONTROLLED MACHINING.—*Electron-beam machining equipment, developed at the Allen Clark Research Centre of the Plessey Co. Ltd., is now being used to study methods of fabricating silicon solid-state circuits.*

The system can be electronically controlled to enable delicate machining operations to be carried out and, in particular, it has been used for preliminary studies of the methods of making high-tolerance thin-film resistors for use in solid-state circuitry

and meteorology) and also for computing large scale service work, for which there will be a great demand in the future.

Transatlantic Data Transmission

After its successful operation in Britain, the Post Office's DATEL 600 service, which sends coded information for computers over the public telephone network, has now been extended across the Atlantic; the Post Office is at present negotiating with European countries to extend the service to the continent.

For use over international circuits (as with the inland ones), the Post Office supplies a unit known as DATEL Modem 1A, which converts data signals into a form suitable for telephone-line transmission and provides data transmission in the 600–1,200 bits per sec speed range.

Numerical Control of Machine Tools

The National Engineering Laboratory is setting up a new division to help British industry in programming numerically-controlled machine tools. It is to examine and develop programmes for all the main types of machining operations and the information and expertise acquired will be made freely available to industry.

Divisional Organization of E.E.A.

The council of the Electronic Engineering Association has established a divisional organization with the aim of expanding, through collective action between the Association's member companies, the markets (both at home and overseas) for British electronic capital equipment.

The divisions will be for aviation, space, maritime, computers, industrial electronics, radio communications and broadcasting. They are intended to provide a forum for the discussion of matters of mutual interest and for the initiation and execution of collective activities in political, commercial or technical fields.

Service to Industry and Research

A new service to industry and research has recently been launched by C & N (Electrical) Ltd., of Gosport. To all types of enquirers the services of a team of designers are available for solving automation problems in the general fields of sequential control, data processing and logic circuitry. Problems can be analysed and converted to practical propositions, and then equipment can be manufactured and installed.

Research on Industrial Automation

The British Scientific Instruments Research Association (SIRA) has been awarded a 'general purposes' grant by the Ministry of Technology for work on industrial instrumentation and control. With the grant, SIRA will become a centre for research on industrial automation and, with other research associations, will provide the necessary link between user industries, instrument makers and control experts.

Ultrasonic Test System

The Ultrasonoscope Co. (London) Ltd., recently installed an automatic ultrasonic testing system at the Gennevilliers Works of S.N.E.C.M.A.; it will be used to inspect the turbine discs of the Olympus engines for the Concord supersonic airliner.

The system consists of an immersion tank fitted with a revolving turntable, over which a gantry traverses; a column carrying an immersion probe is attached to the gantry.

The turntable is rotated as the gantry is driven along the tank and gives a spiral scan of the disc surface; an ultrasonic flaw detector, with a dual channel alarm unit, gives automatic flaw recording on a double-pen two-colour circular recorder. All operations are remotely controlled from one panel by illuminated push buttons, which are interlocked for safety.

R.T.E.B. Dinner

To celebrate its twenty-first anniversary as an examining body in radio, television and electronic servicing, and the founding of the Society of Electronic and Radio Technicians, the Radio Trades Examination Board is to hold a dinner at the Connaught Rooms, Great Queen Street, London, W.C.2, on Tuesday, 12th Oct.

Correction

We have been asked to correct some statements which appeared in the article 'A Survey of some Audio-Visual Teaching Aids' which appeared in the August issue (p. 504) of *British Communications and Electronics*. This issue was one prior to the incorporation of that journal with *Industrial Electronics*.

In the reference to the Educational Systems Ltd. machine it was stated that it is a linear machine and that it is not easily programmed by the user. This firm informs us that it is not a linear machine but incorporates a branching system. Also it claims that it is easy to programme but not easy for the user to photograph without a special jig. Furthermore, the machine is not for hire only, but for sale at a cost of around £250.

In the reference to the Shipton Tutor it was stated that this apparatus was designed jointly by Shipton Automation and Telefunken A.G. and that it is equipped with the Telefunken tape deck. We are informed by Shipton Automation (Manufacturing) Ltd. that this is incorrect and that the Tutor was designed by Shipton Automation; also that while the tape deck originated from Telefunken it has been considerably modified.

NEW BOOKS

The Analytical Engine

By JEREMY BERNSTEIN. Pp. 127. Secker & Warburg Ltd., 14 Carlisle Street, Soho Square, London, W.1. Price 16s.

Based on a series of articles written for *The New Yorker*, this book about computers is intended primarily for laymen and is non-technical in its 'popular' approach to the subject.

The history of computers is traced in relation to the men who influenced their development, and an account of the programming and capabilities of computers is given. Such topics as the similarity between computers and the human brain, machine languages and the ways in which computers have served industry and science, are all discussed clearly and engagingly.

Electronic Equipment in Industry

By W. D. GILMOUR, B.A.(Oxon), A.M.I.E.E. Pp. 265. Iliffe Books Ltd., Dorset House, Stamford Street, London, S.E.1. Price 50s.

This book provides a thorough guide to the design and operational techniques and principles involved in the industrial applications of electronic instrumentation and control equipment. Practical in its approach, the treatment is descriptive and non-mathematical and all aspects of the subject are examined clearly, concisely and in logical order. The book includes a large number of diagrams and, to illustrate the text, many typical circuits and applications are discussed.

Fundamentals of Relay Circuit Design

By ALAN R. KNOOP. Pp. 312 + vii. Chapman & Hall Ltd., 11 New Fetter Lane, London, E.C.4. Price 120s.

Beginning with a description of the various different types of relays and their operating characteristics, this American book continues with an explanation of basic circuit-design concepts, stressing the logical basis upon which complex systems rely. The major portion of the book examines, with copious circuit diagrams, typical systems in different control fields and shows how many of the problems in one field are similar to those in others. Throughout the book, stress is laid upon the economy and efficiency of relay control and practical advice on design and maintenance is given.

Radio Research 1964

Pp. 37 + vi. Published for the Science Research Council by Her Majesty's Stationery Office, York House, Kingsway, London, W.C.2. Price 4s. 6d.

This is the annual report of the Radio and Space Research Stations, Ditton Park, Bucks.

Guide to the Specification and Purchase of Electronic Equipment for Industrial Systems

Pp. 19. Published by The British Electrical and Allied Manufacturers' Association, 8 Leicester Street, Leicester Square, London, W.C.2. Price 21s.

This guide has been prepared by the Industrial Control and Electronics Division of BEAMA. It is intended to help both the customer and the manufacturer to ensure that all the necessary conditions for the successful specification of the full requirements of a system are initially known by both parties, and that at the conclusion of the contract adequate predetermined tests can confirm that these requirements have been met.

Copper-Clad Synthetic-Resin Bonded Laminated Sheet: For Use in Telecommunication and Allied Electronic Equipment

B.S. 3888 : 1965. Pp. 30. The British Standards Institution, 2 Park Street, London, W.1. Price 8s. 6d.

This Standard has been published to give the requirements for epoxide resin bonded glass fibre laminated sheet and phenolic resin bonded paper laminated sheet, which are for use as base materials in printed wiring.

It specifies preferred nominal thicknesses and tolerances, weights per unit area and conductivities of copper foil, and lays down limits and tests for mechanical and electrical properties. A simple statistical method of defining levels of quality is incorporated in this publication.

European Miniature Electronic Components and Assemblies Data, Part 1, Germany and Italy : 1965-66

Edited by G. W. A. DUMMER, M.B.E., M.I.E.E., Sen. Mem. I.E.E.E., M.I.E.R.E., and J. MACKENZIE ROBERTSON. Pp. 1193. Pergamon Press, Headington Hill Hall, Oxford. Price £12 10s.

Part one covers the products (small electronic components) of Germany and Italy. Special features include a glossary of microelectronic terms, in six languages, some two hundred and fifty selected abstracts relating to the components and assemblies field and a number of tables, charts and applications formulæ.

Principles of Inverter Circuits

By B. D. BEDFORD and R. G. HOFT. Pp. 413 + xvi. John Wiley & Sons Ltd., Glen House, Stag Place, London, S.W.1. Price 96s.

This is a comprehensive and authoritative volume on solid-state inverters explaining in full the fundamental principles and techniques of inverter circuits.

Technical Dictionary of Television Engineering and Television Electronics

By PETER NEIDHARDT. Pp. 340. Pergamon Press, Headington Hill Hall, Oxford. Price £7.

This is a technical dictionary in English, German, French and Russian.

Computing Methods, Vols. 1 and 2

By I. S. BEREZIN and N. P. ZHIDKOV. Translation from the Russian by O. M. Blunn. Pp. 464 + xviii and 679 + xv. Pergamon Press Ltd., Headington Hill Hall, Oxford. Price £5 the set.

Dynamic Systems Analysis

By SAMUEL SEELY. Pp. 514 + xiii. Reinhold Publishing Corp., U.S.A., available in the U.K. from Chapman & Hall Ltd., 11 New Fetter Lane, London, E.C.4. Price 88s.

This book has been written to meet the needs of the engineering students at Case Institute of Technology in their introductory work in dynamic systems analysis. Dynamic systems analysis relates to the responses of interconnected systems of lumped linear elements to any of a wide range of excitation functions.

Theory of Sampled-Data Control Systems

By DAVID P. LINDORFF. Pp. 305 + xiv. John Wiley & Sons Ltd., Glen House, Stag Place, London, S.W.1. Price 81s.

The text is aimed at the reader who has a background of at least one course in automatic control and some familiarity with complex function theory.

Design Theory and Data for Electrical Filters

By J. K. SKWIRZYNSKI. Pp. 701 + xxviii. D. van Nostrand Co. Ltd., 358 Kensington High Street, London, W.14. Price £8 10s.

This gives a detailed treatment of electric filter networks having Chebyshev response in pass and attenuation bands.

The Analysis and Design of Electronic Circuits

By PAUL M. CHIRLIAN. Pp. 570 + xviii. McGraw-Hill Publishing Co. Ltd., Shoppenhangers Road, Maidenhead, Berks. Price 94s.

Electronic Amplifiers for Automatic Compensators

By D. YE POLONNIKOV. Translated from the Russian by Rita R. Inston. Pp. 324 + xii. Pergamon Press Ltd., Headington Hill Hall, Oxford. Price 80s.

Radio and Audio Servicing Handbook

By GORDON J. KING, Assoc.I.E.R.E. Pp. 256. Odhams Books Ltd., 96 Long Acre, London, W.C.2. Price 25s.

Industrial Isotope Techniques

By LARS G. ERWALL, HANS G. FORSBERG and KNUT LJUNGGREN. Pp. 338. Munksgaard International Booksellers & Publishers Ltd., 47 Prags Boulevard, Copenhagen S, Denmark. Price 120 Dan. Kr.

Manufacturers' Literature

The Temblehorough Electric Melting Shop. In a 12-page brochure produced by Steel, Peech and Tozer, to mark the completion of their electric melting shop (Spear project), the processes in the melting shop are described and illustrated. Many aspects of this new plant are dealt with from the electronic central control to the railway system serving the melting shop.
The United Steel Companies Ltd., The Mount, Broomhill, Sheffield, 10.

For further information circle 44 on Service Card

Counting and Measuring. Trumeter Co. Ltd. have produced a catalogue of 16 pages (No. 65) which deals with various counting and measuring devices manufactured by them. An index provides for ease of reference to particular instruments and illustrations and specifications are included as well as a price list.
Trumeter Co. Ltd., Milltown Street, Radcliffe, Manchester.

For further information circle 45 on Service Card

Beryllium Copper Alloys. This 28-page booklet, publication No. TP10-165, provides an introduction to the constitution and characteristics of beryllium copper before discussing in greater detail, and with full specifications, the various alloys available, components manufactured and applications recommended. Illustrations and tabulated physical properties are presented clearly and several treatment techniques are described.
Telcon Metals Ltd., Manor Royal, Crawley, Sussex.

For further information circle 46 on Service Card

Aeronautical and Electronic Instruments. A 28-page catalogue which lists a selection from the supplier's range of servo equipment, magslips, blower motors, transistors, diodes and rectifiers. Manufacturers, specifications and price are all given and each component is illustrated.
Lind-Air (Supplies) Ltd., 53 Tottenham Court Road, London, W.1.

For further information circle 47 on Service Card

Timing Equipment Selection Charts. Two charts are available to enable a quick and accurate choice to be made from Elremco's range of dial and camshaft timers. They will facilitate rapid analysis of such factors as duty, time range, rating, optional extras, etc.
Electrical Remote Control Co. Ltd., The Fairway, Bush Fair, Harlow, Essex.

For further information circle 48 on Service Card

Oil Hydraulic Equipment. For users of hydraulic units, this 16-page, fully illustrated catalogue of pumps, motors, valves and power units gives the essential ratings of the B & G components available, together with the J.I.C. symbols for the different types of valve.
B and G Hydraulics Ltd., 20 Northbrook Road, Worthing, Sussex.

For further information circle 49 on Service Card

Heat Sinks for Semiconductor Power Rectifiers and Thyristors. This booklet lists and illustrates ranges of cast aluminium heat sinks ready-drilled to take standard semiconductor studs; it includes power dissipation curves, which show the conditions for convection cooling and forced-air cooling.
STC Semiconductor Division (Rectifiers), Edinburgh Way, Harlow, Essex.

For further information circle 50 on Service Card

Baldwin's Photometers and Densitometers. Photometers and densitometers are described and their applications discussed in this 7-page leaflet (No. 117). Specifications and indications of sensitivity are provided.
Baldwin Instrument Co. Ltd., Dartford, Kent.

For further information circle 51 on Service Card

Industrial Heating Catalogue. Detailed technical information on a wide range of industrial surface heating equipment is given in this 32-page catalogue, publication number 436. The applications of this equipment, which is available for standard or special heating applications, cover frost protection and temperature maintenance of pipe-lines, collapsible ovens and heavy duty heating equipment for plant heating or stress relieving.
Electrothermal Engineering Ltd., 270 Neville Road, London, E.7.

For further information circle 52 on Service Card

Gresham Magnetic Recording Heads. This is a 30-page book containing the A4 series of data sheets which describe the range of magnetic recording heads for computers, data recorders, simulators and magnetic drum information storage. Complete specifications are given.
Gresham Lion Electronics Ltd., Twickenham Road, Hanworth, Middlesex.

For further information circle 53 on Service Card

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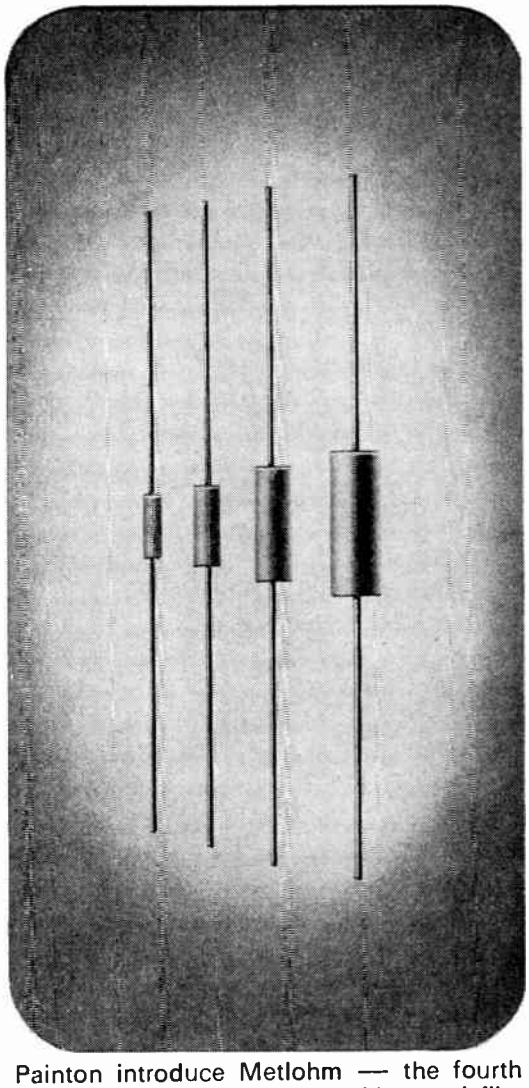

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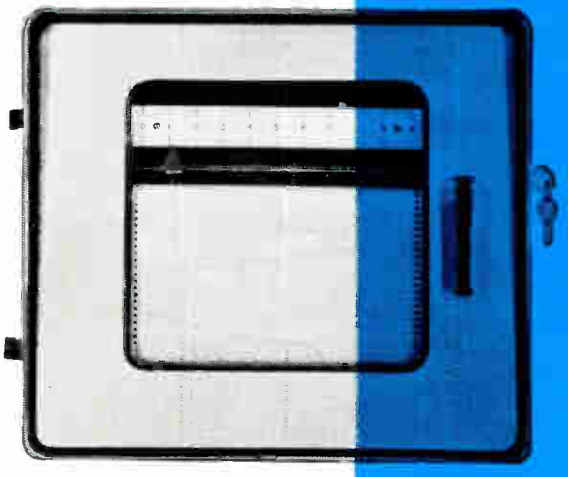

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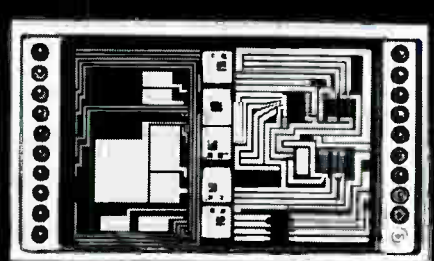

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MULTILIN—is a miniature encapsulated sub-system, designed for linear applications, using silicon integrated circuits and thin film components. As many as 50 semiconductors with their associated passive components can be housed in one miniature unit. ☐ HIGH RELIABILITY—is ensured by careful control of the processes and the virtual elimination of hand made joints. ☐ NOW—a range of servo amplifiers and low drift D.C. amplifiers etc. is available as standard. Circuits can be produced in Multilin to your special requirements at a competitive price.

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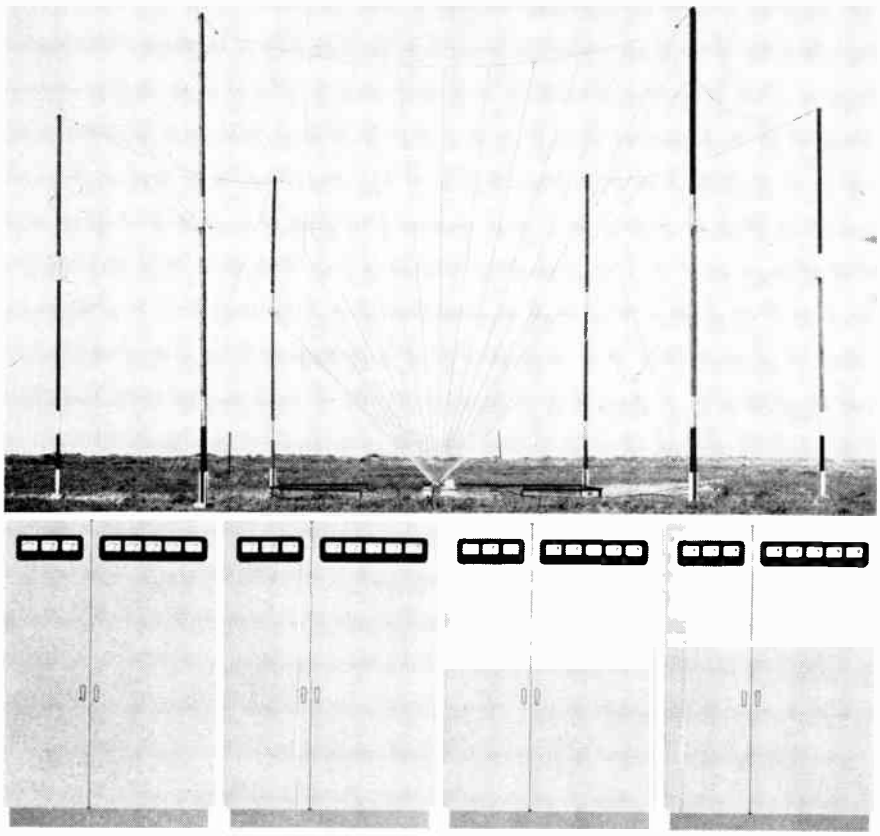

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Frequency measurements to 40Mc/s or 100Mc/s with TCD40 or TCD100 frequency dividers.

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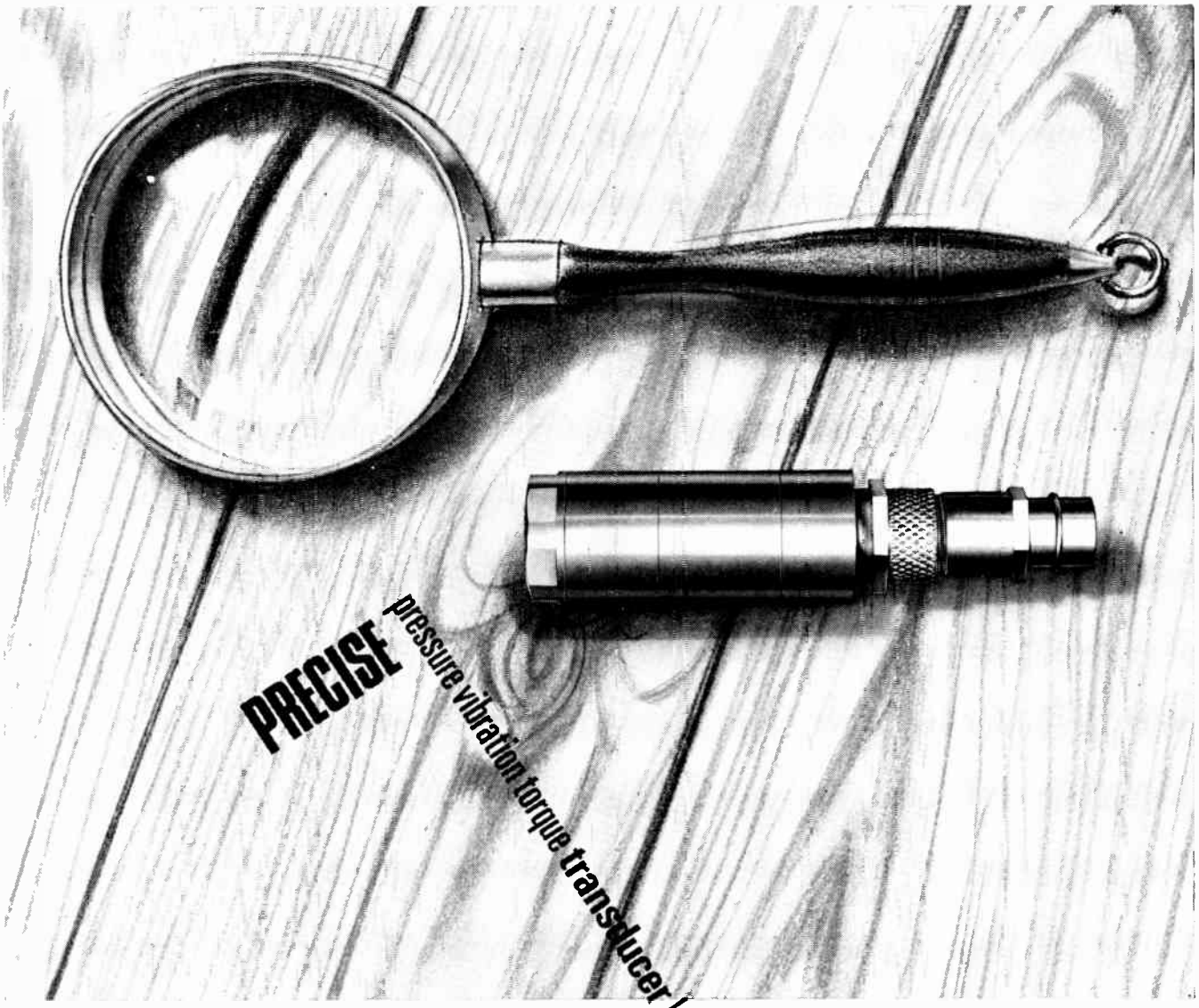

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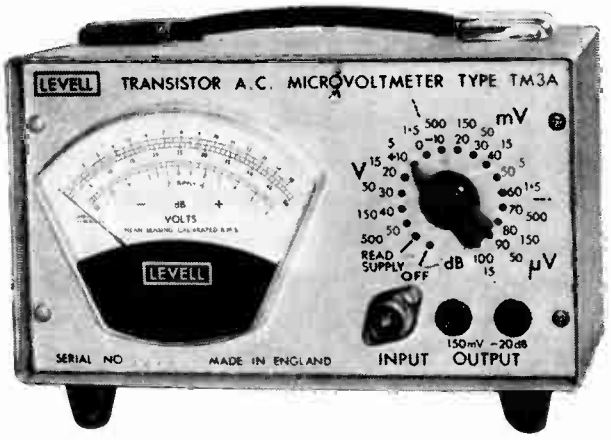

TYPE TM3A

Can be used as an A.C. Voltmeter or A.C. Amplifier. The frequency response extends from 1c/s to 3Mc/s. Sixteen ranges are provided in 10dB steps from 15μV f.s.d. to 500V f.s.d. with selection by a single rotary switch which also has "Off" and "Read Supply" positions.
Ideal as an oscilloscope preamplifier as it has a low noise level, low microphony, no hum and is independent of a mains supply.

SPECIFICATION

VOLTMETER RANGES
15μV, 50μV, 150μV ..... 500V f.s.d. linear black meter scales.

ACCURACY
1.5% 1.5% f.s.d. 1.5μV at 1kc/s.

dB RANGES
100dB to 50dB in 10dB steps with red meter scale from −20dB to +6dB relative to 1mW into 600Ω.

INPUT IMPEDANCE
Above 50mV, 4.3MΩ and 20pF.
On 50μV to 50mV, 3MΩ and < 40pF.
On 15μV, 1MΩ and < 100pF.

FREQUENCY RESPONSE
On "mV" and "V" ranges: 3dB from 1c/s to 3Mc/s.
0.3dB from 4c/s to 1Mc/s.
On 500μV: 3dB from 2c/s to 2Mc/s.
On 150μV: 3dB from 4c/s to 1Mc/s.
On 50μV: 3dB from 8c/s to 500kc/s.
On 15μV: 3dB from 20c/s to 200kc/s.

AMPLIFIER OUTPUT
150mV at f.s.d. on the 15μV range corresponding to a gain of 80dB.
Output may be connected to a load of 100kΩ and 50pF with negligible loss of accuracy of frequency response.

MAXIMUM INPUT VOLTAGES
On 15μV to 50mV ranges: 250V D.C., 100V A.C. up to 20 kc/s, 30V A.C. above 20kc/s.
On 150mV to 500V ranges: 750V A.C. peak plus D.C.

INPUT NOISE LEVEL
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One type PP9 battery, life 1000 hours.

SIZE AND WEIGHT
5" x 7¼" x 4½". 4¼lbs.

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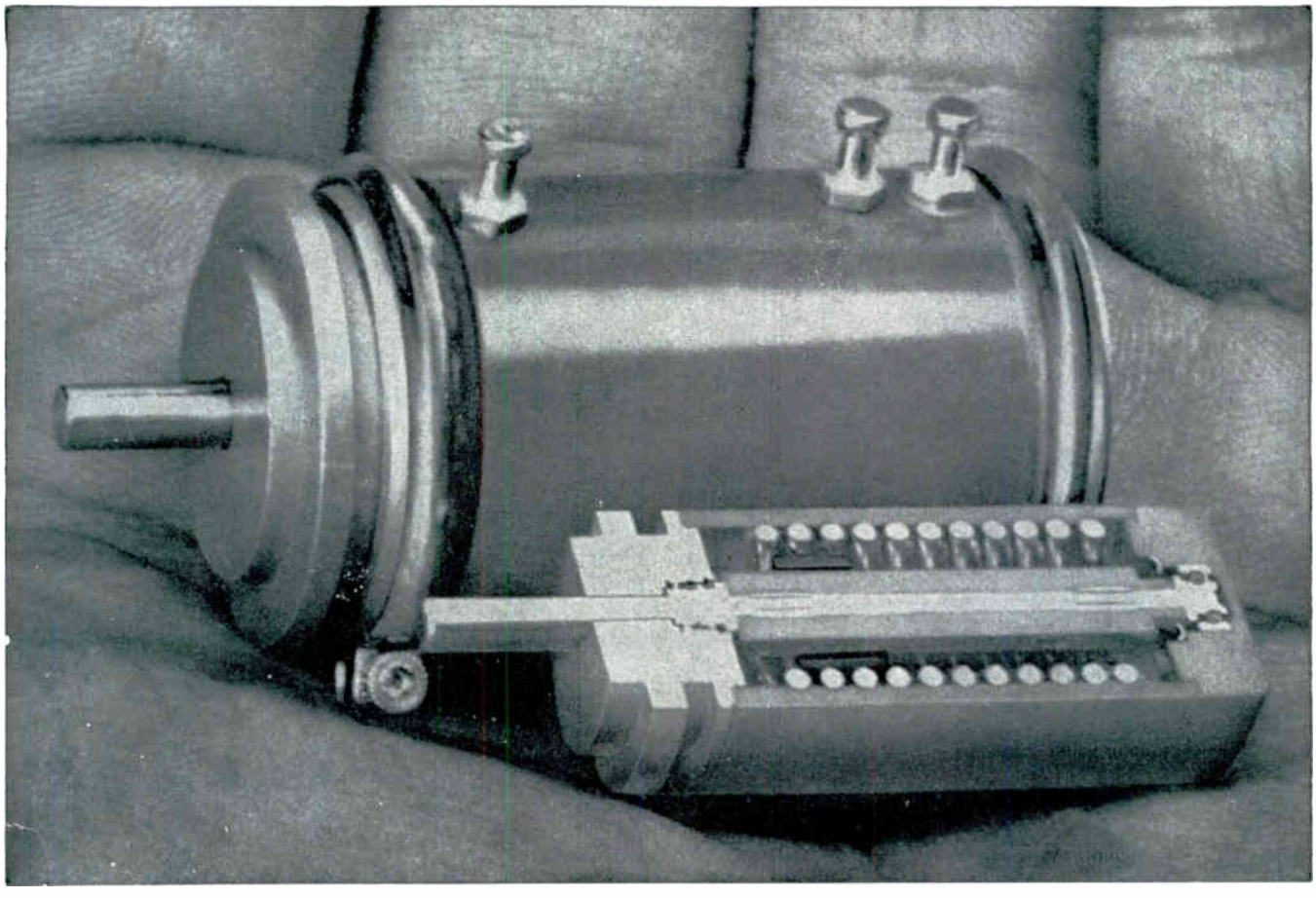
The many advanced design concepts introduced by Bourns miniature precision potentiometers in the past two years are now available in two brand-new servo-mount units. The new Models 3550 and 3750 deliver 25 to 39% more total resistance in smaller-than-conventional packages because their thin-wall plastic cases make room for a 20% longer resistance element.

There's more—the new units also provide better linearity and finer resolution. Their shafts are supported by precision ball-bearings and the rotors are virtually backlash-free. In addition, new case materials make possible a maximum operating temperature 20° higher than that of competitive units now available.

Both the Model 3550 and 3750 incorporate the Bourns exclusive SILVERWELD® multi-wire termination. Both are also subjected to 100% inspection and the rigorous double-check of the Bourns Reliability Assurance Programme. All the advanced features of these two new potentiometers strengthen our statement: Don't MIL-SPECulate—SPECify Bourns!

Write today for complete technical data.

	MODEL 3550	MODEL 3750
Size:	¾" x 1½"	¾" x 1 7/16"
Standard Resistances:	50Ω to 500K	50Ω to 250K
Resolution:	0.06 to 0.007%	0.09 to 0.02%
Independent Linearity:	±0.20% Std.	±0.25% Std.
Power Rating at 70 C:	2.5 Watts	1.0 Watt
Operating Temp. Range:	−65 to + 125 C	−65 to + 125 C
Meets Steady-State Humidity Requirements:	Yes	Yes



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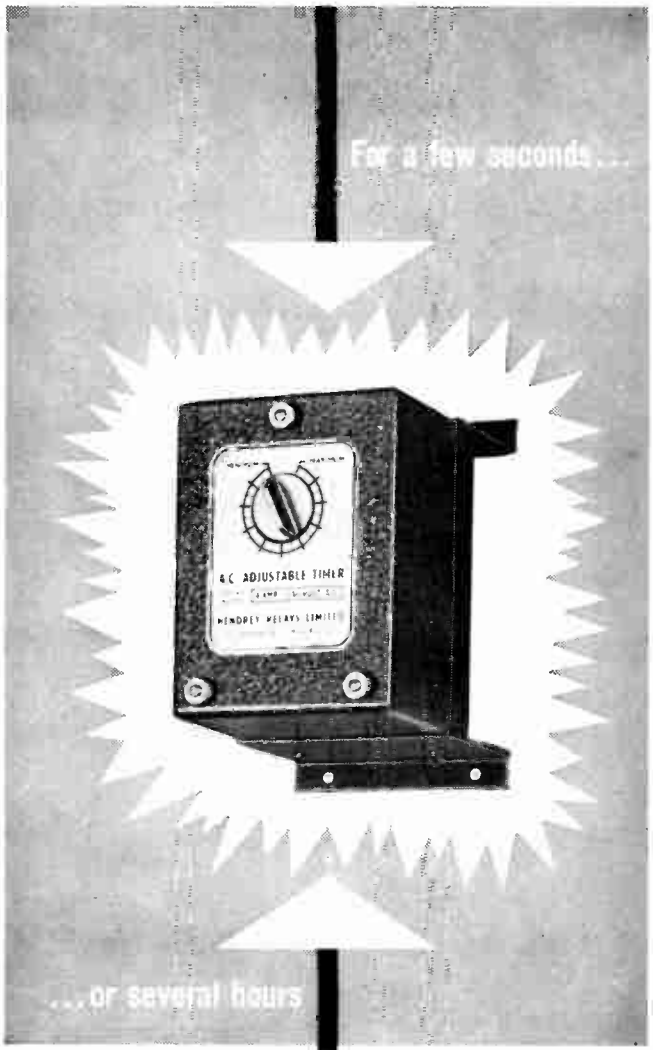

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—Wound for 110 V. or 230 V. 50 c.p.s. Consumption—8 V.A. approx. total.

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—Micro switchette.

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—4 amps. at 230 V. A.C.

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—The minimum delay setting recommended is approximately 10 seconds.

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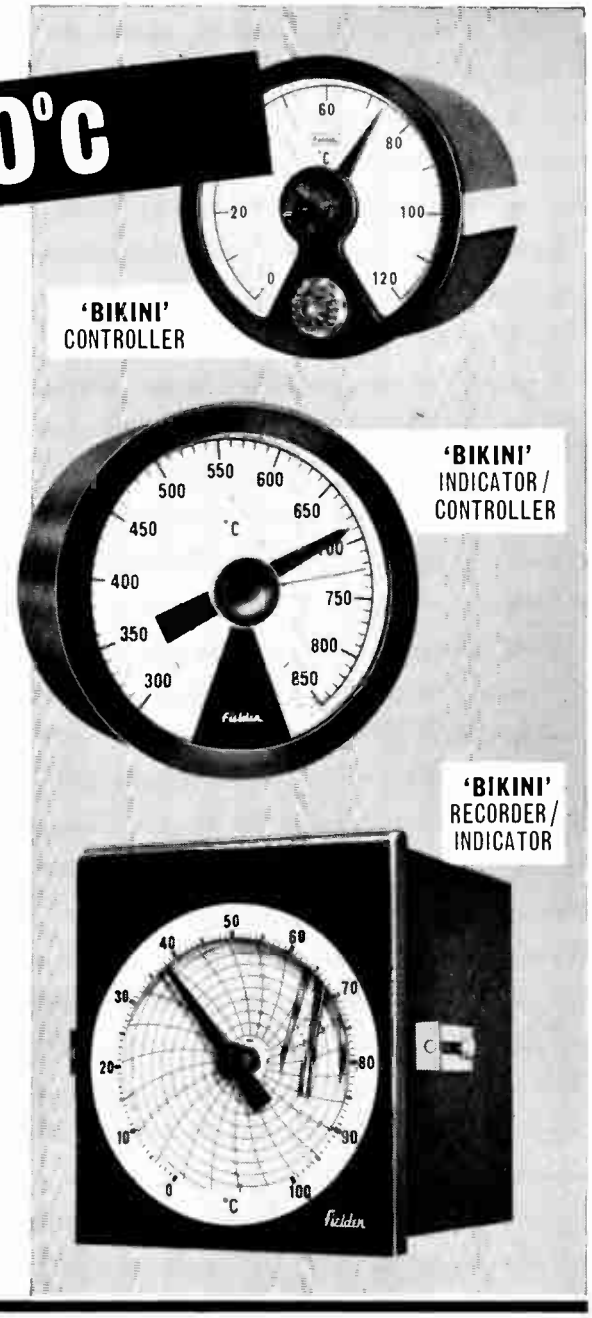

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Ind/ Controller	12½"	± 0.5%	App. 1000 yds. (500 Ω)	6" dia.	BIK PT/2/1
Recorder/ Ind	13"	± 0.5%	App. 1000 yds. (500 Ω)	8¾" x 7½"	BIK PT3/1
Rec/Ind/ Cont	13"	± 0.5%	App. 1000 yds. (500 Ω)	8¾" x 7½"	BIK PT3/1
Rec/Ind/ Prop.Cont	13"	± 0.5%	App. 1000 yds. (500 Ω)	8¾" x 7½"	BIK PT3/1

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Indicator	12½"	± 0.5%	300 feet	6" dia.	BIK 2/C
Ind/ Controller	12½"	± 0.5%	300 feet	6" dia.	BIK 2/C
Recorder/ Ind	13"	± 0.5%	300 feet	8¾" x 7½"	BIK 3
Rec/Ind/ Cont	13"	± 0.5%	300 feet	8¾" x 7½"	BIK 3
Rec/Ind/ Prop.Cont	13"	± 0.5%	300 feet	8¾" x 7½"	BIK 3 & EPC3

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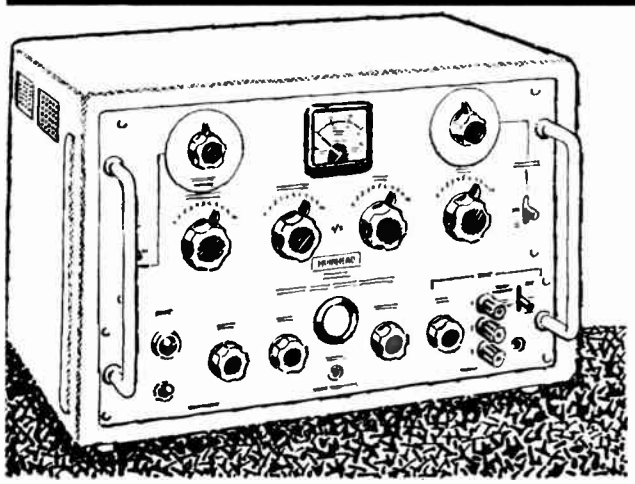

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Frequency Accuracy	Using the crystal check facility, accuracies in the range ±0.005% to ±0.1% can be achieved.
Hourly Frequency Stability	±0.02%
Maximum Output	126V into 8 kilohms (90V above 50kc/s) 25V into 600 ohms

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Until a recent breakthrough in design, everyone built high-current, semiconductor rectifiers the same way. As the heart of the device, they employed a single, large rectifier junction that had to be increased in size as the current requirements were increased. A major trouble with this outmoded design is that large-area rectifier junctions cannot be made without significant imperfections — and the larger the junction area, the greater the number of imperfections. And yet, today, everyone is still making high-current rectifiers in this same old way! Everyone, that is, except Motorola.

The Motorola Multi-Cell Rectifiers employ a number of virtually perfect small-junction, medium-current units connected in parallel to handle high currents of practically any desired rating. This new design breakthrough eliminates the many problems associated with large-junction rectifiers and provides these specific advantages: (1) increased maximum current handling from 400 amps to 1000 amps *and more*; (2) increased surge capacities up to 6 times greater than other units; (3) greater reliability with up to 25% reserve capacity; (4) reduction of the need for current-balancing accessories in many applications; (5) less expensive than single-junction units.

Only Motorola — a company already producing more than 20 million rectifier cells annually — has already developed the stabilized volume production necessary to ensure near-perfect matching of the electrical characteristics of each cell in these multi-cell devices. And only such volume production could provide you with these high-quality devices at prices less than what you are paying for the less desirable single-junction units.

Come aboard! Prove to yourself that Motorola multi-cell, high-current rectifiers will improve your equipment performance. Contact your Motorola Distributor now for full data on this competitively priced and fully proven range — CELDIS Ltd. 4 TRAFFORD ROAD, RICHFIELD ESTATE, READING, BERKSHIRE. 'phone 56256/55391

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Semiconductor Products Inc.
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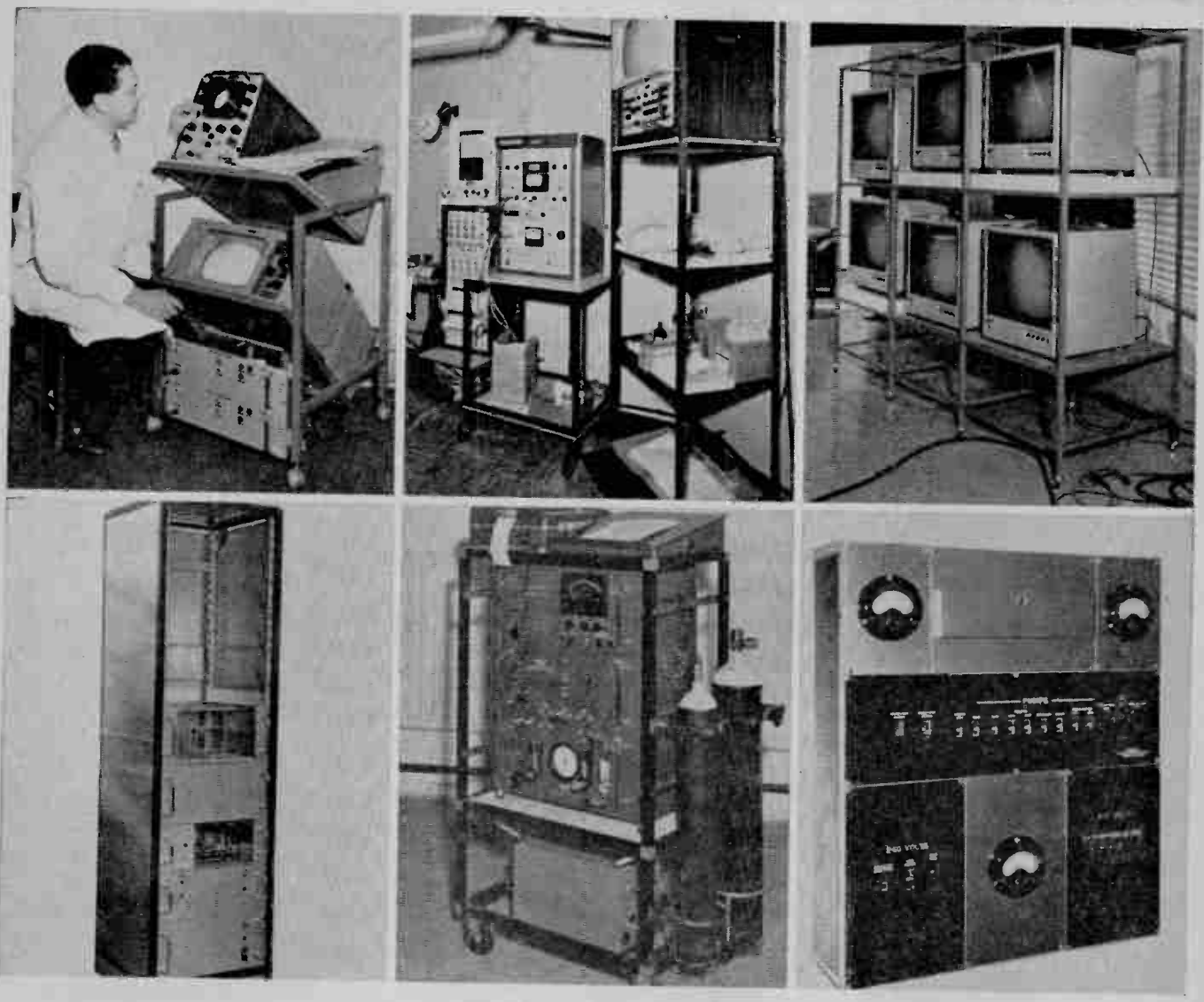

clean, simple—looks terrific

What's that? Dexion Speedframe.
What's it for? Test consoles and benches; trolleys, switchgear mountings, monitor stands; one-off prototypes or complete furnishing and equipment projects.
What's it do? Any size, rigid frames in moments. Uses 1" square-tube. Tailor-made for every project, at far less cost than ready-made frames!
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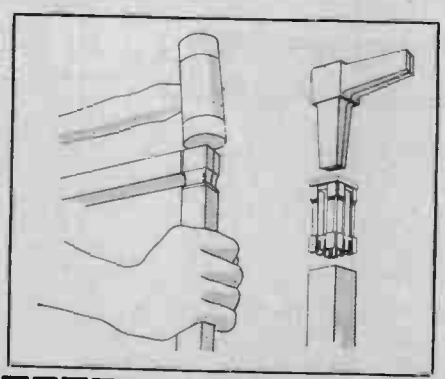
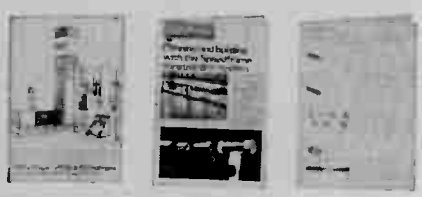


Here's the Speedframe tube-jointing idea:
Joint which, when hammered into the tube, is wedged by an **insert** which in turn jams tight inside the **tube** to keep the joint weld-firm.

You could do with Speedframe in your next project,
We'll be delighted to send you material specifications, fresh ideas on Speedframe in electronics, further details of Dexion products. Send in the coupon now.

Please rush me full details and prices.



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Position .....
Company .....
Address .....
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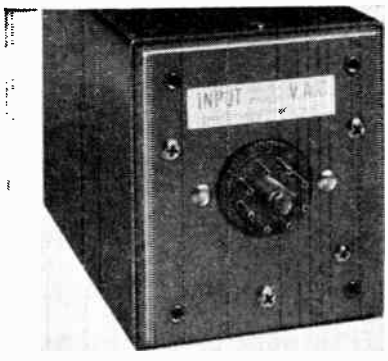
Phone .....

Dexion Ltd

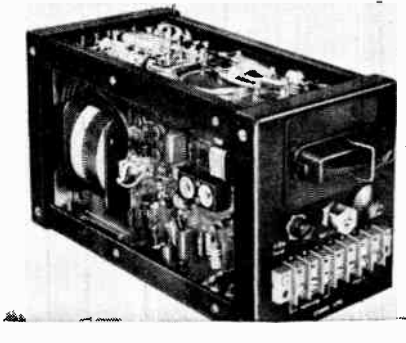
Speedframe Division, Dexion House, Empire Way, Wembley, Middlesex.
Tel: WEMbley 1281 B 2475



we can't hide our power supplies under a bushel

The ETHER range of power supplies has been designed to provide stabilised D.C. power for the widest range of applications.

Stabilisation ratios as high as 5000:1, very low ripple and noise, fully transistorised printed circuitry—these, and competitive prices are some of the reasons for choosing ETHER D.C. power supplies. Enquiries for adaptations and units to special requirements are welcome.



- ✳ **Stabilisation Ratios up to 5000:1**
- ✳ **Ripple and noise as low as 200μV**
- ✳ **Modular construction**
- ✳ **Quick delivery**
- ✳ **Low cost**

ETHER A.C. voltage regulators provide a clean regulated output with very low distortion. Valve and transistor types with outputs from 200VA to 5000VA for rack mounting or as cabinet units.

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Telephone: Stevenage 3040-55

there are too many of them

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STC

CHOOSE SERVISCOPE* FOR QUALITY CONTROL

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TELEQUIPMENT
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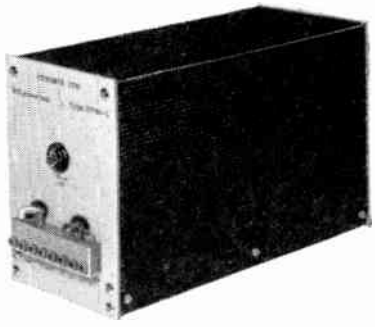

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RANGE OF UNITS AVAILABLE

SIZE REF.	10	30	40	50	70	90
VOLTAGE	CURRENT					
6	5	8	15	30	50	100
12	3	5	8	20	30	70
24	2	3	5	12	20	40
48	1	2	3	7	10	20

ETRONIX LIMITED

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The service consists of inclusive facilities for the design, development, and large scale production of all types of electronic equipment, instruments, etc., together with all processes involved in the design, development and production of printed circuit boards.

The unique location of T.E.S. Ltd., allows this first class service, which is to be found nowhere else, to be brought to your doorstep by an almost daily transportation service to 100 miles all for the price of a telephone call. Shanklin 3096.

Special attention will be given to very welcomed enquiries from customers outside the U.K.

TRANSMETRIX ELECTRONIC SYSTEMS LTD.
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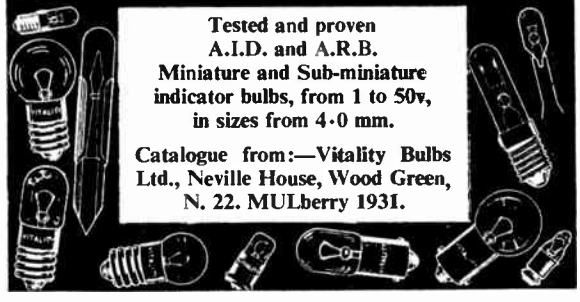

Tested and proven A.I.D. and A.R.B. Miniature and Sub-miniature indicator bulbs, from 1 to 50v, in sizes from 4·0 mm.

Catalogue from:—Vitality Bulbs Ltd., Neville House, Wood Green, N. 22. MULberry 1931.

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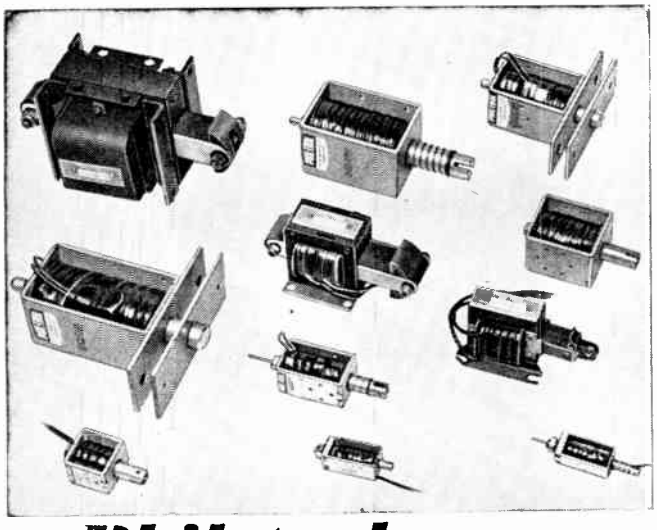

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For the Widest Range of Solenoids

Phil-trol Solenoids range from the small type 45, suitable for $\frac{3}{8}$" spacing (i.e. for typewriters), to the AC type 83, 47 lbs over $1\frac{3}{4}$" on impulse duty and also up to 650 lbs-ins for the DC type 96, with a complete range of AC and DC types between, push type, pull type, spring return and DC fitted with fully damped silicon rectifier circuits for AC supplies.

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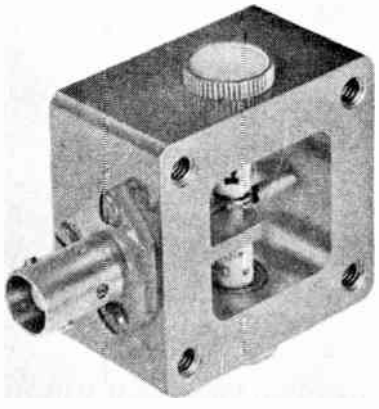

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TRADE MARK

THICKNESS GAUGE

For measuring the thickness of paint, enamel, plastic, varnish and other non-conductive coatings on aluminium, brass, copper, Austinitic stainless steels, etc.

The Minitor meets the need for a stable and reliable lightweight instrument for the measurement of non-conductive coatings on non-ferrous bases. This pocket-size precision instrument, fully transistorised and with miniaturised printed circuit for lasting reliability, is designed to provide simplicity of operation. Setting procedure and calibration to a new base material are straightforward. Choice of five scales, from 0-5 thou. to 0-500 microns, built-in probe in base with contact tip capped with hard wearing compound. Three ball contact for general use; flat base model for measurements on flat surfaces or soft materials; V base model for measurements on round bar; separate probes for confined spaces.

£48 Complete with 60-hour stable voltage Mallory battery, scale to choice, calibration foils, hide leather case.

The Minitor can also be used to measure conductive coatings on non-conductive bases and to segregate ferrous metals and their alloys, etc.

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features

1. Excellent A-M noise cancellation.
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3. Small size.
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9. Models available now for frequency bands within range 5·0 — 10·0 Gc/s.

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For further information circle 319 on Service Card

MINIATURES from Airmed Ltd

Rugged high-performance carbon microphones for communication use. They can be mounted on headset booms where a small size and weight are obvious advantages. Both types can also be mounted in various ways to meet individual requirements.

These microphones are designed for close speaking, where the special acoustic screens, high electrical output and tailored frequency response make an important advance in speech transmission.

SPECIFICATION	A301	A303
Frequency response:	200-5000 c/s	200-4000 c/s
Sensitivity:	—50dB/V/dyne/cm² at 1000 c/s.	
Load Resistance:	100 to 250 ohms	100 to 250 ohms
Feed Current:	approx. 40 mA, 60 to 85 mA s/c current.	
Mounting:	By two 8-BA screws which also form the contacts.	Special clip contact for mounting on headset boom.
Finish:	High-impact injection-moulded case. Hermetically sealed except for small equalising leak. Fully tropicalised.	

LEAD SWITCH

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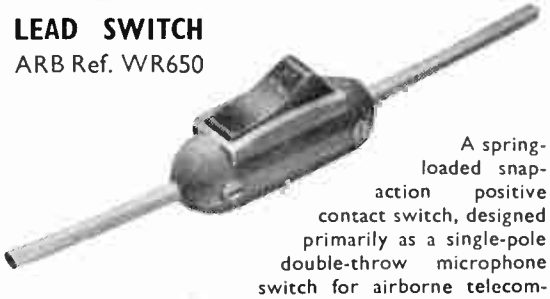

A spring-loaded snap-action positive contact switch, designed primarily as a single-pole double-throw microphone switch for airborne telecommunication headsets.

RATINGS: D.C. 28 v. D.C. maximum at 100 mA
A.C. 240 v A.C. at 2 A

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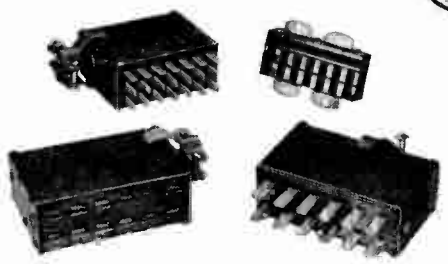

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General purpose connectors with five or fifteen amp contacts. Insert arrangements from two to thirty-six contacts.

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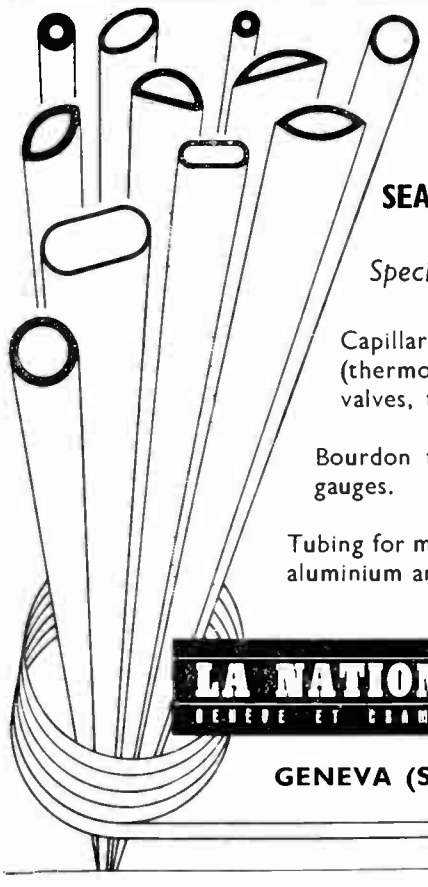

PRECISION SEAMLESS TUBING

Specialists in :

Capillary tubing for controls (thermostats, thermostatic valves, thermometers, etc.)

Bourdon tubing for pressure gauges.

Tubing for measuring pointers in aluminium and aluminium alloys.

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

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ASSISTANT SECRETARY in the Ministry of Technology

Applications are invited for a post of Assistant Secretary in the Ministry of Technology in London. This appointment is being made as part of the plan to recruit to the Administrative Class a small number of men and women possessing experience not normally available within the Service.

The Ministry of Technology has the general responsibility for guiding and stimulating a major national effort to bring advanced technology and new processes into industry. It has a special responsibility towards the computer, electronics, and telecommunications industries, and the successful candidate will be concerned with the formulation and execution of government policy in relation to one of these industries in accordance with his qualifications and experience.

Candidates must be at least 40 and under 46 years of age on 1st October 1965, and should have had recent experience in a senior capacity of management and policy making in an industrial organisation, and have been primarily concerned with the field of electronics.

The salary scale is £3,385—£4,385. There are prospects of promotion to Under Secretary (£4,785) and above.

Selection will be by interview in November 1965.

Appointment may be made on an established (i.e. permanent and pensionable) basis or for a period of five years initially. This will be a matter for agreement between the Ministry of Technology and the successful candidate. A five year appointment would be unestablished (i.e. non-pensionable) but with the possibility of extension or conversion to pensionable status later. It may be possible in certain cases to preserve existing superannuation rights during a non-pensionable appointment.

For further details, application form, and descriptive booklet write to the **Civil Service Commission, 23 Savile Row, London, W.1,** *quoting 6194/65. Closing date 15th October 1965.*

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ROYAL COLLEGE OF ADVANCED TECHNOLOGY, SALFORD

Proposed University of Salford

Electronic Engineer

APPLICATIONS are invited from electronic engineers for a post of Experimental Officer to join a group from the Civil and Electrical Engineering Departments developing an electronic analogue computer for use in the design and analysis of complex pipe networks. The successful applicant will be required to contribute to the current development programme, to commission and run the machine, and to participate in future development work.

Applicants should have a good working knowledge of both linear and pulse transistor circuitry, be capable of working under the minimum of supervision, and be Graduate Members of the Institution of Electrical Engineers or hold an equivalent qualification.

The salary scale is £920-£1,340 (bar) to £1,555 per annum.

Applications giving full details of education and experience, together with the names and addresses of two referees, should be sent to the Secretary, Royal College of Advanced Technology, Salford 5, by 20th September, 1965, quoting reference C/40.

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TUITION

BRADFORD INSTITUTE OF TECHNOLOGY

(Proposed University of Bradford)

A Short Course on
Circuit Techniques in Modern Measurement Oscilloscopes
will be held at the Institute on Tuesday evenings, 7–9.30 p.m., 5th October to 7th December, 1965.

This is a course for electronic engineers with degree or equivalent qualification and is being run to provide information on some aspects of electronic circuitry and techniques used in measurement oscilloscopes. Topics will include vertical deflection amplifiers, time base and trigger circuits and signal probes. The course will include some of the principles involved in sampling and storage type oscilloscopes.

For details apply Registrar, Ref. 78X/LN, Bradford Institute of Technology, Bradford 7.

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SCOTTISH HOME AND HEALTH DEPARTMENT

SENIOR WIRELESS TECHNICIANS

2 pensionable posts for men aged 23 and over: one at Edinburgh and one at Thorntonhall, Glasgow. Considerable travelling involved.

QUALIFICATIONS: High standard of practical knowledge of wireless principles and equipment, thorough training and at least 5 years' experience, together with ability to supervise and instruct junior technical staff and to drive private and commercial vehicles, essential. Also required, O.N.C. in Electrical Engineering, including some electronics, *or* City and Guilds Intermediate Certificate in Telecommunications (old syllabus, i.e. subject No. 50) plus Radio II, *or* Intermediate Telecommunications Certificate (new syllabus, i.e. subject No. 49) plus Certificates in Mathematics B, Telecommunications Principles B, and Radio and Line Transmission B, *or* equivalent or higher standard of technical education.

SALARY: £1,091–£1,285.

WRITE: Establishment Officer, Room 365B, St. Andrew's House, Edinburgh, 1, for application form. Closing date 18th September, 1965. [452

APPOINTMENTS FILLED

Dissatisfaction having so often been expressed that unsuccessful applicants are left in ignorance of the fact that the position applied for has been filled, may we suggest that Advertisers notify us to that effect when they have arrived at a decision? We will then insert a notice free of charge under this heading.

THE GOVERNMENT OF EASTERN NIGERIA

has the following vacancies:—

LECTURER (ELECTRICAL ENGINEERING)

SCALE OF SALARY: Scale A, £720-£1,584 per annum. Twenty per cent contract addition to basic salary and inducement addition ranging from £180-£300 depending on salary are payable if appointment is on contract. Incremental credits for approved experience are awarded.

QUALIFICATIONS: Applicants must be graduates in Electrical Engineering or must be holders of Dip.(Tech.), or recognised College of Advanced Technology, or Associates of Institution of Electrical Engineers, plus 5 years' industrial or teaching experience.

DUTIES: To be responsible to the Head of Department for teaching Electrical Engineering up to Ordinary Certificate level. They must be particularly required to have a good knowledge of electrical machines and laboratory.

LECTURER ELECTRICAL ENGINEERING (TELECOMMUNICATIONS)

SCALE OF SALARY: Scale A, £720-£1,584 per annum. Twenty per cent contract addition to basic salary and inducement addition ranging from £180-£300 depending on salary are payable if appointment is on contract. Incremental credits for approved experience are awarded.

QUALIFICATIONS: Applicants must be graduates in Electrical Engineering with Electronics as a subject, or Associates of the Institution of Electronics and Radio Engineers, plus at least two years' teaching or industrial experience in each case. Previous experience in practical work at any level either post or ante qualifications will be an advantage.

DUTIES: Teaching students preparing for the following:—

(i) The final certificate of the City and Guilds of London Institute of Telecommunications Technician subject No. 49.

(ii) Electronics required for the Ordinary Certificate in Electrical Engineering including the paper Radio, and communication.

(iii) Additional papers for communication Radio papers after the completion of subject No. 49.

(iv) The operation of the approved syllabuses and the compilation of teaching schedules and the maintenance of students' records.

(v) Advising on the necessary equipment to complete syllabuses.

(vi) The maintenance and upkeep of all laboratory equipment.

(vii) To perform such extra curricular duties as may be required.

Application forms, which are to be returned in quadruplicate as soon as possible, are obtainable from the

RECRUITMENT OFFICER
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LONDON W.C.2

Further enquiries are welcome.

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ARTICLES FOR SALE

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TEL. LYE 2460 please apply quoting ref. No. B.C.E. [464

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for industry

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Flash Street, Bolton, Lancs.

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An excellent opportunity for a graduate in Mechanical Engineering or the holder of HNC. Applicants should be aged 28/35 years, and have a good practical engineering background, preferably with some knowledge of electrical circuitry. Duties will include customer contact, mainly on technical aspects, and the application of the unique and revolutionary Pressductor magneto-elastic load cell in various industries.

Successful development of these opportunities would lead to senior national responsibility. There are exceptional prospects for the right man who will be based on ASEA's expanding Northern Office at Wilmslow, Cheshire, where initial training will be given. Later 6/8 weeks will be spent in Sweden for further training.

ELECTRONICS ENGINEER—COMMISSIONING

A progressive opportunity in a new field for a man aged 23/30 years with HNC in Electrical Engineering or equivalent and practical experience in industrial electronics.

We need a man to undertake responsibility for commissioning, calibration and service of the revolutionary new Pressductor load cell, working with advanced digital electronic equipment. The post has unique opportunities for national responsibility based on the rapidly expanding Northern Office at Wilmslow, Cheshire.

Initially training will be given in this country but a later period of 5/6 months in Sweden is envisaged.

Application should be in writing to The Manager,

ASEA

ASEA (Great Britain) LTD.
Wilmslow House
Wilmslow, Cheshire

The leading heavy electrical engineering company in Northern Europe

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Articles For Sale (*continued*)

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Automatic Telephones, Reconditioned and indistinguishable from new . . . . **£4 10s. 0d.** p.p. **4/-**
or
Complete and in good working condition . . . . **£1 5s. 0d.** p.p. **4/-**

MASTER STATION — We have a number of loud speaking key calling units complete with amplifiers, and also a number of key calling only units for disposal **£20 and £30 each.**

LOUDSPEAKERS . . . — 4 ohms 2½" Cone. **7/6 each.**

UNISELECTORS — complete with banks.

RELAYS . . . — Variety 3000 and 600 types. Send details of your requirements.

LYE ELECTRICAL SERVICES LTD., 20/21 LONG LANE, BLACKHEATH.

Please apply quoting ref. No. B.C.E. **Tel.: LYE 2460.**

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SOUTH OF SCOTLAND ELECTRICITY BOARD

COMMUNICATIONS AND ELECTRONICS

APPLICATIONS are invited for a post as THIRD ASSISTANT ENGINEER in the Plant and Equipment Development Section of the RESEARCH AND DEVELOPMENT BRANCH at Board Head Office, Glasgow.

The duties of the Communications and Electronics Group include the promotion and evaluation of new designs of equipment, the preparation of general specifications and technical standards, the technical assessment of tenders, and the association of service experience with this work.

Applicants should have had experience of either the design and testing or application of telecommunications and electronics equipment. The successful applicant will be working in a group studying the latest developments in data transmission over both physical and radio channels and will advise on their application in the Board's telecommunications telemetering, control and protective systems.

Applicants should possess the necessary qualifications for Graduate Membership of the Institution of Electrical Engineers. A University Degree will be an advantage.

Salary (according to qualifications and experience) commencing at £1,550 and rising to £2,045 per annum; or commencing at £1,460 and rising to £1,910 per annum (in each case plus a supplementary payment of £60 p.a.).

Applications quoting reference E65/65, should be submitted on the standard form to the Chief Personnel Officer, South of Scotland Electricity Board, Cathcart House, Inverlair Avenue, Glasgow, S.4, not later than 13th September, 1965.

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IF YOU HAVE STAFF PROBLEMS WHY NOT LET US HELP YOU?

BOOK NOW FOR OCTOBER

BOOKS

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"SECOND Thoughts on Radio Theory." By *Cathode Ray* of WIRELESS WORLD. Forty-four articles reprinted from popular WIRELESS WORLD series, in which the author examines various aspects of elementary radio science, explains them clearly, and shows that there may be more behind them than is apparent from the usual text-book. This volume deals with basic ideas; circuit elements and techniques; circuit calculations; and some matters in lighter mood. An entertaining and helpful textbook for the student, refresher course for the engineer, and reference book for all, combined. 35s net from all booksellers. By post 36s 5d from Iliffe Books Ltd., Dorset House, Stamford Street, London, S.E.1.

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Meetings

The Institute of Physics and the Physical Society

47 Belgrave Square, London, S.W.1.

29th Oct. (postponed from 30th Sept.) at Queen Mary College, Mile End Road, London, E.1, 'Spectroscopic Studies of Vibrational Modes' ('Phone: Belgravia 6111).

Society of Relay Engineers

Obelisk House, Finedon, Northants.

19th Oct. 2.30 p.m. at the Institution of Electrical Engineers, Savoy Place, London, W.C.2. 'Testing Methods and Equipment Applicable to V.H.F. and H.F. Wired Television Systems'. Tickets will be required.

Conferences, Symposia and Colloquia

6th–10th Sept. Convention on 'Machines for Materials and Environmental Testing'. Held at the Manchester College of Science and Technology, Manchester. Organized jointly by The Institution of Mechanical Engineers and The Society of Environmental Engineers from 1 Birdcage Walk, London, S.W.1 ('Phone: Whitehall 7476).

6th–10th Sept. 9th Conference of the European Organization for Quality Control. To be held in Rotterdam—details from the organization's Secretariat, Weena 700, Rotterdam 3, Netherlands.

8th–10th Sept. Symposium on 'Electronics in Industry'. Held at The University of Durham, Durham. Organized jointly by The Ministry of Technology and The Institution of Electronic and Radio Engineers from Wellbar House, Gallowgate, Newcastle-upon-Tyne, 1 ('Phone: Newcastle-upon-Tyne 27575).

13th–18th Sept. Engineering Materials and Design Conference. Held in conjunction with an exhibition at Olympia, London. Organized by Industrial & Trade Fairs Ltd., Commonwealth House, 1-19 New Oxford Street, London, W.C.1 ('Phone: Chancery 9011).

19th–25th Sept. International Conference on Elementary Particles, to be held in Oxford. Organized by the Rutherford Laboratory in collaboration with the Science Research Council. Details from The Rutherford Laboratory, Chilton, Didcot, Berks. ('Phone: Abingdon 1900, Ext. 438).

20th–23rd Sept. Annual Inspection Conference on 'Engineering Inspection in the Future'. Held at New College, Oxford. Organized by The Institute of Engineering Inspection. 616 Grand Buildings, Trafalgar Square, London, W.C.2.

20th–23rd Sept. Conference on 'Assembly, Jointing and Fastening Methods' at Melton Mowbray. Sponsored by the Production Engineering Research Association. Applications to attend should be sent to the Conference Organizer, PERA, Melton Mowbray, Leicestershire. ('Phone: Melton Mowbray 4133).

20th–25th Sept. International conference on 'Thermionic Electrical Power Generation'. Held at The Institution of Electrical Engineers, Savoy Place, London, W.C.2 ('Phone: Covent Garden 1871). Organized jointly by I.E.E. and O.E.C.D. European Nuclear Energy Agency.

21st–23rd Sept. Symposium on 'Applications of Microelectronics'. Held at Department of Electronics, The University, Southampton. Jointly organized by the I.E.E. and I.E.R.E. from The University of Southampton.

21st–24th Sept. First European Conference on Magnetism, Vienna. To be held at Technischen Hochschule, Vienna. Conference Secretariat: Verein Deutscher Eisenhuttenlente, 4 Dusseldorf. Briete Strasse 27.

23rd–24th Sept. Conference on 'Non-Metallic Thin Films'. To be held at 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).

27th–30th Sept. Conference on 'Optics in Space'. Organized by the Institute of Physics and the Physical Society and to be held at the University of Southampton. For registration and details apply to I.P.P.S., 47 Belgrave Square, London, S.W.1 ('Phone: Belgravia 6111).

27th Sept.–1st Oct. Conference on 'Design criteria and equipment for transmission at 400 kV and higher voltages'. Organized by the Institution of Electrical Engineers and to be held at their London headquarters. Details from the I.E.E., Savoy Place, London, W.C.2 ('Phone : Covent Garden 1871).

28th Sept.–2nd Oct. Manchester
The Twentieth Annual Electronics, Instruments, Controls and Components Exhibition and Convention, Belle Vue, Manchester. Organized by The Institution of Electronics, 78 Shaw Road, Rochdale, Lancs.

5th–6th Oct. Conference and Exhibition on 'Ultrasonics in Industry', to be held at St. Ermin's Hotel, St. James's, S.W.1. Applications to the organizers: *Ultrasonics*, Dorset House, Stamford Street, S.E.1 ('Phone: Waterloo 3333).

7th–13th Nov. International Conference of Electrical Engineers to be held in Berlin (East Germany) and organized by the Berlin Chamber of Technology. Information from Lex Hornsby & Partners Ltd., Wellington House, 125/130 Strand, London, W.C.2 ('Phone : Temple Bar 3731).

15th–20th Nov. Industrial Conference on 'Productivity, Technology and Change', to be held in conjunction with the Industry '65 Exhibition at Earls Court. Registration forms from the British Productivity Council, Vintry House, Queen Street Place, London, E.C.4 ('Phone : Central 9613).

18th–19th Nov. Conference on 'Computational Methods in Crystallography' to be held at the Institution of Electrical Engineers, London, and organized by the Institute of Physics and the Physical Society, 47 Belgrave Square, S.W.1 ('Phone: Belgravia 6111).

22nd–23rd Nov. International Conference on U.H.F. Television, to be held at the I.E.E., Savoy Place, London, W.C.2. Sponsored by the I.E.R.E., the I.E.E. Electronics Division, the I.E.E.E. and the Television Society. Information from 9 Bedford Square, London, W.C.1 ('Phone: Museum 1901).
Note that this conference was to have been held from the 1st–2nd Sept.

WHAT'S ON AND WHERE

Continued

Exhibitions

3rd–12th Sept. Brussels
Ninth European Machine Tool Exhibition at the Palais de Centenaire, Palais 1, Brussels 2, Belgium. Organized by the European Committee for the Co-operation of Machine Tool Industries. Details from: The Machine Tools Trade Association, 25 Buckingham Gate, London, S.W.1 ('Phone: Victoria 7542).

4th–12th Sept. Italy
Third International Exhibition of Electronic Components (together with thirty-first National Radio and Television Show and second Household Appliance Exhibition), to be held in Milan. Details from the Secretary, A.N.I.E., via Luciano, Manara 1, Milano, Italy.

7th–11th Sept. Basle
INEL 65 International Exhibition of Industrial Electronics, Basle, Switzerland. 61 Clarastrasse, 4000 Basle ('Phone: Basle (061) 323850).

9th–19th Sept. Paris
Salon International de la Radio et de la Television, Porte de Versailles, Paris. Organized jointly by the Office de Radiodiffusion—Television Francaise and the Federation Nationale des Industries Electroniques. Details from the Societe pour la Diffusion des Sciences et des Arts, 16 rue de Presles, Paris 15e ('Phone: 273-24-70).

11th–26th Sept. Moscow
International Exhibition, 'Chemistry in Industry, Construction and Agriculture', Sokolniki Park, Moscow. Organized by the U.S.S.R. Chamber of Commerce. Further details: Industrial & Trade Fairs Ltd., Commonwealth House, New Oxford Street, London, W.C.1 ('Phone: Chancery 9011).

12th–26th Sept. Brno, Czechoslovakia
7th Brno International Trade Fair. Details from: Mezinarodni veletrh Brno tiskove stredisko, Hlinky 104, Brno, Czechoslovakia.

13th–17th Sept. London
Engineering Materials and Design Exhibition. Held in conjunction with a conference at Olympia, London. Organized by Industrial & Trade Fairs Ltd., Commonwealth House, 1-19 New Oxford Street, London, W.C.1 ('Phone: Chancery 9011).

14th–22nd Sept. Utrecht
HET Instrument 1965 Exhibition, Royal Dutch Industries Fair, Utrecht. Further details from: Cooperative Vereniging, 'HET Instrument' u.a., Sparrenlaan 2, Soest, Holland ('Phone: Soest (02955) 3047).

28th Sept.–1st Oct. Brighton
Medical Electronic and Instrumentation Exhibition (in conjunction with The European Symposium on Medical Electronics) at Exhibition Hall, Brighton, Sussex. Organized by Events Promotions Ltd., Ashbourne House, Alberon Gardens, London, N.W.11 ('Phone: Meadway 5555).

28th Sept.–2nd Oct. Manchester
The 20th Annual Electronics, Instruments, Controls and Components Exhibition and Convention, Belle Vue, Manchester. Organized by The Institution of Electronics, Pennine House, 78 Shaw Road, Rochdale, Lancs. ('Phone: Rochdale 48759).

2nd–10th Oct. Ljubljana, Yugoslavia
XIIth International Exhibition on Modern Electronics. Details from: Gospodarsko razstavisce (Ljubljana Fair), Ljubljana, Titova 50, Yugoslavia.

4th–13th Oct. London
Business Efficiency Exhibition, London (Olympia). Organized by Business Equipment Trade Association, 64 Cannon Street, London, E.C.4 ('Phone: Central 7771).

13th–19th Oct. Dusseldorf
3rd International Congress and Exhibition of Measuring Instrumentation and Automation (Interkama), Dusseldorf, Germany. Represented by John E. Buck (Trade Fair Agencies) Ltd., 47 Brewer Street, Piccadilly, London, W.1 ('Phone: Gerrard 7576).

26th Oct.–2nd Nov. Rumania
SIMA Exhibition on Instrumentation for Industry, Research & Education, to be held in Bucharest. Details from SIMA House, 20 Peel Street, London W.8 ('Phone : Park 2614).

27th–30th Oct. London
R.S.G.B. Radio Communications Show, Seymour Hall, London. Organized by P. A. Thorogood, 35 Gibbs Green, Edgware, Middlesex.

30th Oct.–7th Nov. Genoa
Second International Communications Fair, organized by the Genoa International Fair, Viale Brigate Partigiane, Genoa, Italy. To be held in conjunction with the Second International Aircraft Exhibition.

30th Oct.–7th Nov. Genoa
Second International Aircraft Exhibition, organized by the Genoa International Fair, Viale Brigate Partigiane, Genoa, Italy. To be held in conjunction with the Second International Communications Fair.

3rd–10th Nov. Oslo
Automatica 65—an exhibition of automatic control. Held in the Exhibition Hall, Skoyen, Oslo. Details from: Studieselskapet For Norsk Industri, Forskningsveien 1, Oslo 3.

15th–20th Nov. London
Industry '65 Exhibition—the International Industrial Equipment and Services Exhibition at Earls Court, London. Organized by the Industrial and Trade Fairs Ltd., Commonwealth House, 1-19 New Oxford Street, London, W.C.1 ('Phone: Chancery 9011).

15th–20th Nov. London
Industrial Photographic and Television Exhibition at Earls Court. Sponsored by *The Financial Times* and organized by Industrial & Trade Fairs Ltd., 1-19 New Oxford Street, London, W.C.1 ('Phone : Chancery 9011).

Courses

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Automatic Computing Techniques in Industry

A series of ten Monday evening lectures, commencing on Oct. 4th, to provide a general introduction to the digital computer and the associated peripheral equipment for process-control applications in industry.

Further information from the Department of Electrical Engineering, Hendon College of Technology, The Burroughs, Hendon, London, N.W.4 ('Phone : Hendon 0083).

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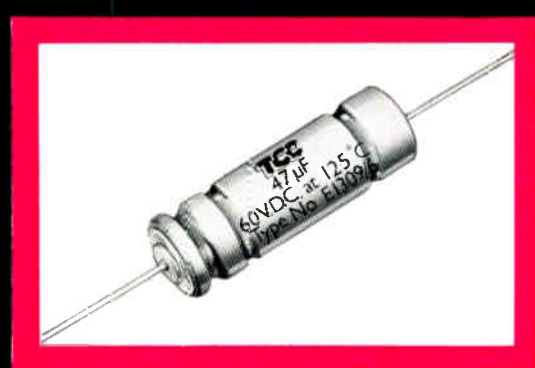

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