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OCTOBER 1965

469 Editorial Comment
470 Domestic Receiver Survey
474 The Season's Sets
483 A Non-resonant Loudspeaker Enclosure Design by A. R. Bailey
487 World of Wireless
489 Personalities
491 News from Industry
493 Letters to the Editor
495 German Radio Show
499 Radio and TV In East Germany
501 Paris Radio Show
503 Slow-motion Television by M. Leeuwin
507 R.E.M.E. School of Electronics
509 INEL 65
511 October Meetings
513 Electronic Laboratory Instrument Practice—10 by T. D. Towers
518 Economical Logic by H. R. Henly
524 Keeping the Radio Peace
526 Books Received
526 New Products
532 Real and Imaginary by "Vector"
534 Commercial Literature
534 H.F. Predictions—October

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Hi-Fi Television

IN an endeavour to fill, even if only in part, the gap caused by the cancellation of the London Radio and Television Show planned for September, we have devoted a considerable amount of space in this issue to a survey of technical trends in both television and sound receivers and to a review of new sets. The overall picture of what's new in the domestic equipment field is further enhanced by the inclusion of reviews of the recent German Radio Show, the International Show held in Paris and, for full measure, an impression of the East German industry gained during a visit to the Leipzig Autumn Fair.

What is the state of the art in television receiver design? As will be seen in the following pages there are few new techniques, and in fact some manufacturers are resorting to sales gimmicks. One interesting development is the inclusion of a d.c. restoring circuit to maintain black level in receivers. Perhaps the most significant is the growing use of transistors and there are now completely transistorized receivers both in this country and abroad. In the radio field the coming of semiconductors saw the introduction of low-quality portables—the ubiquitous "transistor"—and it is to be hoped that the same trend will not invade the television field.

This leads us to ask whether the present-day television receiver is really doing justice to the transmitted picture. Only those who have seen the picture on a monitor in a control room of either the B.B.C. or I.T.A. have had the opportunity of judging the true quality of our 405-line service, and it would be true to say that few viewers are getting anything like the transmitted picture.

In his Fleming Memorial Lecture to the Television Society a few months ago Dr. R. D. A. Maurice, of the B.B.C. Research Department, discussed "The specification of an adequate television signal." One might ask, adequate for what? He showed the lengths to which the broadcasting organizations go to ensure a good quality picture, and also the impairment introduced in receiving installations. It would be unfair to lay the responsibility for poor pictures solely at the door of set manufacturers. For, although they are by no means blameless, they do, by and large, go to great lengths to design receivers to give a satisfactory picture. We believe that the weakest link in the chain is the aerial installation. This is undoubtedly where the users of a relay service have the edge on their "over-the-air" neighbours. The operators of relay services have the advantage of either a cable feed from the station, or of an aerial installation at a vantage point often well outside the range of interference. It need hardly be added that a good aerial installation—not necessarily outdoor—is of even greater importance for reception on the u.h.f. bands.

Despite what we have said we believe there is a growing demand for a hi-fi television set. This does not necessarily mean large-screen, but it must have those refinements which have been pruned in the run-of-the-mill receivers, in order to keep them within certain price limits. Some discerning viewers will want one thing and some another—better scanning linearity, maximum bandwidth, greater tuning stability, video response adjustment—but one thing that is certain to be demanded is better sound reproduction. In the average set it is deplorable—in fact, little better than from a pocket transistor set. One reader has recently suggested we should publish the design of a tuner for Bands I and III, so that he can feed the television sound into his audio amplifier.

It would be interesting to know readers' views.
DOMESTIC RECEIVER SURVEY

TECHNICAL DESIGN TRENDS IN TELEVISION AND SOUND

The television receivers produced by the majority of groups this year are similar to last year's with the exception of several smaller points of detail. In many cases system switching (405-625) is ganged to the push-button tuners so that selection of any programme is simply a matter of pushing the appropriate button. In the Thorn range of receivers solenoids are used to drive the system switch to minimize mechanical linkages.

The "panorama" (Mullard) or "ringguard" (Mazda) type of tube presentation is to be seen in many receivers. This type of picture tube does not require any implosion screen, the face of the tube being directly accessible to the viewer. The tube is completely safe from implosion by virtue of a steel band that surrounds the rim of the tube. The advantage of this type of picture presentation is that there is no dust trap behind the old type of implosion screen and at the same time reflections caused by room lighting are minimized.

Although the majority of receivers are similar to last year's models there are one or two important trends emerging which will probably set the pattern for future receivers.

The first of these is the use of an "integrated" tuner, that is, a combined tuner for all the v.h.f. and u.h.f. channels. The first production receivers to feature the use of such tuners in this country are those marketed by the Pye/Ekco group. Also featured in the receivers produced by this group are fully transistorized vision and sound i.f. amplifiers.

The second is the use of a black-level stabilizing circuit to reinsert the d.c. component; this is incorporated in the latest Bush/Murphy receivers. These receivers also feature transistor sound and vision i.f. amplifiers as do the latest in the Sobell/G.E.C./McMichael range. Transistor u.h.f. tuners are used in many otherwise valve receivers and in fact the days of the "all-valve" television receiver appear to be numbered.

Mean-level a.g.c. is used exclusively, the a.g.c. potential being derived in the conventional manner from the grid circuit of the synchronizing pulse separating valve. In the Plessey and Grundig receivers, however, an amplified mean-level system is used. In hybrid receivers, in which transistors are employed in the sound and vision i.f. amplifiers, a transistor is also used to provide the necessary forward bias for the i.f. and r.f. transistors but again mean-level circuits are used. In the Bush/Murphy and Sobell/G.E.C./McMichael receivers the a.g.c. potential is taken from a low impedance point in the video amplifier but in the Pye/Ekco receivers a separate video detector diode is used.

The normal complement of transistors is two for a u.h.f. tuner, one operating as an r.f. amplifier, the other as a self-oscillating mixer. In the v.h.f. tuner three transistors are normally employed, the first operating as an r.f. amplifier, the second as a mixer and the third as the local oscillator. A self-oscillating mixer cannot be used on v.h.f. because of the close spacing of channel 1 (45 Mc/s) to the i.f. (38 Mc/s). In the case of separate tuners a gain differential exists in that the gain of a typical u.h.f. transistor tuner is some 20 dB and for a v.h.f. tuner it is about 30 dB. This problem can be simplified in an integrated tuner.

Since a self-oscillating mixer cannot be employed on v.h.f. it follows that the v.h.f. part of an integrated tuner will require three transistors. However, the first stage can be common provided the transistor is suitable for v.h.f. and u.h.f. amplification and also that the combination of the u.h.f. and v.h.f. tuned circuits can be satisfactorily accommodated. If the mixer transistor is arranged to be of the self-oscillating type on u.h.f. the v.h.f. mixer transistor can be employed as an i.f. amplifier to equalize the gain. The block diagram of the Pye tuner is shown in Fig. 1.

Separate band filters apply the r.f. signal to the base of the r.f. amplifier transistor (AF186). The output of the r.f. transistor feeds the u.h.f. and v.h.f. bandpass filter circuits. A unique feature of the Pye tuner is in the use of a folded halfwave lecher line that is tuned at each end by a variable capacitor. The halfwave tuning elements are "U" shaped, allowing each end to be connected to the split stators of the tuning capacitors. On u.h.f. the circuits are halfwave but tuned at each end and hence the midpoint of the line is a low potential point. The v.h.f. tuned circuits are connected to this point of the line without influencing the u.h.f. performance. Since no switches are involved for this particular function no trouble from switch re-setting accuracy is experienced. On v.h.f. the u.h.f. bandpass tuning elements act as low inducance conductors for the v.h.f. circuits, thus placing the split stator tuner capacitors in shunt with the v.h.f. bandpass coils. In

Rear view of the Pye 16 in transistor television receiver showing the i.f. strip and integrated tuner.
this way the same tuning capacitors are able to tune both the v.h.f. and u.h.f. circuits to any channel in Bands I, III, IV and V.

The u.h.f. and v.h.f. oscillator stages are not common. On u.h.f. a second AF186 transistor functions as a self-oscillating mixer, while on v.h.f. two AF178 transistors are used, one as the oscillator and the other as the mixer. The latter has two functions, for u.h.f. the particular circuit is re-arranged so that it becomes an additional i.f. amplifier. The overall tuner gain is substantially constant throughout the v.h.f. and u.h.f. bands.

The integrated tuner produced by Sydney S. Bird (Cyldon Type IT100) and used by several set makers features a push-button system switch ganged to the tuner. Only 60° gang rotation is used to eliminate errors due to gear drive. This tuner also employs four transistors (2 off AF186 and 2 off AF178) and has a substantially constant gain (27 dB) over the whole band.

Receivers manufactured by the Pye Group and the newest designs from the Bush/Murphy and Sobell/G.E.C. groups incorporate transistor i.f. amplifiers. In these receivers three transistors are used in the vision i.f. with a further two in the sound i.f. In the Bush range of receivers an additional transistor is used as an a.g.c. amplifier, the a.g.c. input being derived either from the anode or the cathode of the video amplifier valve depending upon which system of modulation is being used. In the case of the Pye receiver a second video detector diode is employed to generate the necessary a.g.c. voltage together with the intercarrier sound signal and two transistors are employed as amplifiers between this diode and the i.f. transistors. The Sobell receivers also use a double-diode video detector circuit to reduce system switching but a single a.g.c. transistor driven from the cathode of the video amplifier is used.

With the use of transistors in the tuners and i.f. amplifiers the heater chain of the receiver requires a rather large mains dropping resistor. In these hybrid receivers the resistor is in fact replaced by a diode to reduce the power in the heater chain.

An additional problem of the hybrid receiver is that of obtaining the required power supply for the transistors. In the Pye and Sobell receivers the d.c. for the transistors is obtained from the heater chain itself, see Fig. 2. A capacitor is shunted across the transistor supplies so that the a.c. component of the heater current flows to earth and the d.c. component of the heater chain is used to drive the transistor circuits. In parallel with the input to the transistor circuits in the Pye receiver is a positive temperature coefficient resistor (p.t.c.). The function of this resistor is to eliminate the switch-on surge that would possibly damage the transistors when the receiver is first switched on. When the resistor is cold it has a low value and therefore effectively shorts the transistors out. As it warms up its resistance increases and thus

---

**Fig. 1.** Block diagram of the Pye integrated tuner.
permits a voltage to be applied to the transistors. In this way it serves the same purpose in the reverse way to the normal thermistor used in the heater chain. In the Sobell receivers a catching diode is connected between the transistor h.t. line and the cathode of the vertical output valve to eliminate the switch-on surge.

The transistor supply in the Bush receiver is also unusual in that the d.c. for the transistors is obtained from the vertical timebase. The transistor circuits are connected in series with the timebase output valve as part of the cathode resistor. To prevent voltage variations a shunt regulator transistor is used (see Fig. 3). The regulator transistor acts as an emitter follower and holds the transistor h.t. potential at substantially the base potential of the transistor.

The Thorn range of receivers now includes a 16-in portable. The receiver chassis is basically the same as the 950 series (19 and 23 in) which employs selenium e.h.t. rectifiers (see W.W., January, 1965), a mains auto transformer in the power supply and a 3-gang transistor u.h.f. tuner. In the 16-in receiver, however, the limited space precludes the use of a mains auto transformer and it has been replaced by a capacitor in series with seven of the valves, the remaining four being wired in series with the receiver's h.t. supply circuit.

The video amplifier and synchronizing pulse separator circuits in most receivers follow conventional lines; the Bush/Murphy circuit, however, is slightly unusual in that it incorporates a black-level stabilizing circuit. This circuit has been previously described (Wireless World, May 1964) and is shown in Fig. 4 together with the contrast control and c.r.t. blanking circuits.

The principle of the circuit is that the pentode valve is normally non-conducting but driven into conduction on the trailing edge of the synchronizing pulse. When the valve conducts it charges the cathode capacitor to a voltage dependent on the black-level of the signal applied to the screen grid. The cathode voltage therefore effec-
tively follows the black-level variation of the picture tube cathode and this d.c. potential is applied to the picture tube grid. In this way the grid and cathode of the picture tube move up and down together so that variations in black-level caused by the mean-level a.g.c. system are not reproduced by the picture tube. Brightness control is affected by variation of the screen-grid potential of the valve.

Flywheel synchronizing now appears to be incorporated in virtually all receivers. Line oscillators consist of sine-wave oscillators controlled by a high impedance phase detector or in some cases a multivibrator or a blocking oscillator with a cathode follower.

Diode phase detectors are employed almost exclusively but in the Decca receiver a triode-pentode phase detector is employed which is of the coincidence type and in the Philips range of receivers a triode phase detector is used.

A feature of the Philips receivers is the increase in the e.h.t. potential to 18 kV which together with the use of the "panorama" tube presentation gives an increased brightness which is claimed to be some 20%. These receivers also feature a transistor u.h.f. tuner.

Also featured on one range of Philips receivers is an automatic time switch coupled to an electric clock. The "on" and "off" time can be pre-set so that the receiver switches itself on automatically for a selected programme. A clock/timer switch is also incorporated in the R.G.D. "Night Owl" combined television and u.h.f. sound receiver.

**Sound receivers**

Radio receivers this year have followed more or less established lines, with one or two minor exceptions. The modern technique of modular construction, which by now has been applied to most branches of electronics, including television, is gradually infiltrating into radio. The Alba Scout (model 737) and the Ekco PT447 are typical examples. Ekco have eliminated the usually untidy situation surrounding the mixer/oscillator circuitry with their "integrated switch pack" (I.S.P.) which is featured in the PT447 and A449 and will be included in future models. The pack houses the waveband switches and associated mixer/oscillator wiring. The push-button wavechange switches are totally enclosed—a technique which is being increasingly used in the domestic field.

Transistor receivers in sizeable wooden cabinets are noticeably on the increase (teak in particular) and these are often quite broad and quite unrelated to the size of the chassis. Because of the use of larger loudspeakers, reproduction from these receivers is markedly better than from the ubiquitous "transistor" (sic).

The relative scarcity of mains-operated transistor receivers has always been something of a mystery (to us) since portability is not necessarily of primary importance. This year's additions to this class include the Ferranti A1143 (which incidentally uses a German standard D.I.N. tape recorder socket) and the Ekco A449. Both have wooden cabinets and the A449 includes the "integrated switch pack."

The crowded situation which exists at the high-frequency end of the medium-wave band is eased to some extent with the bandspread scales which appear on a number of receivers—and Radio Caroline has found its place on the scale in some cases! Alba, in the Japanese-
THE SEASON’S SETS

MANY of the British receiver manufacturers have held exhibitions during what has traditionally become known as “Show time.” From the information gained from visits to these shows and from the manufacturers who were not holding exhibitions, we have compiled a brief summary of the new television and sound receivers and radiogramophones. In the following pages these are listed under trade names and where several come from the same “stable” these are grouped together under a combined heading.

K.B., Regentone, R.G.D.

“Night Owl” is the name given by R.G.D. to a combined television set, v.h.f. sound receiver and clock/timer, in which the clock can be used to switch on either the television or the sound receiver at a predetermined time, thereby providing an early morning alarm or ensuring that a selected programme is not missed. A two-hour delay timer allows the receiver in operation to be switched off automatically at the end of a programme. The set is based on S.T.C.’s “Featherlight” chassis but has a larger cathode-ray tube—a 12-inch.

K.B.’s latest television set is a 23-inch de luxe model, KV107. It has two front-facing loudspeakers, an illuminated u.h.f. tuning scale and push button v.h.f. station selection, with two sliding doors on the cabinet. Flywheel sync and pre-set fine tuning are used, and the u.h.f. tuner can be either a valve or a transistor unit.

K.B. has also introduced a four-wave-band radiogram with stereo output, the KG031. It has a seven-valve chassis, a B.S.R. record changer and each sound channel has an output of 2.5 watts, driving a 10in x 6in elliptical speaker. Stereo balance and tone controls are provided.

A portable 12-transistor radio receiver from Regentone, the TR419, covers the medium- and long-wave bands and v.h.f. It has front-facing controls, a 3½-inch speaker and a 25-inch telescopic aerial for v.h.f.

There have been no drastic changes in sound receiver circuitry—the vast majority using well-tried designs. Complementary transistors dominate the output stages, but there are still a large number of receivers using transformer-coupled output stages—the advantage of transformerless stages not being so great in receivers with small loudspeakers. In the more ambitious radiograms, complementary driver stages and p-n-p output transistors are common. Silicon transistors both in audio and r.f. stages are now appearing more frequently.

The Grundig Ocean-Boy receiver, now available in this country, uses a separate oscillator transistor. The mixer emitter current is stabilized by an additional transistor, for reception on the short-wave band. The essential circuitry is shown in Fig. 5. The new Grundig Satellit uses a similar circuit and also the mixer stabilizing arrangement, but includes an r.f. stage, an additional i.f. stage, and for the six s.w. bandspreading ranges, separate oscillator, mixer and stabilizing stages. Both sets incorporate a 9 kc/s whistle filter, a feature not frequently met. The receiver uses a total of 18 transistors.

It will be obvious that in the available space it is impossible to do justice to all the new sets on the market, but we hope this section of the issue will provide an “armchair” radio show for readers.

At the end, under “Imported Sets,” we have listed most of the makes which were shown at one or other of the trade exhibitions. Some of the latest products from overseas will be found elsewhere in the issue in the reviews of the German Radio Show and the International Show held in Paris.
Ferguson, H.M.V., Marconiphone, Ultra

A 16-in portable television set in "brief-case" format weighing 27 lb has been introduced by this group (British Radio Corp.). Known variously as the "Courier" (Ferguson), "Companion" (Ultra) and "Sixteen" (H.M.V.), it features automatic line system switching (using switches operated by solenoids when the channel selector is turned to the BBC-2 position); a transistor u.h.f. tuner; pre-set ("memory") fine tuning for individual channels; and a capacitive mains dropper which reduces heat dissipation within the cabinet but restricts the set to a.c. mains supplies. The chassis is the standard Thorn design on a single printed-circuit board, except that in the interests of compactness the scanning and sound output circuits have been separated off and conventionally wired.

All four makes have an all-transistor radiogram with four wavebands and stereo output; a common chassis and record-changer (Garrard 3000 with low-mass pickup arm and high-compliance ceramic cartridge) are used, but the cabinets and other details of presentation vary (as do the prices). The Ferguson 3322 has 7 watts output per channel while the H.M.V. 2318, Marconiphone 4310 and Ultra 6320 have 3 watts output per channel. Marconiphone, who, unlike the other makers, supply only through wholesalers, have a remarkably low priced four-waveband radiogram (monophonic), the 4308 "Popular," at 391gn.

Dual-purpose car/home portable transistor radio receivers are also featured by the group—the Ferguson Auto Twin Mk. II, the H.M.V. "Convertible," the Marconiphone "Travelmaster" and the Ultra "Road Ranger." All are characterized by a "car" push-button which when operated cuts out the internal ferrite aerial and substitutes a permeability tuned circuit for working with the car aerial, thereby improving performance and reducing ignition interference. Wavebands are m.w. and l.w. but H.M.V. have a de luxe model providing in addition v.h.f., and another model housed, unusually, in a wooden (teak finished) case.

Decca

Latest of this company's radiograms with stereo output is the SRG700 Mark II, which has an all-transistor circuit, four-waveband reception and a Garrard AT6 record changer with a Decca Deram pickup. In each sounding channel the 5-watt output drives a system of four loudspeakers: a 10in X 6in bass unit, and three 4-in units for middle and high frequencies which can be rotated on their axes to vary the sound direction by an edge-operated wheel on the front of the cabinet.

Decca Diadem transistor receiver.

All the new portable transistor radio receivers cover v.h.f. as well as m.w. and l.w. and one model, the TP89, priced 30gn, includes also a short-wave band (16.451 m). A telescopic aerial is provided for v.h.f. and s.w. reception. One of the three-waveband sets, called the "Diadem," is presented in solid wooden cabinet (teak or rosewood), with a lid covering the horizontal tuning scale, after the fashion of a musical box.

Two 19-inch and one 23-inch dual-standard television sets all have forward-facing loudspeakers and a pre-set fine tuner for 405-line channels.

Ferguson Companion portable receiver.

Ferguson 3322 transistor radiogram.
Pye, Ekco, Ferranti, Invicta, Pam, Dynatron

New television receivers from the group use a transistor integrated tuner with six push button settings which can be preset mechanically to select any six channels in Bands I, III, IV and V. A separate line system switch is not required, changing from 625 to 405 lines is automatic when selecting the channels. Some of the television receivers which use the integrated tuner are—the 19-in Pye 40/F (69 gn), the 16-in Invicta 7166 (65 gn) and the 23-in Pam 5151 (82 gn).

In their radio receivers, Ekco have introduced the recently developed integrated switch pack which they state will form the heart of new Ekco press button receivers for several years. The pack contains the wave change circuit in one precision-built unit which is connected to the printed circuit by only four wires. One of the first Ekco receivers to incorporate the switch pack is the PT447 (25 gn) which uses a 7-in elliptical speaker giving over 1 W output. Four wavebands are covered, and v.h.f. Sockets for earphone, tape recorder and external aerial are provided.

Features of the range of Dynatron radiograms with stereo output include separate tuners and preamplifiers and amplifiers utilizing semi-conductor circuit techniques. The range is divided into two groups—the 16/20 Transpower and the 12/10 Transpower. Details of models in the 16/20 group include a four-waveband press button radio tuner (long, medium, short and v.h.f.) which is adaptable for multiplex stereo radio by plugging in a decoder unit; a preamplifier; and two 10 W push-pull output amplifiers which at full power have less than 3% distortion and an overall frequency response of 30 c/s to 15 kc/s ± 3 db; a Garrard AT6 Mk. 11 auto changer. In this group, prices range from 132 gn for the RG37S to 260 gn for the RG29S. Models in the 12/10 group cover the same wavebands but the power output is 5 W per channel and the overall frequency response is 80 c/s to 14 kc/s. Prices range from 99 gn for the RG41S to 139 gn for the RG39S.

Ferranti have introduced a three-channel four-waveband radiogram, SRG1144 (96 gn) in which the output from the pickup is fed into a 500 c/s crossover filter for frequency separation in order to minimize intermodulation distortion. Signals above 500 c/s are fed to left and right channel amplifiers for normal stereo reproduction, but signals below 500 c/s, not being particularly directive, are fed to a third amplifier channel which drives a 10 in elliptical bass-reflex speaker mounted between the two 8-in left and right speakers. Music power is 3 W for each stereo channel, 5 W for the bass channel and distortion is less than 0.5%. Sensitivity is 5 µV for 500 mW output.

Two table model transistor receivers for a.c. mains operation are available from Ferranti. These are the four waveband A1143 (33 gn) and the A1149 (15 gn) covering the l.w. and m.w. bands.

Roberts

Latest addition to the Roberts range of portable radio receivers is the R404. This two-waveband set employs seven transistors (including a complementary pair in the output stage feeding one watt to a 7×4 in loudspeaker) and three diodes. Sockets are provided for a car aerial and earphones. The wooden case, which stands on a ball-bearing turntable, measures 11½×7×4 in. It weighs 6 lb and costs 17 gn.
Bush, Murphy

Included among the new transistor radio receivers from Bush are the TR116 (17 gn) with long-, medium- and short-wave coverage and the TR130 (15 gn) for the medium- and long-wave bands. Two receivers which incorporate bandspread tuning for the lower end of the m.w. band are the TR132 (17 gn) covering also the l.w. band, and the VTR133 (23 gn) with l.w., m.w. and v.h.f. coverage. A new radiogram with stereo reproduction, the SRG107 (125 gn) has been introduced. Three wavebands are covered, long, medium and v.h.f. The circuit contains twelve semiconductors, and an output of 5 W per channel energizes a loudspeaker system which incorporates six speakers in an acoustically balanced network.

Three new television receivers, each available with a u.h.f. tuner, have also been announced. These are a 19-in TV 135R (59 gn), a 19-in TV 135 (65 gn) and a 23-in TV 138R (71 gn). The tuner costs an additional 8 gn for each model.

In the Murphy Magna range three new transistor radio receivers are available each of which has an output of approximately 1 W. Bandspread at the lower end of the m.w. band is featured on two of the models. The B815 (16 gn) for medium and long waves, and the B837 (23 gn) which also covers the v.h.f. band. A telescopic aerial is fitted for v.h.f. reception and provision is made to connect an external v.h.f. aerial. The other model, the B818 (15 gn) has push button selection for long and medium bands and 208 m. Sockets for car aerial, earphone, tape recorder or extra speaker are fitted.

Three new 19-in television receivers—V939 (63 gn), V979 (66½ gn) and V929 (59 gn)—are announced together with a 23-in model (69½ gn). Each model can be obtained with a u.h.f. press button tuner for BBC-2 at an additional cost of 8 gn.

Sobell, G.E.C., McMichael, Masteradio

Three screen sizes are available in the new range of television receivers and six of the seven models use identical chassis. The 19 in receivers are models 1012 (Sobell), 2012 (G.E.C.), 3011 (McMichael) and 4011 (Masteradio) and the 23 in are models 3013 (McMichael) and 4013 (Masteradio). (The price of the 19 in models is 69 gn and the 23 in models 79 gn.)

The model 2015 (G.E.C.) is the first British 13 in receiver to appear on the market and uses an RCA tube. The chassis is a modified version of the 1010 (which uses the Mullard v.h.f. tuner and a transistor u.h.f. tuner) —a PL81A is used in the timebase circuits in place of the PL500.

Wireless World, October 1965
Philips, Cossor, Stella

Features of the new range of Philips television receivers are increased e.h.t. giving, it is said, a 12.5% increase in brightness, and the inclusion of an electric clock which automatically switches the set on at a pre-set time. The two receivers incorporating a clock are the 19 in model 9173 (72 gn) and the 23 in model 3173 (81 gn) which each employ a panorama tube, as do the companion models 9170 (63 gn) and 3170 (75 gn) which have different styled cabinets and no clock. A new 19 in receiver (CT1974A/02) has been introduced by Cossor which has the same basic chassis as the Philips range.

Two new transistor portable radio receivers are added to the Philips range—the 345T "Le Mans" and 247T "Cadiz". A feature of the "Le Mans" (154 gn) is that its normal output of 400 mW can be stepped up to 1 watt for group listening. Two i.f. stages give increased selectivity. A 6 x 4 in speaker is employed and sockets are provided for car aerial, tape recorder and earphone.

A feature of the new Stella ST7228T a.m./f.m. portable is a special biasing circuit which reduces distortion normally introduced as the battery voltage falls. Nine transistors and seven diodes are employed. The ST7228T weighs 4 lb and costs 251 gn. Cossor’s latest portable is the CR1315T (131 gn) which covers the l.w., m.w. and v.h.f. bands, has a 500 mW output from its 5 x 3 in speaker and has provision for a car aerial and earphone.

Four radiograms, two with stereo outputs, comprise the new Studio Range of Philips. They are the Studio Three (39 gn) the radio of which covers the m.w. band only, the Studio Five (47 gn) covering both l.w. and m.w. and employing a Garrard 1000 autochanger unit; the Studio Seven (61 gn) with an output of 3 W on each channel; and the Studio Nine (72 gn) covering v.h.f., l.w. and m.w. with stereo output and the Garrard 2000 autochanger.

Defiant

Under the trade name of Defiant, the Co-operative Wholesale Society has introduced several new models among which are four new dual-standard television receivers, two radiograms and two radio receivers. The television receivers are the 19-in., 9A72U (72 gn); the 19-in., 9B63U (79 gn); the 23-in., 3A66U (81 gn) and the 23-in., 3C65P (89 gn). Each uses the well tested Mk. 9 chassis with refinements. The 3C65U has separate push-button tuners for u.h.f. and v.h.f.; the u.h.f. tuner utilizes mesa transistors, whereas low-noise frame grid valves are used in the v.h.f. tuner. One of the radiograms, the PC6 (33 gn) for a.m. reception and mono record reproduction has a four-valve circuit with a B.S.R. UA25 record changer. The other radiogram, the AF88, is "all transistor" (14 in all), has stereophonic output of 4 W per channel and is priced at 72 gn. A Garrard 1000 series record changer, fitted with a Sonotone 20T1 stereo cartridge, is used. Both the new radio receivers—the A44 (14 gn) and the A58 (16 gn)—cover the l.w. and m.w. bands and employ 7-transistor circuits with a complementary-symmetry output stage. Power output is 0.4 W and 1 W respectively for the A44 and A58.

Portadyne

Two new a.m. radiogramophones, one (RG400S) with stereo output, have been brought out by Dynaport Radio and Television. Both receivers cover three wavebands. The mono radiogram (RG880 costing 32 gn) has a 4.5 watt output from the three-valve receiver. The RG400S (381 gn) has an output of 2.5 watts per channel. Both have four-speed automatic record changers and are fitted with roll away doors concealing the motor compartment.

Fidelity

Latest introduction to this firm’s range of sound receivers is the RG32 radiogram with stereo output. The receiver covers m.w., l.w. and v.h.f. and each 3-watt sound channel feeds a 9in x 6in loudspeaker. The record changer is a B.S.R. 101-inch model. A companion monophonic radiogram is the RG31, again with a three-waveband a.m./f.m. receiver circuit.

Transistor portable radio receivers include the "Galaxy" which covers the long, medium and short (5.5-15 Mc/s) wavebands and has a telescopic s.w. aerial, and the "208" which provides bandsplitting at the lower end of the m.w. band and has a 7in x 4in loudspeaker.
Grundig

The chassis for the two television receivers introduced some months ago by Grundig Great Britain are produced by Plessey but are housed in imported cabinets. The two models are the K230 (129gn) and the K430 (365 gn) which is also a radiogram with a stereo output of 6 W per channel. Both sets have 23 in tubes.

Three receivers have recently been introduced from Germany. The Transonette 60 (15 gn) is a m.w./l.w. portable in a similar styling to the Transonette 70, which covers m.w. and s.w. The transistor line-up is different and the (complementary) output stage delivers about 1 W into a 5 in loudspeaker with a ceramic magnet.

The Ocean Boy receiver is now available in Britain, and was first introduced in Germany in 1962. The receiver features two loudspeakers, a tuning/battery meter, a.f.c. and covers l.w., m.w., s.w. (now 1.6-30 Mc/s, in four bands) and v.h.f. Bass and treble controls are included. For short-wave reception, the oscillator emitter current is fixed by an additional transistor in a stabilizing stage. The circuit has undergone considerable change, but the stabilizing stage and a 9 kc/s (a.m. only) whistle filter remain. The number of transistors in the audio stages has been reduced from 8 to 4 and an additional i.f. stage is included. Ferrite beads are used in the emitter decoupling capacitor leads in one of the i.f. stages.

This Satellit (illustrated) is similar in appearance to the Ocean Boy, but with a bandspread scale added above the loudspeaker grille. The s.w. coverage is as for the Ocean Boy but the separate bandspread scales cover the 16, 19, 25, 31, 41 and 49 m bands. (An amateur version is available in Germany which covers the 10, 15, 20, 40, 80 and 160 m amateur bands). Three additional transistors are used in the bandspread circuits. (The price of the Ocean Boy and Satellit is 87 gn and 117 gn respectively.)

Baird

The four latest television receivers in the Baird range all employ the same basic dual-standard chassis which has changed little since last year, although modifications, including the introduction of an integrated tuner, are being made. The 625 (76 gn) employs a 23 in panorama tube needing no safety screen. The second 23in receiver, a console with doors (654, costing 87 gn), and the 19in model 650 (68 gn) are not fitted with panorama tubes. There is also a 27 in receiver for group viewing. This meets the "schools" requirements and is housed in a heavy wooden cabinet with protecting doors which when opened, together with a top flap, screen the tube from ambient light. This receiver (656) costs £125 and is exempt from purchase tax. Each of these receivers has a front facing loudspeaker and the 656 has an output of 5 watts.

Bandspread tuning at the lower end of the m.w. band is provided in the a.m. two-waveband transistor receiver 103 (13 gn).

Hacker

Two specially developed Goodmans bass speakers, plus six high-note units, are employed in the Constellation RG50 radiogramophone introduced by Hacker Radio. Four of the treble speakers are mounted on extending panels that slide out from the sides of the cabinet to improve the stereo separation, the other two are fitted centrally. The twin class-A amplifiers each have an output of 10.5 watts and the receiver covers the v.h.f., l.w. and m.w. bands. Fitted with a Garrard AT60 changer the price is 185 gn. If a Garrard Lab 80 is fitted it costs an extra 14 gn.

Wireless World, October 1965
Valradio

Large-screen pictures of 33in x 24\(\frac{1}{2}\)in are provided by the "Unitel 33" projection television receiver illustrated here (price £280). As the one-piece top and side, which contains an internal mirror, is pulled forward the screen rises vertically to the viewing position and the set is automatically switched on. The "Duotel 34" (price £340) is of similar electrical design but the screen, which presents a 34in x 25\(\frac{1}{2}\)in picture, is in a separate cabinet.

The receiver covers both v.h.f. and u.h.f. television bands, has flywheel sync on both line systems, double-D scanning for maximum brightness and a 3.5-watt sound channel output. To ensure consistent performance and reduce readjustments to a minimum the mains supply is regulated to give a constant voltage ±0.5% for supply changes up to 25%. Comfortable viewing distances are stated to be from 5 ft to 50 ft.

Alba

The "Scout" Model 737 (14 gn) transistor receiver is an interesting addition to the Alba range. It is unusual in that it does not use a printed circuit! The major part of the circuit consists of two micro-miniature modules which replace the conventional i.f. and a.f. stages. Two wavebands (long and medium), with bandspread at the lower end from 195-215 m, are selected by means of push-buttons. Car aerial and tape recorder sockets are provided. Other additions to the Alba range include seven radiograms and three television receivers. Of the radiograms, the "Viscount" model 9004 with stereophonic output is the most expensive at 134 gn. In addition to covering the l.w. and m.w. bands it covers 3-27 Mc/s in two bands and the v.h.f. (87.5-108.5 Mc/s) band. A bandspread control is operative on all wavebands except v.h.f. which has an a.f.c. tuning facility. Frequency response is 35 c/s to 18 kc/s and power output is 8 W per channel. A socket is provided for connecting an f.m. stereo decoder. The T1095, 19-in television receiver (68 gn complete with u.h.f. tuner) incorporates a facility on the v.h.f. tuner for permanent fine tuning adjustment of any channel in bands I and III. The control is pressed in to engage the tuning mechanism, the fine tuning adjustment is then made and when the control is released the channel tuning remains set for future use.

Falcon

What must be one of the lowest priced of the new radiograms is this company's "Monaural," an all-transistor model covering m.w., l.w. and s.w. (15-50 m) and giving 2 watts output into the single 8in x 5in speaker. The price is 31 guineas.

Other radiograms (in which this maker specializes) all have stereophonic outputs and are based on two main chassis: a 7-valve design covering l.w., m.w., s.w. and v.h.f., and an all-transistor circuit for long- and medium- and short-wave reception only. Two 8in x 5in speakers and a B.S.R. record changer are used in all models.

Elpico

A continuously tuned r.f. stage is employed in the CR655 car radio from Lee Products. Other features of this transistor receiver, which retails at 14 gn, include a push-button tone control, its small size (2 X 7 X 4 in) and a 3-watt output. It is suitable for all 12 volt d.c. systems of either positive or negative polarity and is provided with an external 7 X 4 in speaker. Flying leads for aerial, speaker and power connections are also provided along with speaker baffle and all the necessary hardware. Sensitivity is quoted to be better than 6.5 \(\mu\)V in the medium-wave band and better than 12 \(\mu\)V on long waves.

Perdio

Perdio have added a transistor radiogram to their range. Called the Stereo 22, it has a BSR UA25 deck and covers the long- and medium-wave bands and 15 to 50 metres. Two 8 X 5 in speakers are fitted to the Stereo 22, which is priced at 52 gn.

Wireless World, October 1965
Dansette

The Princess Olympic transistor portable radiogram (19½ gn) added to the Dansette range of receivers is powered by six HP2 batteries, but a mains adaptor is available for an extra 2gn. It incorporates a two-waveband receiver, is fitted with a BSR GU7 motor and measures 12½ x 13½ x 6¼in.

Daystrom

Although there are no new receiver kits for the home constructor from Heathkit this year we feel that one, although not new, deserves mention. This is the GC-1U (Mk 2) general-coverage receiver covering 580 kc/s-30 Mc/s in five bands with four bandspread scales. The most interesting feature is the use of piezo-electric i.f. transformers which do not appear to have been taken up by manufacturers generally, which is perhaps odd since alignment procedure is simplified and in many cases space would be saved. The Heathkit design eliminates two conventional transformers and two further ceramic resonators are used in place of emitter capacitors in two of the i.f. stages. This produces a sharp i.f. response and the 6dB bandwidth is about 3 kc/s.

Ever Ready

The latest additions to the Ever Ready range of transistor portables are the Sky Baby (£11) and the Sky Queen Mk III (14gn). Both have complementary transistor output stages; the audio output of the first being 200 mW and of the second 500 mW. The seven-transistor Sky Queen employs a two stage i.f. amplifier; the Sky Baby having a single stage.

IMPORTED SETS

SABA have just introduced their first transistor stereo radiogram. Called the Breisgau 16, it has an output of 12 watts per channel and the volume control is connected to a tone compensatory network which raises the bass and treble at low volume. A reverberation unit is fitted. Another all transistor unit from Saba is the Hi-Fi Studio II tuner/amplifiers. This covers the long- and medium-wave bands, v.h.f. and the 49 metre band (bandspread), and has an output of 12 watts per channel. A stereo decoder is fitted as standard and, complete with two speakers, the price is 168 gn.

STANDARD.—Claimed to be the world’s smallest f.m./a.m. receiver is the Model SR-Q460F nine-transistor portable from the Standard Radio Corporation, of Japan. Its actual dimensions are 2½ x 2 x 1½in and it weighs 7oz, with batteries. A 1½in speaker is used in this set which has a quoted output of 160 mW maximum (90 mW undistorted); an earphone socket is also provided. Coverage is from 88 to 108 Mc/s in Band II and 540 to 1600 kc/s. Retail price is 19½ gn.

AKKORD.—A new model in the range of West German Akkord transistor car/portables is the de luxe Finguin 800. This is a four-waveband (40 to 50 metres on the short-wave band) set, which may be operated from either its own battery (six U2), a car battery or from the mains, via a converter costing £5 10s. Features of this receiver include automatic preset push-button tuning for three f.m. stations, a tuning indicator and two tone controls. An extension speaker (price 3gn) is available for this 69gn set. A somewhat similar portable-cum-car radio, the 770, with the same coverage as the 800 has also just been released in the United Kingdom. This is priced at 48gn, with extension converter and car bracket as extras.

TELEFUNKEN.—While sockets are provided for stereo decoders on some of the table radios and radiograms, others are already fitted with pilot-tone decoders. One such radio is the fourteen-valve Opus Stereo tuner/amplifier. This four waveband unit has an eight-watt per channel output and an f.m. input sensitivity of 1 eV for a 26 dB signal-to-noise ratio. Other features include separate, continuously variable bass and treble controls (up to 12dB, switched in and out of circuit by two push buttons), up to 40dB adjustment on the balance control and a stereo indicator. Speaker enclosures, each containing a medium treble indicator (5½ x 7½in) and a woofer (7½ x 13½in), price 20gn each, are available for this 99-gn tuner/amplifier.

KÖRTING.—Two new portable-cum-car radios have just been added to the range of transistor portables made by the West German company Körting. The cheaper of the two, the TR643 at 29½ gn, covers the long- and medium-wave bands and f.m., and the other, the TR680 (36½ gn), is a four-waveband receiver (one short-wave band) with a.f.c. A special mounting bracket is offered for the TR680 which allows the receiver to be fitted beneath the instrument panel.

ARENA.—Only recently introduced into Britain is the Arena range of stereo table radio receivers, tuner/amplifiers and associated equipment, made by Hede Nielsen Fabriker A/S, of Denmark. The Model TI900H mains-operated table radio employs transistors throughout and has an output of eight watts per channel. Sinus 4 x 6 in pressure-chamber speakers are used in this receiver which can be supplied with or without stereo decoder (prices 72 and 65 gn respectively).

CLAIRTONE.—A range of stereo radiograms using the same chassis is available; variation being in the choice of gram deck and in cabinet styling. The a.m. section of the chassis covers the long- and medium-wave bands and 170 to 345 kc/s. The latter, which partly overlaps the long-wave band (140 to 290 kc/s on this receiver) has been incorporated to allow reception of the Swiss wired broadcasting service, which is put out over the country’s telephone
system. (The upper part of this range of frequencies is used throughout the world for radionavigation.) The f.m. section of the receiver covers 88 to 108 Mc/s and has a stereo decoder fitted as standard. A 10 watt r.m.s. rating is quoted for each of the two audio amplifiers which require an input of 50 mV for an 8 watt output at 1000 c/s.

UNITRA.—A low-priced five-wave band radiogram (39 gn) from Poland has just been introduced to Britain by Daltrade. Actual coverage is 89.5 to 108 Mc/s in Band II, 6 to 10 and 11.8 to 22 Mc/s in the short-wave band, 150 to 280 kc/s long-wave band and 560 to 1600 kc/s medium-wave band. A Garrard 1000 four-speed automatic changer (fitted in this country) is employed. Five valves are used, giving an output of two watts.

BANG & OLUFSEN.—The latest item in the Bang & Olufsen range of products is the Beomaster 1000 stereo amplifier/f.m. tuner. Features of this shallow transistor amplifier/tuner (3½ x 19½ x 10 in), which has an output of 15 watts per channel, include push-button speaker changeover switches, separate bass and treble controls, separate bass and rumble filters and a compensated volume control. A decoder unit is fitted as standard in the British version of the Beomaster 1000, which has a sensitivity of 2 µV for 26 dB signal-to-noise ratio; full limiting at 3 µV. Channel separation on the decoder is better than 35 dB.

NATIONAL.—Automatic tuning is featured in the R-1000 ten-transistor portable from National. This Japanese set employs a clockwork mechanism, which when operated sweeps the medium-wave band—in one direction—until a station is reached. Three levels of sensitivity are provided; for “DX,” medium distance and local listening. Provisions are made for manual tuning. The price is 19 gn.

SONY.—For more than a year a small portable television receiver has been on the cards from Sony. It has now arrived, a nine-inch model that weighs only 12 lb, but it will not be in the shops until later this year. Known as Model TV 9-306UB, it is a dual-standard receiver covering Bands I, III, IV and V and will operate from either the mains, a car supply (12 volt) or from a re-chargeable battery pack (12 gn). Sockets are provided for an external aerial, for tape recording and for earphones. The price is 85 gn.

BLUE SPOT.—Two Blue Spot (Blaupunkt) car radios with v.h.f. coverage appeared this year. Both receivers offer multi-wave band coverage. The higher priced set, the Köln ATR (78 gn), has an automatic station finder, which utilizes an electric motor. A sensitivity switch is provided which allows the station finder to over-run the lower strength stations. Manual tuning is also provided on this German receiver which covers the long- and medium-wave bands and 87 to 104 Mc/s in Band II. In addition, a short-wave band covering 5.9 to 6.35 Mc/s is provided on the other receiver, the Frankfurt (52 gn).

A transistor converter suitable for any Blaupunkt car radio is offered at 18 gn for the short-wave listener. Known as the KV 900 adaptor, it is easily fitted beneath any installed receiver and derives its power from the main receiver. Waveband coverage is 13, 16, 19, 25, 31, 49, 60 and 90 metre bands; selection is by push-button. The medium-wave scale of the main receiver is used for an indication of tuning.

Many “made-to-measure” installation kits for British cars are offered along with numerous accessories, from a second speaker to a voltage divider for 24 volt systems.

SHARP.—A world time chart is contained in the lid of the Model FV-1700 “Intercontinental” transistor receiver. This Japanese set covers 1.6 to 26.5 Mc/s in the short-wave band (split into three), the long- and medium-wave bands and 86.5 to 108 Mc/s in Band II. Operating from 12 volts, the receiver FV-1700 may be used in a car, sockets being provided for connection to an external power source and car aerial. A 6 x 4 in speaker is used and the maximum output of the receiver is quoted as one watt (0.7 W undistorted). Features include a b.f.o. for c.w. reception, a.g.c. and a.f.c. Retail price is 69 gn.

NORDMENDE have introduced a baby brother to their 15-waveband Transita-Globetrotter named Globetrotter Jr. (in all countries other than U.S.A. and Canada where it is called Transita TS de luxe). This covers five wavebands with bandspread tuning on the 49 metre band and can be used as a car radio; output is quoted as 4 watts when operated from a car battery. Features of this set include an internal 5 x 7 in speaker, a bass control and a continuously variable treble control. The dimensions are 8 x 11 x 3½ in, and the price 49 gn.
A Non-resonant Loudspeaker Enclosure Design

By A. R. Bailey, M.Sc. (Eng.), Ph.D., A.M.I.E.E.

—USING ACOUSTIC TRANSMISSION LINE WITH LOW-PASS FILTER CHARACTERISTICS

Over the years, the design of loudspeaker units has progressed steadily until some are now available with very good performance capabilities. In particular, the advent of expanded polystyrene as a cone material has greatly reduced the distortions due to cone break-up.

Unfortunately, the design of loudspeaker cabinets has not kept pace with these developments, and there is little doubt that many enclosures now introduce more coloration than that produced by good loudspeakers. The loudspeaker enclosure to be described was developed to give as little coloration as possible, but to understand its evolution it is necessary to return to basic principles.

![Fig. 1. Section through bass reflex cabinet.](image)

By far the largest number of current loudspeaker cabinets are based on the "bass reflex" cabinet design. This is shown in Fig. 1 as a sectional view. This cabinet appears to have only a relatively short path-length between the back and the front of the cone and would therefore be expected to give relatively poor low frequency response. In fact the response at low frequencies can be quite large, this being due to the cabinet having a Helmholtz air-column resonance at about the lowest frequency being reproduced. In the reference given previously, the theory is well explained.

Unfortunately, this resonance in the cabinet causes coloration in the bass output of the system. This "ringing" on bass transients can be very noticeable, particularly on such instruments as string bass.

In addition the cabinet itself is frequently unlagged and consequently the sound is still emerging long after the original signal has stopped. Very heavy lagging is necessary to stop this effect and in so doing the cabinet "Q" is reduced so that the bass reflex action is lost.

Sine-wave testing does not necessarily show up the defects of a speaker system. Rapid cut-off at the edges of a flat response can make it sound far worse than a slower rate of fall at the edges of a system with apparently a poorer bandwidth. This is shown in Fig. 2.

The effect of the abrupt change in slope of the amplitude/frequency characteristic is to give "ringing" at the frequency where the slope change takes place. This effect is unavoidable and is the necessary price to pay for the extension of bandwidth by the use of resonance effects. It is for this reason that loudspeaker systems can sound very "boomy" in the bass, even though the measured amplitude response shows no resonant peaks.

One method of testing that has not apparently been widely used is that of impulse-testing of loudspeaker cabinets. This method is very powerful and is described later on. For the moment it is sufficient to state that it confirmed that normal loudspeaker enclosures are not very good.

It is now apparent that it is the sound waves produced at the rear of the cone that have to be absorbed if delayed output and resonances are to be avoided.

Acoustic labyrinths have been used in the past in an attempt to "lose" the sound down multiple paths. Such an enclosure is shown in Fig. 3, but the size needed is excessive. Unless there is adequate internal lagging, then these cabinets will also possess pronounced energy storage and the consequent lack of sound clarity.

Transmission line approach

The only safe method of removing the rear cone sound energy is by transmitting it down an infinite transmission line. This is obviously impracticable so the nearest approximation was examined.

If a transmission line for acoustic waves is filled with

![Fig. 2. Response curves having different transient responses.](image)
a light acoustically-resistive medium, then the transmitted wave will be rapidly attenuated. After a certain distance the wave will be so weak that a blockage of the line will give only a minute reflected wave back to the speaker cone. The magnitude of the reflected wave can be determined by the standing-wave ratio immediately behind the speaker.

The choice of acoustic absorbing material will greatly affect the final performance so an initial investigation was made into the reflecting properties of various acoustic transmission line terminations. Many materials including glass fibre were tried, but the best results were obtained from long fibre wool. This gave a remarkably good absorption down to quite low frequencies. A typical set of the curves obtained is shown in Fig. 4.

For practical purposes a long pipe is not desirable so experiments were then made with a folded pipe of total length of about 8ft. This gave a remarkable good absorption down to quite low frequencies. A typical set of the curves obtained is shown in Fig. 4.

Opening the port had two effects. First, the bass response was improved to become approximately flat and secondly the cone excursion was greatly reduced between 30 and 50 c/s. The bass improvement was due to the line length being such that the delayed bass wave from the line was in phase with that radiated by the front of the cone. Also as the bass frequencies were radiated from two spaced sources, the diffraction effects would be reduced.

As the wool-filled line acts as a low-pass filter, the radiation from the vent cuts off before cancellation can occur at the higher frequencies. The rapid cut-off of this acoustic line is shown in Fig. 6. This shows the sound pressure at the port end of the line with the port closed.

**Impulse response**

As the performance so far appeared to be satisfactory it was decided to investigate the impulse response of the loudspeaker cabinet. The square-wave testing of loudspeaker units had previously shown that it was not possible to generate a good square-wave of sound pressure, let alone an impulse. Several mechanical methods were then tried but none proved to be really satisfactory. The author is therefore indebted to his colleague, R. V. Leedham, for suggesting the use of exploding wires as a standard impulse source.

Exploding wires proved to be a delightfully simple and accurate method of generating an acoustic impulse.
Basically the method involved discharging a low inductance capacitor of high value (1000 µF) charged to about 250 V through 1 cm of 40 s.w.g. tinned copper wire. The wire is vapourized almost instantaneously and the acoustic impulse produced had a rise time well into the supersonic region. Spark-generated impulses could have been used, but a high-voltage source is necessary of considerable stored energy if an adequate impulse is to be produced. As exploding wires were less lethal experimentally and only needed standard power supplies, the use of a spark source was not pursued.

The measuring microphone used had a working bandwidth of 30 to 10 kc/s and was used inside the cabinet at a distance of 18 in from the exploding wire source. The exploding wire was operated at the position where the loudspeaker would be used, the loudspeaker opening being blanked off.

The results appear in Fig. 7a, the initial impulse being just discernible. The results were felt to be very creditable, the large damped oscillation being the flexure of the 1/4 in blockboard immediately behind the exploding wire. The experiment was then repeated with a bass-reflex cabinet of identical size having a port area of some 24 in² and unlagged internally. The results were markedly dissimilar. Acoustically a much louder hollow explosion could be heard and the microphone pickup showed a far larger spurious output for a much longer time. This is shown in Fig. 7b, the sensitivity and time scales being identical with that of the previous test.

The cabinet was then lagged internally with sound absorbent and the test was repeated. The result is shown in Fig. 7c, the resonance obviously being better damped but still far worse than the line type of cabinet.

Listening tests proved that the cabinet had a "cleaner" sound than the bass reflex type, the effect of the line being very noticeable in its lack of coloration on speech. Transient response was definitely better on the line speaker, the sound being more "tight" and natural.

For obvious reasons it is preferable to have the long axis of the loudspeaker in the vertical plane. The cabinet ducting arrangement was therefore rearranged and one commercial form is as shown in Fig. 8. To make the most of the cabinet it is obvious that the loudspeaker units must not possess large colorations of their own. The units quoted give very good performance although other equally good units may be available. The cross-over frequency used is 1500 c/s.

The frequency-amplitude response of the complete loudspeaker system is shown in Fig. 9. The rate of fall at the low frequency end is creditably slow and far better than the majority of systems in use. It is not unknown for rates of cut-off to be as high as 18 dB per octave and to start very rapidly. This gives rise to a "heavy" bass effect that some people prefer; it is, however, not natural.

The bass resonant frequency of the speaker unit is below 15 c/s in the enclosure (about 30 c/s in free air) and quite well damped, so this will have no noticeable effect on the output. As the acoustic loading of the pipe
is, therefore, dominating the speaker unit, the low-frequency waveform will be better as the non-linearity in the loudspeaker unit suspension will be swamped by the linear acoustic loading.

The final subjective tests were very good. The sound quality is effortless and natural. At first hearing the bass sounds to be deficient but extended tests show that this is not so, it is merely that one has been conditioned to hearing resonant bass. The overall effect is surprisingly unexciting—only natural. In over a year's use of the system the author has noted, however, that musical listeners were very impressed with the result.

Practical Points

The cabinet design is not critical, and many variations are possible. The only cardinal point is that of keeping the pipe area above that of the cone. A rather strangled result can occur if an attempt is made to save space by restricting the pipe area much below that of the speaker cone. It must also be noted that a poor speaker does not usually sound much better in a good cabinet as the speaker deficiencies dwarf the improvement.

The application of the principle of the design is the subject of a Patent, but there is no restriction, of course, on private individuals making cabinets for their own use. For the amateur constructor the following points may be of use:

(1) The cabinet should be made of thick acoustically dead material, chipboard being generally better than plywood. Due to the absence of high internal pressures and the absorbing effect of the wool, the cabinet thickness and bracing are not as important as in the case of the bass-reflex.

(2) Acute bends in the pipe should be arranged to occur as far from the loudspeaker cone as possible to reduce the magnitude of standing waves due to reflections.

(3) The wool should be of long fibre length and packed fairly loosely, about one pound to every two to three cubic feet. The grade of wool is still being investigated for the optimum specification.

(4) Either spray the wool with mothproofer or take other suitable action or the cabinet performance may suffer from an ageing process.

The author has constructed several different cabinets of totally different sizes and geometry, and apart from narrow pipes and badly angled bends the performance has been remarkably similar. In fact a low resonance 4in unit has been used effectively and gave a good output at 35 c/s. The power handling capacity was, however, limited.

Acknowledgements.—In conclusion the author would like to thank Radford Electronics Ltd. for permission to give the details shown in Fig. 8. Also thanks are due to R. V. Leedham and other colleagues for their help and criticism.

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WORLD OF WIRELESS

V.H.F. or U.H.F.? 405 or 625?

LORD HILL, chairman of I.T.A., said recently, “It is clear that u.h.f. broadcasting is here to stay, but it may not be going to make the complete take-over bid that once seemed likely. Expert opinion has altered somewhat since 1962 when the Government White Paper proposed to change, by stages, the existing 405-line services to 625 lines. It now appears that there are technical and financial difficulties in duplicating the services in u.h.f. Some minds are turning to the possibility of changing to 625 lines within u.h.f. It seems clear that, whatever its merits, the u.h.f. system could not provide the same total coverage as v.h.f.; and then, of course, u.h.f. requires so many more stations.

“ If a suitable method of conversion to 625 could be found, several advantages are argued for keeping TV and the BBC-1 in v.h.f. First, it would avoid the great and continuing expense of duplication; second, it would avoid using valuable air space which may be needed for future services. Third, it would give the television industry a firm technical basis on which to plan their operations for the foreseeable future.”

Lord Hill went on to say, however, that “it rather looks as though the 405-line services may become a permanent feature of British Television and if this were so, then there might be grounds for reconsidering the original idea that only the 625-line services should have colour.”

The industry’s latest statement on this subject stresses the need for one standard (625 lines) for all services whether v.h.f. or u.h.f. B.R.E.M.A. in its statement acknowledges the difficulties in accomplishing the changeover to the new standard but it adds “these are not sufficient to justify a reversal of this decision,” as has been expressed in some quarters.

Higher-Power Satellites

DIRECT broadcasting of sound and television programmes from satellite repeater stations should be a reality within the 10 years, according to R. M. Bentley, manager of the “Early Bird” communications satellite project for Hughes Aircraft Company. Outlining his company’s present and future work in this field at the INEL 65 exhibition in Basle (p. 509), Mr. Bentley mentioned particularly a new communications satellite under development, the HS307. Weighing 600 lb and using a 600 W solar cell power supply, this satellite will have an e.r.p. of 7.5 kW (using a high-cain electronically “de-spun” aerial) and a capacity of 5,000 voice channels or 12 television channels. Hughes will also have a new low-cost (£350,000) fixed aerial ground station in operation in Arkansas by the Spring of 1966.

Amateur Radio Growth

THE 21 European national member societies of the International Amateur Radio Union now muster between them more than 150,000 members, of whom 40,000 hold transmitting licences, but by no means are all transmitters members of societies. Topping the list is the Radio Sports Federation of the U.S.S.R. (RSF) with 71,000 members followed by the Yugoslav society (SRJ) with 24,000 members. Both societies have a very large number of young members who pay only a nominal subscription. There are 10,500 amateur transmitting stations in the U.S.S.R. and 3,600 in Yugoslavia, but of these only 3,500 and 950 are members of the respective societies.

The Federal German Republic with 11,465 and the United Kingdom with 11,250 have the highest number of licensed stations among the western group of nations. Numerically the German society (D.A.R.C.) with 15,700 members (8,300 of whom are licensed) is ahead of the Radio Society of Great Britain with 12,750 members, of whom 7,700 are licence holders.

Looking beyond Europe, the Japanese Amateur Radio League with 16,100 members ranks second only to the American Radio Relay League with its 88,000 members. The U.S.A. with 255,000 amateur stations and Japan with 38,000 are world leaders followed by Germany (11,465), the United Kingdom (11,250) and Canada (10,500). At the other end of the list we have Syria (9), Iceland (10), Burma (25), Lebanon (25), Greece (26) and Jamaica (32).

The world total of licensed amateur stations is 498,000—by far the largest number of stations in any of the communication services recognized by the International Telecommunication Union.

American Subscription TV

R.K.O. GENERAL, operator of the only American subscription TV station (Hartford, Conn.), has obtained options on the Zenith Radio Corporation’s Phonevision system for operation in New York City, New Haven, Philadelphia, Washington D.C. and San Francisco. Exercise of these rights will depend upon assessment of results from the Hartford station and approval of the Federal Communications Commission. The Hartford station has been in operation as an experimental subscription TV station for three years, and recently the F.C.C. extended the licence for a further three years to give the station the opportunity to increase the number of subscribers. Programmes do not contain advertisements and are transmitted as scrambled u.h.f. signals and are unscrambled by a device fitted to the receiver.

On October 8th the opening of the 620 ft Post Office Tower in London will be marked by the issue of 3d and 1s 3d stamps featuring the tower. The design of the 3d stamp shown in the illustration uses two shades of blue and yellow and shows the tower rising from a symbolic foreground of Georgian type houses which are a feature of the immediate vicinity.

The Granada Lectures on problems of communications in the modern world arranged by the British Association for the Advancement of Science in collaboration with Granada Television will this year be held on three successive Wednesdays in October in the Guildhall, London. On the 13th Alistair Cooke will speak on “transatlantic communications,” on the 20th Dr. J. B. Rhine’s lecture is entitled “E.S.P.—what can we make of it?” and on the 27th Admiral H. G. Rickover, U.S.N., will discuss “a humanistic technology.” Tickets are obtainable free from the British Association, Sanctuary Bldgs., Gt. Smith St., London, S.W.1, or Granada, 36 Golden Sq., London, W.1.

The new members of the board of the Electronics Division of the I.E.E. are: R. J. Clayton (G.E.C. Electronics) who is a vice-chairman, Prof. J. Brown (University College, London), Dr. F. G. Heath (I.C.T.), G. King (Standard Telecommunications Laboratories), C. A. Marshall (Systems & Communications), Dr. W. H. Penley (Ministry of Aviation), and J. B. Smith (Ferranti).
Radio Show Special.—The Pye/Ekco group have fitted out a thirteen-coach train as a travelling radio show. One coach contains a fully operational local broadcasting station, another supplies 405- and 625-line pictures to other coaches, and another contains working demonstrations of radio-telephones and other communications equipment. Remaining coaches display the full range of Pye/Ekco domestic equipment. Cities in which the train will stop are Birmingham, Sept. 29th-30th; and—during October—Manchester, 1st-2nd; Glasgow, 4th-5th; Newcastle, 6th-7th; Nottingham, 8th-9th; and Norwich, 11th-12th. Free admission to the train is between 10.00 and 21.00.

A recently issued 24-page booklet, Careers with Instruments, broadly describes the various fields in which instruments are used together with comprehensive details of the different levels of technical education and the careers to which they lead. The booklet, price 2s 6d, is available from the Society of Instrument Technology, 20 Peel Street, London, W.8.


A changed specification for enameled and rayon covered conductors has been issued by the British Standards Institution under the title "B.S.3902 Enamed and rayon covered copper conductors (oleo-resinous enamel), Part 1 Round wire." The new specification replaces part of B.S. 2479 which is being withdrawn because the rayon it specified as an alternative to natural silk is no longer available. The publication, price 6s, is obtainable from British Standards Institution, Sales Branch, 2 Park Street, London, W.1.

Amateur transmitting licences in the U.K. totalled 13,531 at the end of June. There were 13,130 "A" sound licences including 1,893 for mobile operations, 236 "B" sound licences (for telephony operation above 420 Mc/s) including 2 for mobile operation, and 165 television licences.

Madam Popova, daughter of the famous Russian radio inventor Alexander Popov, is curator of the museum of radio in Leningrad—the city in which Popov gave in 1895 his first practical demonstration of radio telegraphy. (The city was then St. Petersburg of course.) Here she talks to Daniel Moillard, general manager of Société de Diffusion de Radio-Télévision, the French company which sells Ducretet Thomson domestic receivers. Eugène Ducretet was a contemporary of Popov's and collaborated with him on radio experiments for a period at the end of the last century.

A scholarship is being awarded annually by Dynamic Instruments Ltd. to allow a suitable candidate to attend a post graduate course in electronics at Southampton University. To qualify, a candidate should possess a degree or equivalent qualification in physics or electrical engineering although other qualifications, in mathematics for example, may be acceptable. The illustration shows the recipient of the 1965-66 scholarship, Mr. Charles Bockett-Pugh, who recently gained an honours physics degree from the new St. Catherine's College, Oxford.

Acoustics Congress.—The 5th International Congress on Acoustics was held from 7th-14th September at the Palais des Congrès, Liège, Belgium. An account of the proceedings will appear in the November issue. The 6th Congress will be held in Tokyo during the latter part of August, 1968.

Navigation Satellites.—The use of the forthcoming series of NASA Applications Technology Satellites (A.T.S.) was discussed at a meeting of the American Astronautical Society held recently in San Francisco. Mr. Leonard Saffe, NASA Communication and Navigation Programme Director, referred to a navigational system whereby satellites in medium-altitude and synchronous orbits would provide information on the position of ocean craft to ground computer stations. It was also suggested that experiments will be undertaken enabling small ground stations to have radio access to satellites.

The sixth in the series of international conferences on microwave tubes will be held at Cambridge University from September 12th-16th next year. The last was in Paris in 1964. Its title has been changed to Conference on Microwave and Optical Generation and Amplification and it is being organized by the I.E.E.

Steerable Aerials.—A forum for the exchange of ideas and information between those responsible for the design, construction and use of large steerable aerials will be provided by a conference being organized for June 6th-8th next year. The sponsors are the I.E.E., I.E.R.E., I.E.E.E., I.Mech.E. and I.Structural E.

The Post Office recently issued the ten thousandth licence for radio-controlled models. These licences, which were introduced in 1954 under the Wireless Telegraphy Act of 1949, cost £1 and are valid for five years. Frequencies allocated for radio control of models are 26.96-27.28 Mc/s and 458.5-459.5 Mc/s.

Which Switch?—Designers and constructors are reminded that Specialist Switches Ltd., of 23 Radnor Mews, London, W.2 (Tel.: PADDington 8866), supply single rotary switches to any specification.
PERSONALITIES

Prof. A. L. Cullen, O.B.E., Ph.D., D.Sc.(Eng.), who has occupied the chair of electrical engineering in the University of Sheffield since it was created in 1955, is the new chairman of the Board of the I.E.E. Electronics Division. After graduating at Imperial College, London, in 1940, Dr. Cullen joined the staff of the Royal Aircraft Establishment, Farnborough. From 1946 until his appointment at Sheffield he was at University College, London, first as a lecturer and later as a reader in electrical engineering. In 1959 he was awarded a grant of nearly £4,000 from the Paul Instrument Fund for the construction of a detector in which radiation pressure is used to convert a microwave signal to an audio or intermediate frequency. For the past year he has been visiting professor at the University of California, Berkeley. Prof. Cullen is joint author with Prof. H. M. Barlow of the book "Microwave Measurements."

Prof. A. L. Cullen

A. W. H. Cole, O.B.E., M.I.E.E., has relinquished his position as manager of the Marconi Company's Communications Division and became director of product planning. He joined the company in 1921, on leaving school. He entered the Marconi College in 1927, and was subsequently appointed to the technical staff, where he was concerned with the construction and operation of the first short-wave "beam" stations. In 1929, he transferred to Cable and Wireless eventually becoming personal assistant to the engineer-in-chief. By 1942, he had taken charge of a design and development group and he was ultimately responsible for the operational planning of services. In 1948, Mr. Cole returned to Marconi's as manager of the Marconi Company, first as technical manager of the Telecommunications Division and since 1962 chief engineer of the Electronic and Equipment Group. From 1947 until joining Plessey Mr. Dukes was with the Standard Telephones & Cables group. In 1961 he was elected a member of the Technical Committee of the British Space Development Company of which Plessey is a sponsoring company.

A. W. H. Cole

J. M. C. Dukes, M.A., D.I.C., A.M.I.E.E., has joined A.C. Cossor Ltd. as technical director. For the past six years he had been with the Plessey Company, first as technical manager of Wireless World, October 1965

D. W. Heightman, M.I.E.R.E., joint managing director of Goodmans Industries, Ltd., has also been appointed a director of Radio Rentals (U.K.), Ltd., and of Rentaset, Ltd. (all associated companies). In 1938 Mr. Heightman formed Denco Ltd., of Clacton, of which he later became managing director. In 1950 he joined the English Electric Company as chief television engineer. Since 1956 he has been with the Radio Rentals group which he joined as chief engineer. He has been a director of Goodmans since 1962.

D. W. Heightman

Sidney Sussex College, Cambridge, he held various appointments in the Admiralty Dept. of Scientific Research and Development from 1929 until 1940 when he was put in charge of development of naval gunnery radar in the Admiralty. In 1946 he joined Elliott Brothers as research director where he stayed until joining the staff at the University in 1952.

Prof. J. F. Coales, O.B.E., M.A., F.Inst.P., is the first chairman of the Board of the recently constituted Control and Automation Division of the I.E.E. For some years he was in charge of post-graduate studies in control engineering at Cambridge University where he now occupies the chair of engineering control. After graduating at

Prof. J. F. Coales

WIRELESS WORLD, OCTOBER 1965

489
Alec H. Reeves, A.C.G.I., inventor of pulse code modulation, is to receive the Stuart Ballantine medal of the Franklin Institute in America on October 20th. Mr. Reeves, originally joined the International Western Electric Company (parent of S.T.C.) and in 1928 went to the associated laboratories in Paris.

Throughout the last war he worked on radio-countermeasures and on guidance and accurate bombing systems for the R.A.F. Since 1946 he has been at Standard Telecommunication Laboratories at Harlow, Essex. Mr. Reeves, who was born in Redhill, Surrey, in 1902, originated p.c.m. while working in Paris but it was not until the coming of transistors that it could be used economically. It was employed to transmit television pictures of Mars from Mariner IV, and is also being used experimentally in the U.K. telephone system.

Lt. Col. J. P. A. Martindale, B.A., B.Sc., M.I.E.R.E., A.M.I.E.E., has been appointed full-time secretary of the National Electronics Research Council, of which Earl Mountbatten is chairman. Since the inception of the N.E.R.C. in 1961, G. D. Clifford, secretary of I.E.A.E., has also been secretary of the Council and will continue to assist it by following up discussions already held in Australia, Canada, India and New Zealand on the formation of similar bodies in those countries. Col. Martindale has been in industry for the past five years. During his military service he held various technical appointments in the Ministries and was at one time a member of the staff of the Royal Military College of Science.

R. W. Beattie has been appointed managing director designate of Electrosil Ltd., of Sunderland, Co. Durham. He was until recently an executive director of the Telephone Manufacturing Co. and manager of their Capacitor Division. Previously he was head of the physical laboratories at Automatic Telephone and Electric Co.

The Marconi Company has appointed D. G. Smees, M.B.E., Assoc. I.E.E., as commercial director. Mr. Smees has been with the Company since 1933, with the exception of the war years, and has been assistant general manager since 1963. He was formerly the manager of the Company’s Broadcasting Division. He joined the Company at the age of 26, working at the Research Laboratories until the outbreak of war, when he joined the Royal Signals. He later transferred to R.E.M.E. in which he attained the rank of major. Mr. Smees succeeds F. Wheeler, who has been with the Group since 1918 and is approaching retiring age.

D. P. Leggatt, B.Sc., who joined the B.B.C. in 1953 and since 1962 has been engineer-in-charge of television recording, has become head of the film unit of the Planning and Installation Dept. He is succeeded as e.-i.-o. television recording by A. E. Nicholas, A.M.I.E.E., who has been with the Corporation since 1947. For the past four years Mr. Nicholas has been engineer-in-charge of film maintenance at the B.B.C. Television Film Studios at Elstree.

Edward J. Whitmore, A.R.C.S., B.Sc., D.I.C., Ph.D., M.I.E.E., has been appointed manager of the newly formed Light Conversion Devices Division of the English Electric Valve Company. Dr. Whitmore was engaged in research into electron diffraction and crystallography at Imperial College from 1939 until 1941 when he joined Ferranti Ltd., Manchester, and worked on microwave engineering. He was chief engineer with Ferranti Ltd., Grangtown, Scotland, from 1947-55. He then joined the Canadian Marconi Company in Montreal as engineering manager. In 1960, he joined the Microwave Division of Sylvania Electronic Products Inc., U.S.A. Shortly after, he was made manager of their Williamsport operation, a position he held until his present appointment.

A. S. Figgis has been appointed chief development engineer of Rank Pullin Controls, part of the Rank Organization. Mr. Figgis, who is 38, joined the company more than ten years ago as a development engineer.

P. Goudine, M.A., managing director of Electronic Instruments Ltd., which was acquired by Cambridge Instrument Company in 1960, has been appointed technical director and as such will be responsible for research and development for both companies. Mr. Goudine, who is a past-president of the Scientific Instrument Manufacturers’ Association, took an honours degree in natural sciences at Cambridge University. He then worked on the design of aircraft navigational equipment and throughout the war was head of the research department of Smonds Aerocessories. Immediately after the war he formed Electronic Instruments Ltd. He is also director of the Minerva Detector Company which he formed in 1950.

M. Leeuw, author of the article describing slow-motion television techniques in this issue, joined the Philips organization in Eindhoven in 1925 at the age of 19. In 1957 he was appointed technical-commercial director of the radiogramophone and television group in Eindhoven. Since 1963 he has been in Japan.
Three Technical Colleges Fitted With Marconi Marine Gear

EQUIPMENT which will assist training students to become marine radio officers is to be installed in specially designed classrooms—closely resembling, in appearance, a vessel's radio room—at the South Shields Marine and Technical College, the Dublin College of Further Education, and at the Lowestoft Technical College. At the South Shields Marine and Technical College, where there is already quite a lot of Marconi Marine equipment, an "Editor" automatic transmission system is to be fitted. This high-speed, high-frequency transmission apparatus has automatic error correcting facilities and, for the past two years, has been used by Shell International Marine to communicate ship's performance data from selected vessels to their central office. The South Shields installation will be suitable for simultaneous two-way working. A close-circuit television installation of the type used to assist vessels in docking and general manoeuvring in restricted waters is also to be fitted. A Marconi Marine "Cruiser" and "Pennant" s.s.b. transmitter and receiver, an "Argonaut" v.h.f. transceiver, a "Forecaster" receiver and an 18-in weather facsimile recorder complete the South Shields installation.

A wide range of communications equipment, radio navigational aids and radar is to be installed at the Dublin College of Technology. This includes two "Oceanstream VII" transmitters and two "Atalanta" receivers, two "Lode-star" echo-sounders and two "Argus I2" stabilized screen radar installations.

At Lowestoft communications equipment and radio navigational aids, similar to that ordered by Dublin, are to be installed.

Myriad, the microelectronic computer developed originally by the Marconi Company, is to be used by the Central Electricity Generating Board in its experiments on automatic control of power generation and distribution. Together with analogue and digital input and output devices the order, placed with English Electric-Leo-Marconi Computers (E.E.L.M.), is worth £130,000 and follows a £1M order last year for four KDF7 real-time computers. The order represents the first sale of a Myriad for civil use, the computer previously being extensively used in radar defence systems. The Myriad, which has been described as a third-generation computer, can perform simple arithmetic in 2.5 μs. Myriad and its associated equipment will be used to study the transfer of information between a computer system and a human plant operator and also to investigate the value of predictive optimum control systems based on the use of a digital computer for continuous plant control. In addition it will be used with a supply system simulator to study plant loading techniques.

£1M Simulator ready for the Royal Navy.—The Solartron Electronic Group, of Farnborough, have completed a £500,000 contract for a digital simulator, which is soon to be installed in H.M.S. Dryad. It is to be used for training in blind piloting navigation, day-to-day firefighting, and manoeuvres—as well as tactical training of Command teams. A high-speed special purpose digital computer with an addition time of one microsecond and a cycle time of two is employed in this simulator, the correct title of which is Surface Tactical and Blind Piloting Trainer. The computer and associated central equipment—such as echo generators, resolver, symbol generators, output circuits, etc.—is housed in 20 nine-foot containers. The master and assistant control desks in S.T.B.P.T. contain normal surface radar display equipment—which can show the radar picture from any one of six radar carrying ships—a tactical display monitor, range and bearing indicators, repeater instruments, and various other controls. Each of the six radar-carrying ships provided by this simulator contains its own coast-line generators. Eighteen mobile targets which can be ships, aircraft, helicopters or submarines (all are steerable at speeds of up to 1,000 knots) are provided along with six fixed targets which can represent buoys or other sea marks.

American Radio and TV Figures.—According to production figures issued by the marketing services department of the Electronic Industries Association, a number of colour television receivers built in the United States in the first six months of this year totalled 1,083,093. This represents an increase of 80.7% on the comparable 1964 figure of 599,345. However, the production figures for black-and-white receivers for the same period during the year inasmuch as there was no significant change at 3,962,000 units in 1965—a rise of only 1.6%. Total radio production for the first six months of this year at 11.5 million units was 29.5 up on the first half of 1964. This figure includes car radios which in both years represents approximately half the total, and f.m. radios. A rise of 72.4% was noted in the production of f.m. receivers; this year's total being 1,410,418.
this year, one at Muro in the north and one at Mendro in the south. Marconi Band III transmitters will be used at both locations, a 5-kW vision and 1-kW sound in the north and a 10-kW vision and a 2-kW sound in the south. When both of these stations are commissioned R.T.P. will cover 95% of the country and reach 97.8% of the population.

Spytec Ltd. is the name of a new company formed by a group of engineers offering a design service to industry. Once a problem is posed, the company states, "the procedure is usually to prepare an initial brief proposal which outlines a practical modus operandi. This will indicate the extent of design aid development work and prototype equipment involved, together with estimates of cost and timescales, etc." The design offices and laboratories are at 34 Broadway, London, S.W.1. (Tel.: SULivan 3946.)

Plessey-T.C.C.—Following the acquisition of the Telegraph Condenser Company, Plessey's have decided to move their solid tantalum capacitor production lines from Towcester to T.C.C.'s premises at Bathgate, Scotland. T.C.C. ranges of solid tantalums will continue to be produced at Bathgate along with the Plessey ranges which, incidentally, will continue to be marketed at Towcester.

An ultrasonic system for locating leaks in underground pressurized communications cables has been introduced by the Delcon Division of Hewlett-Packard, Palo Alto, Calif. Actual locating is effected by placing a microphone (which can detect the ultrasonic energy released by dry air or nitrogen under pressures of 5 to 10 p.s.i.) next to the leak. Aluminium rods, that can be interconnected to give a working distance of up to 300 ft, are used for siting the microphone.

Machtronics Incorporated, manufacturers of video tape recorders of Palo Alto, California, are in future to be known as the MVR Corporation.

Kollsman Instrument Ltd., of The Airport, Southampton, Hants, have received orders for height and airspeed transducers from the Plessey Company and from Royston Industries. These transducers will be used in aircraft accident data and maintenance recording systems.

Japanese closed-circuit television equipment made by Ikegami and imported by Hornton's Electronics Ltd., of Lombard Street, London, W.4, now includes a low-cost video recorder.

Wesgrove Electronics Ltd., who make video tape recorders and automatic television cameras, have moved from New Street, Worcester, to 1 Maddox Street, London, W.1. (Tel.: REdaran 4114.)

U.K. Solenoid Ltd., of Hungerford, Berks, who manufacture rotary switches and contactors, have opened a London office at 19 Old Queen Street, S.W.1. (Tel.: WIlshill 5894, Telex 263994.)

Thorn-Parsons.—The sales office of the Thorn-Parsons Company has moved from Wellington Crescent, New Malden, Surrey, to 146 Great Cambridge Road, Enfield, Middx. (Tel.: ENfield 5353.)

Plessey.—Administrative headquarters of the new Electronics Group of the Plessey Company have been established at Surrey House, Temple Place, Strand, London, W.C.2. (Tel.: TEMple Bar 7722.)

G.E. Electronics (London) Ltd., of Eardley House, 182/4 Campden Hill Road, Kensington, London, W.8, have been appointed sole agents in the United Kingdom for the following American semiconductor device manufacturers: Crystalonics Incorporated; Solid State Products Incorporated; and Unitecon Corporation.

SGS-Fairchild's second United Kingdom factory is to be built on Middleton Farm, Grangemouth Road, Falkirk, Scotland. The site covers 114 acres and the new factory is scheduled to be in full production during 1967. A temporary factory of some 5,000 sq ft is now under construction and will be productive in the early part of October this year.

Green and Davis Ltd., of 104 Hornsey Road, London, N.7, manufacturers and distributors of communications equipment, have changed their name to Green Electronic and Communication Equipment Ltd.

Reslissound Ltd., of 24 Upper Brook Street, London, W.1, announce that all future sales enquiries, orders and general correspondence will be dealt with from their factory at Spring Gardens, London Road, Romford, Essex. (Tel.: R0mford 49087.)

General Dynamics Corporation, of New York, have opened a European operation in office in Paris. The address is 215 Boulevard Saint-Germain, Paris 7e.

The Hyosol Corporation, of New York, have opened offices in Corney Road, Chiswick, London, W.4, and will operate under the name Hyosol International. Their complete range of materials for impregnating and encapsulating components is offered.

After being high-voltage tested at Standard Telephones and Cables factory at Poignan, Devon, this 150 kW triode valve is to be exported to Sweden. It will be used in a high-power broadcasting transmitter.

Burndett Electronics Ltd., of Erith, Kent, are to supply the Royal Australian Air Force with 500 of their search and rescue beacon equipment Sarbe. These beacons, which are worn in the pocket of an airman's lifejacket or packed in survival kits attached to ejection seats, operate on the international distress frequency of 243 Mc/s and have an operational range of approximately 200 miles—to an aircraft flying at 30,000 ft.

W. Mackie & Co. Ltd., who manufacture power supply equipment, have moved from Lambeth Road, London, S.E.1, to a new factory in Willow Lane, Mitcham, Surrey. (Tel.: MITcham 0951.)

The Bissest-Berman Corporation, of California, and the Plessey Company, of Ilford, Essex, have signed a reciprocal marketing and manufacturing licensing agreement covering oceanographic and meteorological apparatus.

Standard Telephones and Cables Consumer Products Division have received orders for nearly £300,000 worth of television chassis from Norway and Sweden since last autumn.

Honeywell Controls Ltd., of Brentford, Middx., have received a contract, valued at £50,000, for the main instrumentation for a new ammonia synthesis plant in East Germany.

Wayne Kerr have received orders worth more than £40,000 from the Chinese Peoples Republic for electronic instruments, consisting mainly of precision a.c. bridges, electrometers and servo performance analyzers. For several years now, Wayne Kerr have exported nearly 50% of their products. About half of their exports go to the U.S.

Decca electronic equipment has been chosen for the Royal Air Force's C.130 transport aircraft. The ordered equipment includes Decca Navigators, Decca Dopplers, Decca lat/long computers and Decca Roller Maps.

Wireless World, October 1965
LETTERS TO THE EDITOR

The Editor does not necessarily endorse opinions expressed by his correspondents

Systems Engineers

I CONSIDER I should be failing in my duty as a professional engineer were I to let pass, without comment, your Editorial on systems engineers in the September issue. As in any business, profession or vocation there are always good, bad and indifferent members practising their skills and arts with varying degrees of success. To class systems engineers in toto as "virtually amateurs" is, in my experience, almost without parallel in the annals of technical journalism.

Has it ever occurred to you, Sir, that there are, broadly speaking, two classes of engineers. The first is the competent engineer who, when presented with a definite problem, can doubtless derive a correct solution. There is also the engineer who has the wit to see that a problem exists to be defined, sets about defining it and finally derives an acceptable solution. I would suggest that it is this latter citizen who contributes the really material advances to our science/art and I would further suggest that it is mainly this type of engineer who is of any value as a systems engineer. It is my opinion that the greatest single failing of professional electronics/radio engineers is that they persist in thinking that their little bits of fancy circuitry are the ends in themselves whereas in fact they can, almost by definition, be only the means to the end.

The systems engineer is concerned primarily with the end result and since the whole is only as good as its component parts he must have a surprisingly wide and detailed knowledge, not only of what can or cannot be done today but what is likely to be done or not done tomorrow. The systems engineer unlike most development and research workers is responsible to his management for not only the technical excellence of his system but also for the justification of capital investment involved and all that that implies, to say nothing of contractual decisions between customer and contractor which, like the poor, are always with us.

In conclusion permit me to add that I do not regret the 18 years or so I spent on research and development with its comparatively narrow field of vision since it enables me as a communications and control systems engineer to understand the equipment designers problems and at the same time dispense the odd pinch of salt as and where it is required.

Bishop's Stortford.

W. T. BROWN

Warning

I THINK your readers ought to be made aware of the fact that there are devices on the market called a.c. adaptors, made in Japan, which are potential hazards to life. When used as a substitute for a 9 V battery it would be possible for a transistor radio's exposed metal parts such as knobs or speaker grille to be connected direct to the live side of the mains.

The adaptor contains a bridge rectifier in series with a 0.2μF capacitor placed directly across the mains supply. The d.c. output is taken from the bridge rectifier with a 50 μF smoothing capacitor across the output connections. This means that one side of the output connection is joined to one side of the mains through a low voltage rectifier. There is no coding on the mains lead, which is 2-core and could be connected so that the live side of the mains appears on the output circuit.

These devices are on sale in shops at about £1 each and have been advertised in your columns.

High Barnet, Herts.

D. A. LEVELL,
Levell Electronics Ltd.

Semiconductors

IN the ordinary meaning of words this is surely a misnomer, among many in electronics. For even if at one end conduction were uniform and at the other insulation were infinite, by no stretch of the imagination, does a piece of slightly impure germanium lie at the half-way point.

Why not mini-conductors? I give notice that in my small corner I shall, in future, call them mini-conductors. Who knows, one day they may be as-known in the States, thus reversing a long term trend.


C. A. HARRIS

OCTOBER CONFERENCES AND EXHIBITIONS

Further details are obtainable from the addresses in parentheses

LONDON
4-10
Business Efficiency Exhibition
Olympia
5-6
Ultrasonics for Industry—Conference & Exhibition
(St. Ermin's Hotel, London, S.W.1.)
7-30
R.S.G.B. Radio Communications Show
(Seymour Hall)

OVERSEAS
4-6
Canadian Electronics Conference
(I.E.E.E., 1819 Yonge St., Toronto 7, Ontario)
7-11
Communication Congress
(Comite International de Television, Casella Postale 33, Novara, Italy)
9-17
Congress of Electrical, Electronics & Mechanical Engineering
(Eng. J. Espinoza, Colegio de Ingenieros, Culiacan No. 113, Mexico City)
11-15
Audio Convention & Exhibition
(Audio Engineering Society, Box 383, Madison Sq. Stn., New York, N.Y.10010)
13-19
Interkama—Measuring Instruments & Automation
(NOWEA, 4 Düsseldorf 10, Postfach 10203)
14-23
Excot—Exhibition & Congress of Telecommunications
(Comite International de Television, Casella Postale 33, Novara, Italy)
20-22
Electron Devices
(I.E.E.E., 345 E.47th St., New York, N.Y.10017)
25-27
National Electronics Conference
(N.E.C., 228 La Salle St., Chicago, Ill.)
27-29
Aerospace & Navigational Electronics
(B. W. Moss, Martin Co., Box 988, Baltimore, Md.)
**DYNAMIC ANALYSIS OF ACOUSTIC NOISE**

IN a number of situations normal methods of noise measurement using frequency and spatial analysis techniques are inadequate for the location of some noise sources. One such situation would be the location of noise sources in automatic machinery. A method which permits the instantaneous recording of dynamic noise levels in a document handling machine is described by R. H. Peterson and R. L. Hoffman in a short communication published in the *I.B.M. Journal of May 1965*. The system uses an oscilloscope to display the instantaneous output of a microphone, which is recorded on film. A computer is used to calculate the r.m.s. sound pressure level during any desired time interval and a detailed plot of dynamic noise level versus time or document position can be obtained.

A microphone is suitably positioned to equalize air-path time delays and attenuations for sources of noise at the parts of the document path to be considered. The output is displayed on one beam of a double-beam oscilloscope which is triggered when a document leading-edge passes a photocell, so that the noise output of a complete cycle of document handling (e.g. stacking) is displayed on one trace. The second beam is delayed and displays the microphone output for an increment of the cycle, and by suitable choice of delays a series of end-to-end pictures of instantaneous noise level are presented. Photographs are also taken of the document at the start of each increment—a flash is initiated from a stroboscopic light source triggered by the delayed timebase in order to correlate document position with the oscilloscope pictures.

Results of various experiments using the apparatus for analysis of document stacking indicate that (a) discontinuous direction changes in the document path should be minimized and their rate reduced by spreading in time (b) the rate of energy transfer to and from the document should be minimized by control of acceleration and deceleration, and (c) effective guides should be used to achieve maximum control of document surfaces.

"**REVERSE FUEL CELL**" GENERATES OXYGEN

AN experimental device which recovers oxygen from the waste products exhaled in breathing—water vapour and carbon dioxide—has been developed by Westinghouse Research Laboratories in the U.S.A. An important possible application would be to manufacture oxygen for astronauts and other living organisms on long space missions for which large quantities of stored oxygen could not be conveniently carried. The device is basically a fuel cell working in reverse. Electric power and combustion products (water vapour and CO₂) are fed into it, and oxygen is generated (instead of being consumed as in the normal fuel cell).

Individual cells are constructed as small hollow cylinders of ceramic material fitted together to form pipes. CO₂ and H₂O flow through these pipes, and the inside and outside surfaces are metal plated to form the cathode and anode, respectively, to which the electric power is supplied. The oxygen is collected from the outside surface—the anode. Several such pipes are combined to form a battery.

The ceramic material of the pipes, composed principally of zirconium oxide, is, in fact, a solid electrolyte. It is heated to a temperature of about 1,000°C and in this red-hot condition the material acts as a sieve through which oxygen ions migrate easily but no other gases present can penetrate. At 1,000°C the CO₂ and H₂O flowing through the pipes decompose, releasing oxygen ions at the cathode. These ions move through the solid electrolyte to the anode, where they lose their excess electrons and become neutral atoms of oxygen, suitable for breathing. By-products of the process are hydrogen gas and solid carbon.

Westinghouse say that a complete oxygen generating system capable of supplying the needs of four men would weigh 60 to 75 lb, occupy a space of about 3 cu. ft. and consume about 900 to 1100 watts of electric power.

**TUNABLE OPTICAL PARAMETRIC OSCILLATOR**

A COHERENT light source tunable over a relatively wide frequency range has been developed at Bell Telephone Labs. The source is a parametric oscillator using a non-linear lithium metaniobate crystal. By varying the temperature of the crystal, the output wavelength has been varied between nearly 9,700 A and 11,500 A.

The pump source is the second harmonic of a pulsed calcium tungstate/neodymium-doped laser (5,290 A). A resonant cavity is formed with dielectric films at the crystal ends. The gain of the light beam at the desired frequency and idler frequency (the difference between the pump and the desired frequency) exceeds the cavity losses and light at these frequencies is generated from noise present in the cavity.

The frequencies of the idler and desired signals are determined by the refractive index of the crystal, which is dependent on the temperature. The output beams are highly collimated and have a peak pulse power of 15 W, resulting from an input pulse power of 6.7 kW. A 12°C change in temperature gave a change in wavelength of 700 A.


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**Testing uniformity of wall thickness of wideband high power waveguide windows (E.M.I.).** The cone-shaped windows are made from a ceramic (alumina) and in order to ensure reliable metal-ceramic seals, the thermal expansion of the metal and ceramic must be closely matched to avoid residual strains.
GERMAN RADIO EXHIBITION

HIGHLIGHTS FROM THE STUTTGART RADIO & TELEVISION SHOW

ALTHOUGH the Hanover Fair in April is traditionally the occasion for the announcement of German manufacturers' new season's models, the biennial Grosse Deutsche Ausstellung gives a wider public the opportunity of seeing and hearing the new sets at first hand. This year the omission of the adjective Grosse from the title does not imply any diminution in size; merely the acceptance of the obvious. In every way the Show at the Killesberg Park, above Stuttgart, equalled in size and quality the standard established by its predecessors in Berlin, Frankfurt and Düsseldorf. The choice of this year's venue was influenced by the feeling that sales in the south of Germany had not shown the buoyancy of those in the northern provinces.

Sound broadcasting

The Bavarian broadcasting organization happens also to be the only one which is not yet transmitting stereo f.m. programmes. Some say this is because of traditional Bavarian independence, but more probably the reason is that the mountainous terrain means that more relay links have to be converted. But a service is promised by next spring and the whole of Germany will be enjoying an average of 10 to 15 hours per week of stereo from each of the Land networks. At present the average is some six hours of stereo a week, although some stations are giving 15 hours per week. Süddeutsche Rundfunk has already developed a stereo outside broadcast van which was shown to the public for the first time at Killesberg.

At the last German Show in 1963 in Berlin the idea of stereo broadcasting was being pushed hard by German receiver manufacturers with the collaboration of one station—Sender Freies Berlin. The other broadcasters, who at that time were sitting on the fence, have now capitulated (if that is the right word) and stereo broadcasting is now established as essential not only for the enjoyment of good music but also (and perhaps more important from the point of view of sales) as a status symbol.

Every German set manufacturer now markets a fully developed range of stereo receivers, either with built-in speakers or separate small high-quality loudspeaker units of the type pioneered in the U.K. The Graetz "Silvretta" is typical of the former group and is also notable for the use of silicon planar transistors in the v.h.f. tuner which uses three-gang inductive tuning.

Stereo signal generators for servicemen are beginning to make their appearance and a good example is the Grundig SCI with push-button selection of function. The cult of "hi-fi," which for some unaccountable reason was slow in gaining ground in Germany, is now well established and the "technische Look," as Telefunken have described it, is characteristic of many firms' new programmes. In this they are following the trend set many years ago and still foremost by Braun who this
year have an even wider range of sound reproducing equipment of the highest quality. The international journalists at the Braun preview were for once in truth "amazed" when told that the price of the Braun "Studio 100"-Musikanlage—an assemblage of the cream of the firm's radio, gramophone, tape and sound amplifying and reproducing units was to be had for a consideration of £1,500 (one thousand five hundred pounds). The Braun stand was also visually attractive, for their backroom boys had devised a colour projection system controlled directly by sound waves. A flat transparent diaphragm covered by a thin oil film is viewed by a Schlieren optical system which diffracts the light through a series of colour filters, depending on the thickness and/or deflection of the oil film. The Chladni figures which chase each other across the surface during the playing of music are pretty to watch. (Penny plain and twopence coloured?)

An important amalgamation in the hi-fi field is that of SABA and Klein & Hummel. In future the products of these firms are to be marketed under the title "SABA-Telewatt."

Stereo is not for everyone's pocket, nor is it absolutely necessary for car radio, which reminds us that Grundig have at last entered the car radio market with two models. Nor have small pocket portables been allowed to stagnate. Philips have made a notable contribution with their "Mariette" (v.h.f./f.m. only, with mechanical selection of any three settings in addition to continuous tuning) and particularly its neat radiogram counterpart, the "Musette de Luxe."

Television

Further use of transistors (for cooler chassis and longer life), and some slightly larger (65cm) tubes are the only general trends, though one or two detailed tuner designs are interesting. Integrated u.h.f./v.h.f. tuners seem now to be the order of the day.

Blaupunkt, Nordmende and Loewe-Opta all have transistor video stages and in the Blaupunkt chassis the video output stage is mounted on the picture tube socket. The Graetz "Landgraf" G921 and the Telefunken FE2065T are examples of the use of 65-cm (25½-in) tubes.

In the Grundig "Monomat" single-knob tuner, capacitance diodes with voltage control are used for the v.h.f. bands. The bias voltage is derived from a specially shaped potentiometer element, the position of the pick-up contact being determined by a somewhat complex mechanical selector.

The aerial manufacturers again staged a "street of antennas" in the exhibition grounds. Siemens made a special point of their latest distribution system for large communal installations and particular interest was also shown in the logarithmic aerial Dezi-Durant 54 shown by Kathrein. This covers 470-790 Mc/s with a gain of 12 dB and a front-to-back ratio of 26 dB.

Loewe-Opta were showing a portable aerial-measuring instrument (Type 60 305) working from batteries and giving a picture check as well as a reading of field strength.

Magnetic tape

Chief talking point in this sector was undoubtedly the spate of miniature cassette tape players and the growing library of recordings in this medium. The start of this trend was the introduction by Philips at the 1963 Berlin Show of the Type 330 pocket recorder with double cassette and non-standard narrow tape. This was fol-
Kethrein Dezi-Durant 54 logarithmic aerial.

Left.—General view of Grundig "Monomat" integrated tuner.

Grundig C100 cassette tape recorder.

Right.—Transistor video output stage mounted on the c.r.t. socket (Blaupunkt).

Loewe-Opta aerial measuring instrument (Type 60 305).

Left.—A 10 cm wide magnetic band carries 126 tracks, each of 22 mins duration, in the Schaub Lorenz "Music Center".

Saba-Telewatt hi-fi stereo amplifier VS-60.

Philips "Musette de Luxe" portable radio-gram. The v.h.f./f.m. tuner provides three pre-set stations as well as continuous tuning.

Below.—"Brushless" d.c. motor and switching transistor panel as used in the Grundig cassette tape recorder.
Band brakes are used in the SL100 Schaub Lorenz tape recorder.

Philips video recorder console.

SABA studio tape recorder, 600 SH.

Optocord 600 television recorder.

Equipment, available in table or console form, consists of a high-grade "all-wave" receiver and a special magnetic tape recorder with a programme duration of nearly 2 days and 2 nights! A 10-cm wide coated band carries 126 parallel tracks, each with a duration of 22 minutes at a speed of 12 cm/sec. Rewind time is only 25 sec and selection of a new track by the single record/playback head is effected by a dial-operated mechanical linkage. Running time for each track is shown by a thermometer type indicator.

Of more conventional design is the Schaub Lorenz portable recorder which is nevertheless of interest because it employs band brakes on the supply and take-up spools. SABA too have introduced a new hi-fi studio tape recorder with three drive motors and other refinements to fit it for inclusion in the new SABA-Telewatt programme (q.v.).

Three television tape recording machines for domestic use were shown. The Loewe Opta "Optacord" has been demonstrated at previous shows and is now much reduced in size and refined in performance. Definition is excellent (3 Mc/s bandwidth) and demonstrations given throughout the show on the open public stand indicate that this machine may soon become available. The linear tape speed is only 15 cm/sec, but a contra-rotating scanning head inclined to the horizontal axis of the tape and traversing the circumference of an approximately 5-in diameter loop in the tape gives an effective scanning rate of 20 metres/sec and one whole picture frame in each diagonally recorded line on the tape. Thus if the tape is stopped on playback the rotating head continues to give a still picture.

Similar machines in development were shown by Philips (now in a console complete with television receiver), and by Grundig. When these machines are available the retail prices will range from £700 to £850.

It is regretted that space does not permit us to do
justice to the many Sonderschauen (special shows) which included a fine historical survey by the German Post Office, culminating in some excellent working models of their "Goonhill" at Raising, near Munich; and, as usual, a first-rate demonstration of amateur long-distance working by the D.A.R.C. And, of course, the all-important publicity and information centres of the equivalents of B.B.C. and I.T.A., the A.R.D. and Z.D.F. We regret this the more because Dr. Erhard, the Federal Chancellor, not only honoured the industry by opening the Exhibition in person, but he made it his business to visit every hall—a tiring but rewarding experience.

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**RADIO AND TV IN EAST GERMANY**

**SOME IMPRESSIONS FROM THE LEIPZIG FAIR**

Production of radio and television sets in East Germany (Deutsche Demokratische Republik) is centred on a handful of firms (including several in East Berlin), and is co-ordinated by Radio Fernsehen Technik, a State organization. R.F.T. has much greater authority and power than for instance the British Radio Industry Council. For example the Stassfurt factory has just been ordered to take over the whole of the D.D.R. production of television sets.

Its headquarters are in Radeberg and the publicity department is in the Städtisches Kaufhaus, Leipzig, behind which still lie the ruins of the old Gewandhaus with its many historical associations with German music of the past. This building, like many others in the older part of Leipzig, is taken over during the Fair period and converted as an exhibition hall. Two floors with an area of 1,300 m² were occupied by 23 radio firms.

Official statistics put the present annual production of the radio industry in D.D.R. at £M130 with an annual growth rate of 10 to 15%. Export is vital to the D.D.R. (as to everyone else) and special efforts are made to earn foreign currency. Chassis are well sectionalized with interchangeable units to suit the standards (transmission characteristics and climate) of any country. Thus orders from anywhere can be quickly executed. About 70% of gramophones and 60% of radio production goes for export, either to non-socialist countries or neighbouring Russian satellite states.

Technically the designs follow established and well tried principles without any straining after innovation or novelty for its own sake. About half the TV sets produced have either 53 or 59 cm screens. We noted that sound quality was particularly good.

A few West German firms’ agents were represented at the Leipzig Fair and also Hitachi of Japan, but the most interesting foreign stand was that of C.F.T. (France) which drew the largest crowds for the first view of SECAM which has now been, or will be, adopted in the...
Russian dominated countries. The colour rendering bears a strong resemblance to the local colour photographic film ("OR/WO Color") and so should find acceptance.

Prices of black-and-white television receivers in East Germany are surprisingly high—in fact they approach the estimated prices of colour receivers in the west. Typical price tickets (converting at MDN 11.6 to the £)

seen in the Central Store in Leipzig were 43cm "Marion" £140; 53cm "Sibylle" £160; 53cm "Stadion II" £173; 53cm "Kosmos IV" £299. The average good table model radio set costs about £65, a radiogram (which in the U.K. might sell for £200) is priced at £210 and a miniature pocket transistor set "Mikki" costs £65.

A tape recorder which might sell for £30 in England was priced at £97.

Among radio receivers and radio gramophones the various cabinet stylings for foreign markets proved the most interesting feature Portable and pocket transistor receivers are also in production.

A start has been made with stereo experimental transmissions from the East Berlin station, but there is no regular service.

There is an indigenous component industry including valves and semiconductors and also a department for the production of (and we hope may be forgiven for using the term) capital goods, including transmitters, studio equipment and TV cameras.

Although the chances of selling British receivers in East Germany are slim we think that it might be worth while for some firms to set up a stall in this 800-year-old caravanserei if only to catch the eye of visitors from other countries who make the annual visit to Leipzig for either the spring or the autumn Fair where for centuries the merchants of the east and the west have met at the crossing of their ways.

"The National Plan"

The country's National Economic Development plan covering the next five years, announced on 16th September in the form of a White Paper (Cmd. 2764), reiterates the Feilden Committee's* conclusions: the application of technology depends to a very large extent upon engineers, and many of the weaknesses of British industries and their failure adequately to meet foreign competition can be attributed to a shortage of engineers and to insufficient attention to the importance of engineering design. The White Paper continues: "There is much evidence that the engineering professions generally, and design activity particularly, are failing to attract a sufficient share of the ablest school-leavers and university graduates. One of the important tasks given to the Ministry of Technology is the difficult long-term assignment of co-ordinating activities which will help to raise the status of engineers, improve their training and make their employment in industry more effective. Much of the Ministry's programme in this field involves the implementation of the recommendations of the Feilden Committee in co-operation with other Departments and organizations."

The formation of the Engineering Institution's Joint Council marks an important step by the engineering professions themselves to raise their professional standards and standing and to co-ordinate training and conditions of entry to the professions."

"Technological change and the state of technical awareness in user industries are the major determinants of the output of the electronics industry," according to the annex to the report which was prepared under the guidance of the Electronics Economic Development Committee.* The British share of world trade in electronics has been falling at the same time as the share of imports in the home market has been rising. Competition is strong both from American firms in advanced equipment, particularly in computers, and in simpler products from the Far East. European competition is also increasing."

Although the British electronics industry cannot expect the same sort of backing the Americans receive from their government, the White Paper states, "It is important that total expenditure by the British Government on electronics, particularly on civil R. and D., should continue at a high level and that the maximum yield in terms of competitiveness should be obtained from it." As regards this field the E.D.C. states that "Adequate support must be given to basic research in the universities... and the R. and D. done within the Government should not be tied narrowly to military requirements; it should extend into the civil field and fit in with a common R. and D. policy worked out in collaboration by government and industry."

Specialist Courses

The following educational centres have sent us details of their specialist courses commencing in October and intended for qualified engineers.

Northern Polytechnic, London, N.7.—Beginning on the 1st, 26 evening lectures on The Principles of Modern Network Theory; beginning on the 4th, 25 evening lectures on Colour Television Engineering; beginning on the 6th, 23 evening lectures on Transistor Engineering; beginning on the 23rd, 13 evening lectures on Audio Engineering Measurements.

West Ham College of Technology, London, E.15.—Beginning on the 12th and extending over two evening terms, Theory and Practice of Automatic Control.

Wandsworth Technical College, London, S.W.18.—Beginning on the 12th, nine evening lectures on Integrated Electronics.

Bristol College of Science and Technology.—Beginning on the 19th, for three full days, Gaseous Electronics and Plasma Physics.

Twickenham College of Technology.—Beginning on the 1st, 12 evening lectures on Transistor Circuit Design.
Paris Radio Show

PORTABLE TRANSISTOR TELEVISION SETS THE MAIN ATTRACTION

THE second Salon International Radio-Télévision held in Paris in September was not what might have been expected from the title. It was essentially a French radio show, designed to sell domestic equipment to the French public, who flocked in their thousands to the Parc des Expositions, attracted by the free entertainment provided by the shows in the television and sound studios, the "pop" stars signing autographs, the pool for radio-controlled model boats and all the other fun-of-the-fair. Of the 209 exhibitors, about 170 were companies of the French radio industry, while the remaining 40 were foreign firms with already established commercial representation and retail outlets in the French market (18 German, 9 Italian, 6 American and others). Only one British manufacturer, Pye, was to be seen.

Television sets seemed to attract the greatest amount of interest. Since the last Salon in 1963 the second television network, 625 lines on u.h.f., has become well established (16 transmitters already installed and 10 more by the end of the year) and all receivers are now equipped for dual-standard, 819/625 lines, operation. As in Britain, the transistor u.h.f. tuner is a common feature. Screen sizes are, in the main, 59 cm (23 in) and 65 cm (25 in), and most sets use tubes with steel bands for protection against implosion (autoprotégé).

Apart from the usual controls, many French sets have gadgets such as automatic photocell control of contrast to suit room illumination; piano-key switches for station selection; and "image relief" control of video frequency response, allowing adjustment of the strength of contour marking with different types of programme material. Other novelties were pedestal-type adjustable stands with wheels, and ultrasonic remote control of on/off, station selection and sound-level.

The multi-standard television receiver for use in frontier areas is, of course, a familiar object at European radio shows and at Paris most of the larger manufacturers had two or three sets in their normal range. Several of the French-made sets will receive the French (14 Mc/s), Belgian (7 Mc/s) and Luxembourg (7 Mc/s) 819-line transmissions on v.h.f., the French 625-line second programme on u.h.f., the Belgian 625-line transmissions on v.h.f., and the European (7 Mc/s, f.m. sound) 625-line broadcasts on v.h.f. from Germany, Switzerland, Italy and Spain. British 405-line pictures can be received on some sets made by Grammont. Apart from all the complex circuitry and switching needed for multi-standard reception, a fairly elaborate aerial system is usually required as well. The old method of turning a handle to rotate the aerial to receive a required station has now been superseded by the remotely controlled electric drive, comprising a motor mounted half-way up the mast and a control box (providing aerial position indication) in the living-room. Belvu were showing a whole range of these controlled drives at prices from about £30 to £150.

What really caught the eye in the television sphere, however, was the large number of portable transistor television sets on show—mostly 11-inch models. A French firm, Radio-Celard, was the first European maker to produce an all-transistor television receiver—a 19-inch table model. It was shown at the 1963 Salon and this year the company had a 23-inch all-transistor table model; but in general there has been little activity in this field, perhaps because transistors do not yet offer any advantage in price over valves. For portables, however, the transistor obviously allows a worthwhile reduction in size and power consumption, and it seems clear that the French manufacturers have concentrated on the possibilities of this sector of the market. Some of the sets on view were Japanese, and it was rumoured that a few of those with Continental brand names were of Japanese manufacture also. The smallest of the television portables was a Sony 5¼-in model, weighing about 9 lb (see photo), which has only recently been introduced into Europe. Like the larger portables, it will operate from a 12-V battery or...
In the swim. The Voxson "Zephyr" transistor set floating in a swimming bath. A sealed plastics case encloses the receiver unit.

220V a.c. mains, but has a detachable u.h.f. tuner with a plug-in aerial for the French second programme. On the back of the set is a row of four push buttons for standards selection, allowing a choice of French or Belgian 819-line or 625-line systems or the European 625-line system.

Colour television was noticeably absent—no demonstrations, no SECAM receivers.

In October the O.R.T.F. experimental stereophonic sound broadcasts in France will be replaced by a regular service of eight stereo programmes a week on the France-Musique f.m. network. Transmissions will continue to use the pilot-tone system and will be receivable in the service areas of the Paris, Gex, Lille, Clermont-Ferrand, Lyons and Marseilles stations. In spite of this, the Salon bore evidence of remarkably little response from the set manufacturers. Certainly some of the two-channel radio-grams incorporated stereo decoders and, of course, the majority of the haute fidelité installations were suitably equipped, but there seemed no sign of more general exploitation. One interesting novelty was a small Sony a.m./f.m. portable transistor set (about 7in × 5in × 2in), available with a separate stereo adaptor of similar size, containing a decoder and second loudspeaker. Considering the small size of the units and the spacing used to demonstrate them—about 2 ft—the sounds produced were quite respectable. Demonstrations put on by the O.R.T.F., using high-quality commercial equipment, gave very agreeable reproduction of the specially arranged stereo music broadcasts, but the effect was not markedly different from that of two spaced loudspeakers working from a single channel.

Three transistor set novelties: remote control (by wire) of station selection and volume on a Telefunken receiver; a Voxson portable set which floats—you throw it in the water when you go for a swim; and a really small pocket superhet receiver (m.w. only) by Standard, measuring 2 in × 1 1/2 in × 3/4 in, with a 2 in × 1 in loudspeaker.

N.B. (Note Bacchanale): Some French manufacturers seem to measure the capacity of their loudspeaker enclosures (enceintes) in litres—perhaps understandable in a nation so appreciative of wine, women and fast cars.

**Video amplifier with thermal feedback**

THE usual method of achieving a fall in amplitude response in an audio or video amplifier is to utilize the coupling capacitors. But these components are bulky and their use with microelectronic circuits is inelegant, to say the least. A microelectronic differential amplifier (SNX1303) with a bandwidth of 50 c/s-10 Mc/s has been developed by Texas Instruments Inc., which uses no capacitors and is contained within two standard 3/4 in × 1 in flat packs.

The amplifier consists of a thermal feedback stage and a differential amplifier, both using normal diffused-silicon integrated circuitry. The feedback loop is thermal and will consequently have a low-pass characteristic due to its relatively slow response. The size of the thermal element is chosen to give a 3 dB frequency of 50 c/s and the maximum attenuation is 32 dB.

![Diagram of thermal feedback loop with low-pass filter response](image)

Fig. 1. Thermal feedback loops with low-pass filter response give an overall response of 50 c/s—10 Mc/s.

The heater component is the emitter resistor (R) of an emitter follower which is fed from the output of the d.c. amplifiers (see Fig. 2). The sensing element, on the same silicon substrate, consists of two negative temperature coefficient diodes, one being the base-emitter junction of an emitter follower for convenience (on left of Fig. 2).

The heater resistor operates at 25°C above ambient temperature and the design allows for a temperature swing of ± 25°C.

![Diagram of thermal feedback elements](image)

Fig. 2. Basic arrangement of one of the feedback stages, the box enclosing the thermal feedback elements.
Slow-motion Television

By M. LEEUWIN

Japanese television broadcasting technique for slowing or arresting events of special interest. Uses a modified video tape recorder and a special magnetic tape storage unit.

During the 1964 Olympic Games in Tokyo excellent televised reports of the games were relayed from Japan to the rest of the world via the Syncom 3 communications satellite. Special professional interest was aroused in Europe by the technique that was used to repeat certain events in slow motion, enabling viewers to see precisely what happened. At certain crucial moments the motion was arrested to make the picture a "still".

This slow-motion effect, combined with the possibility of quick selection at random of any recorded scene, has been achieved by the use of modified video-tape recording equipment. The instrument, specially developed for the 1964 Olympic Games by NHK (the Japan Broadcasting Corp.) in collaboration with the Nippon Electric Company, Shiba Denki and the T.E.A.C. Corp., is based on standard Ampex equipment. It is capable of playing back, 15 seconds after recording, a "slow-motion" picture, a stationary picture of any selected transient image or a combination of both.

Although the machine gave satisfactory performance during the games, various improvements, mainly in connection with stability of operation and useful life of important parts, have been subsequently made. Slow-motion scenes are now being incorporated in NHK programmes as a regular item.

Operation of system.—In order to understand the operation of this slow-motion system, one must be aware of the following basic requirements:

1. The slow-motion effect has to be obtained from a standard recorded magnetic tape.
2. The speed of rotation of the recording/reading head of the standard V.T.R. has to remain unchanged.
3. The television transmitter and receivers in the field have to accept the slow-motion picture without any modifications.

The technique adopted to meet these requirements is to repeat every picture field five times. For still pictures, each field is repeated an indefinite number of times. A repetition of five times has been chosen for slow-motion operation because tests have shown this to be the most desirable compromise; other repetitions having introduced complications. This cycle of repetition is "built into" the machine and cannot be changed without major mechanical and electrical modifications.

In order to transmit each field five times, a one-field memory unit is used, this being so designed that the field is scanned by the reading heads five times in suc-
cessation, a kind of interlacing being restored by a special device. During this interval the reading head of the main V.T.R. unit makes four idle turns. It will be evident that a special method for scanning the standard recording, which for slow-motion operation moves at one fifth of the normal speed, has to be used. This is called intermittent scanning.

**Intermittent scanning**—Normal scanning in the standard Ampex unit is performed by four reading heads mounted in the same plane in the revolving drum, which scans the tape transversely. The tape speed is 15 in/sec and the rotational speed of the drum is 240 revs/sec. Fig. 1 represents the situation at this standard tape speed. At slow speed the tape travels at one fifth of normal speed, that is 3 in/sec. In order to obtain at this slower speed the normal track scanning rate, the artifice of offset scanning heads has been adopted. This means that the reading heads of the slow-motion V.T.R. machine are not arranged in one plane but in four different planes, the spacing being 12 mil. (1 mil. = 0.0001 inch.) Offsetting is necessary because each head has to make in each quarter revolution (1/960 sec) a "retrograde" movement with respect to the movement of the tape during this period.

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**Fig. 1.** Recording pattern and head arrangement for standard Ampex video tape recording. Each vertical bar contains the modulation of 16 picture lines, including line and field sync pulses.

**Fig. 2.** Offset arrangement of heads on the skewed scanning drum of the modified V.T.R. equipment.

**Fig. 3.** Showing the action of intermittent scanning with reference to standard tape recording.
the tape of one "interval", a distance of 15-625 mil (see Fig. 2). The movement of the tape at slow speed during each quarter-revolution of the head drum, however, is 1/960×3000 mil = 3.125 mil. This leaves to be compensated for a distance of 15-625 – 3.125 = 12.5 mil. The slight difference between this required distance and the head spacing of 12 mil is taken up by various compensating factors. In order to compensate for the difference in effective slant between recording and reproduction, the reading head drum is skewed at a small angle.

By the offsetting of the heads, during each revolution of the head drum a group of tracks is scanned at slow tape speed; four active revolutions plus 16 idle revolutions of the drum giving one field.

Idle turns.—By the artifice of the offset heads the effect of a five-fold increase of forward tape speed is achieved. Although the actual tape speed is only 1/5 of normal speed four tracks are scanned in 1/240 sec. The time needed for the next group of four tracks (in the retrograde sense) to move up to the scanning position of head No. 1, from a to b in Fig. 3, is 5/240 sec., i.e., five turns minus one active turn = four idle turns. This is allowed for by periodic electronic gating of the amplifier.

The "fields" of the standard tape, although recorded and read out at the standard scanning rate, now appear in the V.T.R. read-out signal as bursts of four tracks each, separated by intervals of four times the duration of one burst. The sequence is shown in Fig. 4. The desired retardation factor of 5:1 being obtained, and the tape modulation nevertheless being scanned at the standard rate, the basic requirements listed earlier have been fulfilled. The next step is to store this information in the one-field memory unit. In this unit, as already mentioned, each field is read five times in succession, thereby giving the desired effect of continuous motion at slow speed, or, if so desired, a still picture by an indefinite number of repetitions.

One-field memory.—In this storage device a similar general technique as in the main V.T.R., with standard video tape and rotating heads, is used, but the device is a self-contained separate unit. The tape, however, does not move (except at intervals to compensate for wear), the tracks being at a rather small angle. There are two self-contained recording/reading assemblies in the unit, one at each end of the shaft of a driving motor, and these are used alternately for recording and reading.

On the revolving head drum of each assembly two pairs of heads are mounted, one pair for recording, the other for reading, as shown in Fig. 5. From this diagram it can be seen that the first and third quadrants of the drum are inoperative, the tape being fed in in quadrant 1 during intervals.

Not shown in the diagram is the fact that in quadrants 1 and 3 the tape is cleaned of magnetic and other dust particles by the wiping action of a secondary moving tape, which acts as a "broom" in contact with the recording tape. Moreover, in quadrants 1 and 3 some extra lines of video information are recorded for overlapping during reproduction.

Frequency modulation is used, with a carrier frequency of 6.4 Mc/s and a deviation of ±1 Mc/s. This particular carrier frequency has been chosen to make it possible to superimpose successive recordings of a field without erasure. Experimentally it has been found that with this frequency at 1 Mc/s off carrier, the remaining modulation on the tape during superimposition is 35 dB down, which is sufficient. Without knowing this, it is difficult to understand the operation of the memory unit.

The intermittent signals arriving from the slow-motion reading section of the main V.T.R. unit are distributed to the respective recording heads of the memory unit by a switching circuit and amplifier.

For recording, one pair of heads is so positioned and switched that each head covers one trace, there being two traces and four sections altogether. The shaft of the head
assembly rotates at 60 revs/sec, a quarter of the speed of the slow-motion V.T.R. playback heads. The diameter of the revolving drum in contact with the tape is 316 mm, while its circumferential speed is 60 metres/sec. The tape, at an angle to the tracks, covers about 300° of the circumference of the drum. The resulting pattern on the tape is shown in Fig. 6. While the signal of section I, consisting of four tracks (one revolution of reading head drum on slow-motion V.T.R. machine) is fed to the recording head I and recorded, the drum of the memory unit assembly travels through an angular distance of 90° only. This gives the trajectory a-b.

After completion of 90° rotation, recording head II of the assembly is in position for section II, and starts recording between a' and b'. As a result of the positioning and switching of the two recording heads, the next sequences are section III, a''-b'' and section IV, a'''-b''' . Although not represented in Fig. 6, the four idle turns of the head drum on the slow-motion machine take place in the intervals between the trajectories a-b and a'-b' and so on.

When the recording of one field is completed the reading heads 1 and 2 start to play it back five times. During this period, the next field is recorded in the other drum assembly of the memory unit. A continuous scanning of the four sections of the one-field recording is obtained, because the blank interval of 90° is compensated for by the 90° offsetting of the heads.

Recording and reading are repeated alternately for successive fields by each drum assembly during each 5-field cycle, and in this way continuous reproduction of the slow-motion picture is obtained. In order to obtain a stationary picture, the movement of the V.T.R. tape is stopped and the recorded field is repeated indefinitely.

System operation.—The standard recording is made on a normal V.T.R. The recorded tape is then rewound and played back on the slow tape-speed section of the modified machine. After passing through the one-field memory unit the signals are amplified, sent through a switching unit and finally fed into an f.m. demodulator. The demodulated signals have to be compensated for the line sync pulses, in order to obtain a substitute for interlaced scanning. This has to be done because a slow-motion picture consists of one field only, repeated five times, and without this artifice the picture would contain only half the normal number of scanning lines. This compensation is performed in a field setting circuit, in which the line sync pulses are made continuous by a delay-line switching circuit.

Discontinuities occurring between the groups of four tracks, caused by the residual jitter of the system, are corrected by a variable delay line. A standard video signal is obtained after shaping and correction of the field sync pulses. The main characteristics of the system are as follows:

- Slow-motion reproducing ratio \( \frac{5:1}{} \)
- Output signal resolution 400 lines
- S/N ratio \( 41 \) dB
- Life of slow-motion heads \( \text{More than 100 hours} \)
- Life of memory-unit heads \( \text{More than 200 hours} \)

Acknowledgements.—The author wishes to thank Mr. Tanabe, Mr. Yokogawa, Mr. Yoshikawa and Mr. Matsuoka of NHK for information and for reading the manuscript, and Mr. Hirasawa for discussions and contributions.
The task of maintaining the electrical and radio equipment in the Army has over the years passed from the Royal Engineers in the 1914-18 War to the Royal Army Ordnance Corps and since 1942 to the Corps of the Royal Electrical and Mechanical Engineers. It would be true to say that since the formation of the Corps the electronic and radio equipment used by the Army has more than trebled in quantity and it is immeasurably more complex.

Although the Corps is also concerned with the Army's mechanical gear, we must confine ourselves to its electrical interests, 90% of which come within the purview of Wireless World, in fact the "E" in the Corps title might well stand for "electronics."

R.E.M.E.'s function is to maintain the equipment of the Army in a fit state for war and to minimize the effect of battle. The Corps training is done through two schools; one "mechanical" at Bordon, Hants, and the other, the School of Electronic Engineering at Arborfield, near Reading, Berks. This school, which handles over 1,400 scholars a year, has recently been rehoused and the new buildings were officially opened by the Rt. Hon. Fred Mulley, Minister of Defence for the Army, on September 15th.

The officers and men in R.E.M.E. are not concerned with operating the equipment but its maintenance, and are therefore primarily engineers and technicians. Moreover, because of its major role in the maintenance of the Army's equipment, it is also deeply concerned with policy in the design and development of future equipment—particularly on the score of reliability.

The new School comprises 25 laboratories, 7 laboratory-lecture rooms and 21 classrooms, plus library, cinema, drawing and printing office and admin. offices. Col. L. C. Libby, M.B.E., the commandant, who has been at the School since 1962 and has played a major part in bringing it to its present academic position, is ably backed by a teaching staff of some 100. The average weekly attendance at the School is about 500 and includes officers, N.C.O.s and other ranks. There are about 70 courses in progress at any one time.

There are two main streams of entry to the School—through the Army Apprentice School comprising about 40% of entrants, and by direct entry. Those taking the second route receive their initial military training and a two weeks' course for the Army Certificate of Education before starting on a 29-week basic electronics course.

After a short military training course entrants via both streams take a 24-week equipment course during which they are instructed in the operation and mainten-
A technicians' class receiving instruction with the aid of a demonstration console, on which a wide variety of circuits with plug-in assemblies or components can be used.

ance of several pieces of standard Army equipment. At the end of this course the successful trainee passes out as a Class II technician and he then goes into the field as a L/Cpl. for two or three years' experience. Depending on the equipment course for which he has been selected he will now be a telecoms technician, control equipment technician or radar technician.

His school days are not over however. He is encouraged to take a correspondence course; and if he enrolls with the C.R.E.I., which has the Army's approval, he will have to pay only £1, the rest (about £45) being met by the Army. Incidentally, his progress during the course is notified to the School so that, in fact, the C.R.E.I. course is a continuation of his Corps training. After two or three years in the field he returns to the School for up to 23 weeks for an "upgrading" course during which he will specialize in more advanced equipment in his particular branch—telecommunications; radar and guided weapons; or servos and computing. He then goes into the field again for from two to five years. During this period he will be advised to take another C.R.E.I. correspondence course on the same conditions. He will by then be a sergeant and may return to the School for an eighteen-month artificer's course at H.N.C. level and is the culmination of 5½ years' training at the School. The total cost of training an artificer is said to be about £7,000.

The School is not only concerned with training N.C.O.s and other ranks. It has a number of specialized courses for officers (not necessarily R.E.M.E. officers) including a 42-week Officer's Long Electronic Engineering Course at postgraduate level.

It is impossible to deal adequately within the scope of a short article with the training given and the influence wielded by the School. Mention must however be made of some of the specially devised training aids used.

To demonstrate basic electronic circuits a console, comprising "breadboard" circuits (with plug-in components), large-scale meters, and a four-beam teaching oscilloscope, is used. Students each have small "breadboard" circuits on which to carry out their own experiments with plug-in components of different values. With this console over sixty different circuits can be taught.

The circuit assembly board illustrated on the previous page comprises a series of sockets wired in squares of four to facilitate the plugging in of specially mounted components.

At present, commercially produced fault-finding question sheets are used on which the student records each step in his fault diagnosis. The School is however in the process of developing its own electro-mechanical device. What is described as a systems assembly board has been developed which, with plug-in circuit modules, enables systems to be built up for the instruction of artificers.

Among the outside professional interests fostered by the Commandant and his staff is the Students' Branch of the Radar and Electronics Association introduced at the School and it is noteworthy that two of the students recently received the Association's 1st and 3rd prizes for the best apprentices of the year. The School also sponsors a branch of the I.E.E.

One last word. Although the School is run as a technical college and there are no such things as " reveille" or "lights out" the staff does not lose sight of the fact that they are training soldier technicians. The men leave the school as fully trained soldiers.

ADDIT (apparatus for demonstrating digital techniques) designed by the staff being used to illustrate basic computing techniques.
HOWEVER much Europeans may deplore it, electronic technology throughout the Western world is dominated by the U.S.A. That this is true of the industrial side as well as other branches of electronics was very evident from the 2nd International Exhibition of Industrial Electronics, INEL 65, held in the permanent buildings of the Swiss Industries Fair, Basle, early in September. Not only was there a separate, self-contained section of forty or more American firms—many of them small specialist manufacturers not well known in Europe—but the main body of the exhibition was heavily loaded with American-made or -designed products, shown by European subsidiaries of U.S. companies, by European agents and by European manufacturers with licensing arrangements. Attempting to counterbalance this weight of American technology were the few big Continental firms like Philips, Ericsson and Oerlikon and two national groups of exhibitors, French and British respectively. The contribution of the smaller European firms to this counterbalancing was more in the volume than the technical significance of their exhibits. In fact, if it were not for the presence of American technology INEL would probably have a hard time justifying its existence.

The greater part of the exhibits consisted of standard electronic components, units and measuring instruments (mostly for electrical variables). Of the genuinely industrial electronic systems and equipments on show the majority were concerned with the processing of information—a field in which electronics has shown outstanding versatility and has tremendous potential. One example was an equipment shown by the Reliance Electric and Engineering Co. (U.S.A.) for digitally measuring and displaying the linear speed of the paper web in different sections of a papermaking machine and also the "draw," or differential speed, between sections. Speeds and draws are critical in manufacturing papers of particular characteristics, and accurate digital measurement greatly assists the operators in setting up the machine conditions required for a particular type of paper with minimum wastage of material. It is this saving of material which justifies the cost of the electronic equipment.

The measuring transducers are rotary pulse generators driven through gearing from the machine rolls, and arranged so that, for example, one pulse is generated for every one foot of linear paper movement through the rolls. The timebase needed for speed measurement is provided by an accurate crystal oscillator and an electronic counter. This counter gates the output of a selected rotary pulse generator during intervals of one minute, so that if the pulse generator produces 1,000 pulses in one such interval the linear paper speed is 1,000 ft/minute. The gated pulses can thus be counted and directly displayed on a numerical in-line indicator as feet per minute. Differential speeds, absolute or per cent, are measured by a similar technique using two pulse generator inputs and a differential (reversible) counter.

Compensation for changes in roll diameter due to wear, and for gear ratio and other machine errors, is performed electronically by pre-setting the timebase system on a plug-board programming panel. Thus, if the diameter of a roll were reduced by wear the rotary pulse generator driven by it would produce pulses at a frequency slightly greater than 1 per linear foot, and this would be compensated by shortening the timebase so that it gated the pulses over an interval of slightly less than a minute. The whole equipment uses solid-state digital circuitry mounted in a series of plug-in units, which allow flexibility of application. Another equipment using a plug-board programme and semiconductor circuitry was an automatic electric welding machine shown by the Swiss firm, R. U. Schild & Co. The purpose of this machine is to eliminate the majority of the control adjustments which normally have to be made by the operator during a large production welding sequence. The pre-set programme allows a sequence of 12 different welding operations to be performed automatically, and all the operator has to do is to present to the machine the parts to be welded in the correct order. For each operation in the sequence the plug-board allows a choice of four electric welding "powers" (watts/sec) and two welding "pressures" (kg) to be pre-set, and each of these variables can be continuously adjusted in advance. The plug-board programme is scanned electronically by semiconductor circuitry and this scanning allows the sequence to be stopped at will, or to skip several operations, or to repeat a particular operation as many times as may be required. Maximum welding speed with the electropneumatically operated welding head is 180 spots per minute (with a power of 100 watts/sec).

Automatic data processing equipments for accounting, production control and other recording purposes are now being attached to a variety of machines, but probably the most unexpected application to be seen at the exhibition was a system making possible a "help-yourself" petrol
pump. The customer draws as much petrol as required, with the aid of an electronic numerical indicator of volumetric flow mounted in the pump, and the amount drawn and the price is automatically recorded on an adding-listing machine in a nearby office. The advantage of the system is that it allows a variety of accounting procedures to be performed automatically (e.g., totaling all charges made to a particular customer), and the equipment contains various electronic facilities such as flip-flop binary data stores allowing several pumps connected to it to be used at the same time. Developed by the Swedish firm RETAB, the equipment uses semiconductor circuits throughout and a large proportion of these are Texas Instruments integrated circuits (adopted, according to the exhibitors, Fabrimex, for reasons of lower cost and greater reliability). The mechanical flow metering part of the equipment is orthodox, but, of course, the flow measurement is converted into electrical form by a digital transducer.

A high degree of automatization, permitting rapid operation, is a feature of the Beckman Instruments liquid scintillation spectrometer—an instrument for counting beta particles from radioactive isotopes in which the sample is immersed in a liquid scintillating medium. A built-in computer calculates the counts/minute rate every 1.2 seconds, allowing continuous digital presentation of count rate during the counting cycle. The rate is computed for both pre-set time intervals and pre-set count intervals, and there is also an automatic correction for background radiation in which the background count rate is subtracted from the overall count rate. Computing is also involved in an automatic calibration system for the instrument, using an external radiation standard.

Apart from the specialized systems mentioned above, several general-purpose information processing equipments were to be seen. A new approach to the problem of random-access storage of large volumes of data was demonstrated by the Potter Instrument Company, U.S.A. Magnetic tape is the most economical medium for storing large quantities of data but it does not allow convenient random access because of the serial nature of the information on the tape. On the other hand, systems of discrete elements such as ferrite core matrices are very suitable for random access but are too expensive for storing information in quantities of millions of bits. The Potter equipment effects a compromise by using a number of short loops of tape, each loop carrying a multiplicity of tracks, which are driven past read/write heads, using air bearings. A group of eight such loops forms a tape cartridge, a complete unit capable of storing 25.1 million bits which can be loaded into and withdrawn from the main machine. It is claimed that the system is cheaper to buy and to operate than comparable random-access stores using magnetic discs, and a particular advantage over this disc type of machine is said to be that the Potter equipment can check-read data immediately after it is written on the tape, thereby giving faster operation in many storage operations.

Computing equipment

In the field of electronic computing, the French firm Electronique Marcel Dassault were demonstrating a neat desk-top calculating machine for office and laboratory work, using semiconductor binary digital circuits, ferrite core storage of programmes and immediate print-out of calculation steps and results on a narrow paper tape. Numbers and programme instructions are entered by the operation of press-buttons. Designed principally for industrial real-time control operations are the Honeywell H20 and the Liton L-3040 stored-programme digital computers. The last-mentioned is particularly interesting because it is constructed entirely by integrated circuit techniques. Working in the parallel mode with a 32-bit word length, it has a magnetic core store, expandable in 4096-word modules from 4096 to 32,768 words, and a 1.6 usec storage read/write cycle. The circuitry takes the form of NAND logic gates interconnected by laminated boards containing multiple layers of conductors. Such a computer containing an 8,192-word store weighs about 38 pounds, occupies a volume of 0.28 cu ft and consumes 110 watts of power.

In the field of measurement and instrumentation the scene tended to be dominated by test and measuring equipment for electrical variables—multimeters, oscilloscopes and the like. One of the more unusual instruments in this category was a Rohde & Schwarz (German) reflectometer, having the useful features of being direct-reading (on a pointer indicator), working over a broad frequency band without tuning (30 to 1,000 Mc/s) and independently of the input signal generator level, and being able to measure, at the same time, low attenuations in the range 0.05 dB to 5 dB. Reflection coefficients of networks, aerials, transmission lines, etc., can be measured over the range 0.5 % to 100%.

Some of the electrical measuring instruments, how-
ever, could also be used for measurement of other physical variables, such as the sensitive Keithly nanovoltmeter (10 nV d.c. full scale) intended for use with thermocouples and other low-impedance transducers producing small voltages. This American instrument has a resolution of 1 nV, and is claimed to have a stability of 10 nV per 24 hours. Specifically designed for temperature measurement was a Hewlett Packard instrument based on the temperature sensitivity of a quartz crystal in an oscillatory circuit. Changes of temperature affecting the quartz crystal probe vary the oscillator frequency, and this is used to give a digital indication of temperature. The instrument will work between -40°C and +230°C and will resolve temperature changes of 0.0001°C.

Oscilloscopes of particular interest included a new Tektronix instrument, Type 549, combining high speed (5 mm/μsec) with trace storage; a plug-in unit for the Hewlett Packard Type 175A providing a recording on a paper chart of any waveform displayed (a sampling technique being used); and a Ferisol oscilloscope of extremely wide bandwidth (0 to 1 Gc/s) capable of displaying waveforms with risetimes as small as 0.15 nanosecond. In the last-mentioned instrument the wide-bandwidth is obtained by not using a y amplifier but applying the signal directly to the vertical deflection plates. This, of course, means that the sensitivity is limited (10 V/cm), but it is claimed that the fine spot of the CRT allows trace deflections of less than a millimetre to be seen.

Among the many electronic components on show, a notable exhibit on the British group stand was a display of magnetic shields suitable for instruments, relays, watches, cathode-ray tubes, etc.—but manufactured, unusually, by the technique of electroforming. This is an entirely new process for magnetic materials, developed by Plessey Radar on the basis of their experience in the electroforming of copper and nickel microwave components. The advantage of the technique is that shields of high-permeability alloys (similar to well-known proprietary materials) can be fabricated as one-piece shells which are free from the mechanical joints and large internal stresses that normally cause a deterioration of performance. The electroformed shields can be deposited directly on glass devices such as cathode-ray tubes, or made as separate components to any desired shape. Electrical shielding is provided as well, of course, by the conducting property of the material.

Another unusual type of component, in the field of machine control, was an electrohydraulic impulse motor, providing a high-power rotary drive controllable in steps by low-power electrical impulses. Stepped rotary motion can, of course, be obtained from conventional electric stepping motors, but these suffer from poor response speed if high output power is required (because of their mechanical inertia). In the device on show, made by Fujitsu of Japan, hydraulic drive techniques overcome the inertia problem, and the hydraulic power is controlled through a valve system by a small and light electric torque motor energized by low-power electrical impulses. The motor could be used for digital position control on machine tools or other equipment, and, because of the precise angular positioning inherent in the stepping action, it offers the possibility of obtaining accurate control without the need for a closed-loop system.

A useful, simple, non-contacting transducer for timing, position indication or speed measurement of moving mechanical parts was an electromagnetic pick-up made by Electro Products Laboratories of Chicago. It is basically a small pick-up coil combined with a permanent magnet. When the steady magnetic field is disturbed by a ferrous object—say the teeth of a rotating gear wheel—the coil generates an a.c. voltage. Various sizes are available, but one of the latest is a miniature unit measuring ½ in diam. by ½ in long, capable of giving output signals of up to 3 V.

**OCTOBER MEETINGS**

*Tickets are required for some meetings: readers are advised, therefore, to communicate with the secretary of the society concerned*

**LONDON**


6th. I.E.E.—"Discussion on "Filling gaps in v.h.f./u.h.f. service areas" at 5.30 at Savoy Pl., W.C.2.

6th. I.E.S.—"SECAR—a modern s.s.r. ground interrogator and decoding equipment" by H. W. Cole at 6.0 at 9 Bedford Sq., W.C.1.


12th. Radar & Electronics Assoc.—"Transmitting aerial systems for television broadcasting on u.h.f." by G. C. Platts at 7.0 at the Royal Society of Arts, John Adam St., W.C.2.

13th. I.E.E.—"Discussion on "What is group delay" at 5.30 at Savoy Pl., W.C.2.

13th. I.E.E.—"Signal processing using optical techniques" by Dr. D. C. Cooper at 6.0 at 9 Bedford Sq., W.C.1.


14th. I.E.E.—"Long wavelength laser generation" by E. S. Mathias at 5.30 at Savoy Pl., W.C.2.

15th. Television Soc.—"Problems connected with the use of colour film for colour television" by Dr. F. P. Glyons at 7.0 at I.T.A., 70 Brompton Rd., S.W.3.

19th. Soc. of Relay Engrs.—"Testing methods and equipment applicable to v.h.f. and h.f. wired television systems" by W. B. Smith at 2.30 at the I.E.E., Savoy Pl., W.C.2.


20th. Soc. Environmental Engrs.—"Radio frequency interference control" by D. J. Lewis & A.S. Evans at 6.0 at Imperial College, Mechanical Eng'r's Dept., Exhibition Rd., S.W.7.

20th. I.E.E.—Discussion on "Computer/instrument interfaces" at 6.0 at London School of Hygiene and Tropical Medicine, Keppel St., W.C.1.

21st. I.E.E.—Discussion on "Instrument scale graduation" at 5.30 at Savoy Pl., W.C.2.


27th. S.E.R.T.—"Video tape recording equipment" at 6.0 at Royal Soc. of Arts, John Adam St., W.C.2.


OCTOBER MEETINGS
Continued

BATH

BIRMINGHAM
25th. I.E.E. "Safety or disaster—the reliability of electronic equipment" by J. C. Cluley at 6.30 at M.E.B., Summer Lane.

BRADFORD

BRIGHTON
27th. I.E.E. "Automation in computer design" by D. G. Jacobs at 6.30 at College of Technology, Moulsecoomb.

BRISTOL
7th. S.E.R.T. "R.F. transmission lines" by R. Garland at 7.45 at Hawthorns Hotel, 8.
20th. I.E.R.E. "Laser technology and applications" by J. MacDowall at 7.0 at University Engineering Laboratories, University Walk, Clifton.

CAMBRIDGE
14th. I.E.E. "Chance and the communications engineer" by G. R. Nicoll at 8.0 at Engineering Laboratories, Trumpington St.

CARDIFF
4th. I.E.E. "Field effect transistors: another minor revolution in transistor practice" by W. Fishwick at 6.0 at South Wales Institute of Engineers.

CATERICK
13th. I.E.E. Discussion "The communication of knowledge" at 6.30 at School of Signals.

CHRISTCHURCH
20th. I.E.E. "The U.K.3" by H. J. Sketch at 6.30 at King's Arms Hotel.

COLCHESTER
26th. I.E.E. "Some examples of simulation and computer techniques in electronic engineering" by N. A. Hurly at 7.30 at North East Essex Technical College, Sheepen Rd.

EDINBURGH
6th. I.E.E. "Input spectrum and the ability to optimize" by Dr. I. Cochrane at 7.0 at Department of Natural Philosophy, The University, Drummond St.

FARNBOROUGH
14th. I.E.E. "Fuel cells, a customer's viewpoint" by Dr. W. R. S. Davidson at 7.0 at Farnborough Technical College.

GLASGOW
7th. I.E.R.E. "Input spectrum and the ability to optimize" by Dr. I. Cochrane at 7.0 at Institute of Engineers and Shipbuilders, 39 Eimbank Crescent.

GUILDFORD

HORNCOURT
12th. I.E.R.E. "Satellite communications" by W. J. Bray at 6.30 at College of Further Education, 42 Ardleigh Green Rd.

LEEDS
6th. S.E.R.T. "The manufacture of transistors" by A. Lingard at 7.30 at Branch College of Engineering, Cockend St., 2.

LIVERPOOL
11th. I.E.E. "Static electronic protection" by J. B. Patrickson at 6.30 at the Royal Institution, Colquitt St.
18th. I.E.E. "Trends in telecommunications switching" by L. J. Murray at 6.30 at Royal Institution, Colquitt St.
26th. I.E.E. "Blue print of a professional engineer" by J. B. Lachester at 6.30 at the Royal Institution, Colquitt St.

MANCHESTER
21st. I.E.R.E. "PAL colour television" by M. Cox at 7.0 at Renold Building, College of Science and Technology, Sackville St.

NEWCASTLE-ON-TYNE

NEWPORT, I.O.W.

NOTTINGHAM
5th. I.E.E. "Magnetostriiction" by Dr. W. Alexander at 6.30 at Main Lecture Theatre, T.T. Building, University.
12th. I.E.E. "Hall effect devices" by Dr. J. P. Newsome at 6.30 at First Year Applied Science Block, University.

NORWICH
5th. I.E.E. "Instrumentation of a rocket testing site" by J. W. Dalgleish at 7.30 at Assembly House.

PETERBOROUGH

PORTSMOUTH
6th. I.E.R.E. "The microcircuit revolution" by C. E. Tate at 6.30 at Telephone Exchange, Park Road.
20th. I.E.R.E. "Semiconductor operational amplifiers" by R. C. Foss at 6.30 at College of Technology, Anglesea Road.

READING
19th. I.E.R.E. "Research in electronic instrumentation at the University of Reading" by Dr. E. A. Faulkner at 7.15 at J. J. Thomson Physical Laboratory, University of Reading.

SALFORD
18th. I.E.E. "The place of the computer in engineering education" by E. Kerr at 6.15 at Royal College of Advanced Technology.

SOUTHAMPTON
12th. I.E.R.E. "The history of computers" by D. J. Truelove at 6.30 at The Lanchester Theatre, University.
15th. S.E.R.T. "A review of fifty years of electronics" by Dr. K. E. Everett at 7.30 at College of Technology, East Park Terrace.
26th. I.E.R.E. & I.E.E.S. "Loudness of sonic booms and similar sounds" by Professor E. E. Zepler at 6.30 at Lanchester Theatre, University of Southampton.

STOKE-ON-TRENTE
12th. I.E.E. "Computers—present and future" by R. Woolf at 7.0 at North Staffs College of Technology, College Rd.

SWANSEA
21st. I.E.E. "Field effect transistors: another minor revolution in transistor practice" by W. Fishwick at 6.0 at Engineering Department University College.

WHITBY
5th. I.E.E. "Recent developments in multiple access computer operation" by M. W. Wilkes at 7.0 at Bootham's Cafe, Skinner St.

LATE SEPTEMBER MEETINGS

LONDON
29th. I.E.R.E. & I.E.E. "Airborne computers" conference at 10.30 at the London School of Hygiene and Tropical Medicine, Keppel St., W.C.1.

MANCHESTER
30th. I.E.R.E. "Radar" by N. P. Robinson at 7.0 at Renold Bldg., Manchester College of Science and Technology, Sackville St.
Electronic Laboratory Instrument Practice

10.—MEASUREMENT OF FREQUENCY


In a run-of-the-mill electronics laboratory, frequency is one of the things that you have the least occasion to measure and, ironically, it is the one that you can measure with the most accuracy. Almost around the clock, even the most ill-equipped establishment can pick up, for nothing, world frequency standard transmissions of an absolute accuracy of the order of 1 in $10^8$. Not only that; simple frequency comparison techniques exist which lose little of this accuracy. This means that any laboratory can with ease check its frequency measuring equipment to not worse than 1 in $10^7$ (or one part in ten million).

Basic considerations of frequency measurement

Now, academically that may be very interesting information, but it does not really help the poor lab. worker when he is first faced with the problem of arriving at the frequency of an unknown signal. His approach must be primarily practical, and it must be done in four stages. First, he must possess himself of a suitable measuring instrument; secondly, he must find some standard against which to check it; thirdly, he must calibrate his instrument against the standard; and lastly, he can then measure his unknown frequency.

As to the choice of measuring instrument, there are more than a few different types, but they fall into the main categories: (a) wavemeters; (b) grid-dip meters; (c) heterodyne meters; (d) frequency bridges; (e) frequency generators; (f) calibrated oscilloscopes; (g) digital counter-type meters; and (h) miscellaneous instruments. We shall look at these various types individually later, but first it is well to consider what standards are available in the ordinary laboratory for calibrating them and how to carry out such calibration.

Frequency standards

Frequency standards available to a laboratory fall into three main groups: (a) standard-frequency radio transmissions; (b) laboratory calibrated signal sources; and (c) calibrated frequency measuring instruments.

Standard-frequency radio transmissions are within the reach of anyone who owns a domestic radio receiver capable of receiving the B.B.C. transmitters at Droitwich on 200 kc/s (1,500 metres). The deviations of the Droitwich carrier signal are maintained within the limits of ±5 parts in $10^7$ of the nominal 200 kc/s frequency. The nominal frequency is defined on the basis of 200,000 cycles in 1 second of Ephemeris Time (E.T.), this 1 second being realized in practice as 9,192,631,770 cycles of the caesium resonance frequency at zero field. And not only does Droitwich provide you with a highly accurate 200 kc/s carrier signal, but also its transmissions are preceded by a highly accurate 1,000 c/s tuning signal.

With your domestic radio, again, you can use certain medium-frequency broadcasting stations to provide a selection of other carrier frequencies between 150 and 550 kc/s accurate to better than 1 in $10^7$.

Furthermore, if you have a short-wave or communications receiver, you can pick up the British G.P.O. special service of frequency-standard transmissions from MSF (Rugby) radiated simultaneously on 2.5, 5 and 10 Mc/s continuously for 24 hours a day (except for a five minute interruption from minute 15 to minute 20 in each hour).

If, on the other hand, you should happen to have a suitable special f.l. receiver, you can use transmissions on 60 kc/s from MSF (Rugby) and 16 kc/s from GBR (Rugby) as standards. The 60 kc/s transmitter works one hour each day from 14.29 to 15.30 GMT, and the 16 kc/s transmission generally operates for about 22 hours a day (with a maintenance period from 13.00 to 15.00 GMT). Incidentally, when GBR (Rugby) on 16 kc/s is inoperative, GBZ (Criggon) on 19.6 kc/s is available.

Standard-frequency transmissions are also radiated in a continuous 24-hour service from the American National Bureau of Standards' stations WWV, near Washington, D.C., and WWVH, in Hawaii. These radiate carrier frequencies accurate to at least ±1 in $10^7$ on 2.5, 5, 10, 15, 20 and 25 Mc/s.

The modulations on these standard-frequency transmissions change from time to time, but on one or other of them modulations of 1 c/s, 440 c/s, 1,000 c/s and 4,000 c/s are available, which could be used for calibrating local audio frequency standards. However, by using accepted methods of successive frequency division, you can obtain spot frequencies in the audio range to the same order of accuracy as the r.f. carrier standard-frequency transmissions, and this subdivision of r.f. is the more usual method for high accuracy audio frequency calibration.

Conversely, when it comes to frequencies in the v.h.f./u.h.f. bands you can use techniques of frequency multiplication to extend the r.f. transmission frequency standards upwards as required.

Signal Generator Standards.—Active signal sources in the laboratory are the second main group of frequency calibration standards. For example, a good-quality stable signal generator, calibrated against standard-frequency transmissions, makes a very useful transfer standard usable when no suitable transmission is available. Another approach is to make up a quartz-crystal (or high-stability LC) oscillator specially for calibration purposes.

In these days of the transistor, it will not be found very difficult to make up a simple basic oscillator of this type. Fig. 70 gives a typical circuit for a battery—

*Newmarket Transistors Ltd.
operated 100 kc/s crystal oscillator which provides locked harmonics off to many tens of megacycles. The 100 pF variable capacitor in series with the series-mode 100 kc/s quartz crystal is used to adjust the calibration of the instrument against a standard-frequency transmission.

Another "signal-generator" type of laboratory frequency-reference sometimes very useful is a "physical" source such as tuning fork or a vibrating reed. It is surprising what accuracy of frequency can be obtained with even such simple sources as these.

**Frequency-meter Standards.** Standard-frequency transmissions and standard oscillators apart, some laboratories use high-accuracy frequency-measuring instruments themselves as reference standards. Wavemeters and grid-dip meters are typical of this class.

Before we leave the question of standards, however, it is well for the reader to get some idea of the sort of accuracy one can expect from the various types. Typically these are: LC-tuned circuits = 1 in 10', tuning fork = 1 in 10^6, well-designed quartz-crystal = 1 in 10^6, Ephemerical Time standard = 1 in 10^9, and Caesium resonance = 1 in 10^11.

At this point, also, a warning on the accuracy of mains frequency (sometimes used for reference) is not out of place. Generally the frequency lies within ±0.5 cycle of the nominal 50 c/s frequency, thus implying an accuracy of only 1 in 10^2 (1%). But, under abnormal conditions, e.g. load shedding, the frequency may vary from as low as 47.5 c/s to as high as 51.5 c/s, i.e. −5% to +3%. Of course, the mean frequency over a long period is kept very accurately to 50 c/s so that, although synchronized electric clocks may go fast or slow over short periods, they eventually return very near to the correct time.

**Calibrating instruments against standards**

Having obtained a suitable measuring instrument and standard, the next step is to check one against the other. For this you need some sort of frequency-coincidence detector arrangement. Such detectors may be of three types:—(a) acoustic (b) meter and (c) visual.

**Acoustic Frequency-coincidence Detectors.** Acoustic methods can be used in several ways. The first is the simple zero-beat method in which two signals being compared are mixed and adjusted until the audible beat between them falls to zero. This is usually satisfactory when two radio frequencies are being compared, but, because of the uncertainty of hearing below about 20 c/s, it is not entirely satisfactory when two audio frequencies are being compared. In such a case the so-called "double-beat" or "slow-beat" method is used. In this, a third (different) frequency is set up and the standard is adjusted against this to give an audible beat frequency. The unknown signal is then tuned to beat also with this third frequency, and adjusted until the slowest beat is achieved between the two audible beat frequencies. This double-beat method is capable of much greater accuracy than the simple zero-beat one, and differences of 1 c/s can be measured.

Another example of the use of acoustics to provide a frequency-coincidence detector is in the null-detector headphones of a frequency bridge (to be described later). Here the bridge controls are adjusted until the "resonance" frequency of the bridge coincides with the frequency being measured, the indication of synchronism being a minimum signal in the headphones.

**Meter Frequency-coincidence Detector.** Where the headphones of a frequency bridge are replaced by a meter-presentation null detector, we have one example of the next main class of coincidence detectors, i.e. meter types. Another example is where a meter circuit is used with a pointer displacement proportional to the beat frequency. A final example is the meter presentation of frequency-coincidence exemplified in the numerical display on a digital counter-type frequency meter when it is used to monitor the beat frequency while bringing two signals into synchronism.

**Visual Frequency-coincidence Detectors.** Apart from acoustic and meter methods, visual displays of frequency
coincidence are widely used. The commonest example of this is the use of an oscilloscope where the two signals under test are fed to the x and y amplifiers, and one is adjusted until the scope trace becomes stationary. When this happens, one frequency (or one of its harmonics) is in synchronism with the other. Stationary-trace scope comparison of frequencies is really only satisfactory with audio and low radio frequencies. With higher frequencies, it will be found impracticable to hold the trace stationary.

However, if the scope is run on its own time-base, and the two high frequency signals to be compared are fed together in the y amplifier input, it is possible to see visually the coincidence of the frequencies as the envelope of the trace becomes modulated at the beat frequency when synchronism is approached.

Another visual method is the use of a "magic-eye" tuning indicator. There are many possible arrangements. One of these (due to H. V. Beck, p.405 of the October 1951, Electronic Engineering) is given in Fig. 71. When \( f_1 \) is nearly equal to \( f_2 \) in this circuit, the indicator will be found to flicker at a frequency equal to the difference, and a frequency difference of 0.05 c/s is easily distinguished.

One final rather "off-beat" example of the use of a visual frequency-coincidence indicator that may be met with is the "reed" meter sometimes used to check mains frequency. In this, a set of metal reeds tuned at intervals around 50 c/s (the reeds being electrically coil-driven) are arranged to be visible. When the signal to be tested is applied to the driver coil, the reed with a resonant frequency closest to the input frequency oscillates more violently than its neighbours and gives an indication of the unknown frequency.

R.F. measurements

Having dealt with standards and calibration we can now turn our attention to actual measurements of frequency.

Absorption Wavemeter.—For measuring radio frequencies, the least complicated instrument is the absorption wavemeter. In its simplest shape this takes the form of an L.C circuit as shown in Fig. 72, where the tuning capacitor is fitted with a dial calibrated in frequency.

![Fig. 72. Basic circuit of absorption wavemeter.](image)

To measure the frequency of a transmitter or receiver, you tune the wavemeter with its coil loosely coupled to the equipment until the equipment response shows a change caused by the absorption of r.f. energy by the wavemeter resonant circuit. By the use of plug-in coils, a wide frequency range may be covered by the absorption wavemeter. Such meters are often fitted with some form of resonance indicator such as a pilot lamp or meter, so that you can see the synchronism with the signal source without having to watch for any change in response in the source equipment.

Wavemeters can be calibrated from a t.r.f. receiver tuned to a standard-frequency transmission, or from any calibrated standard signal generator.

One of the more useful features of the wavemeter is that it gives a quick identification of the fundamental frequency in the presence of its harmonics, as the circuit is not usually sufficiently sensitive to respond to harmonics.

Grid-dip Meter (or Oscillator).—An absorption wavemeter can be used only to check circuits when r.f. energy is present. Some other arrangement is required to check the frequency of a passive tuned circuit. A handy instrument for this is the grid-dip meter. Not strictly a signal generator, it combines the function of a calibrated variable frequency reference oscillator with that of an absorption wavemeter. A typical circuit of a simple transistor grid-dip meter is shown in Fig. 73. In use, the oscillator coil is loosely coupled to the tuned circuit under test, and the grid-dip meter tuned by the main tuning capacitor \( C \) until the reading on the milliammeter dips to a minimum. What has happened then is that the variable oscillator frequency has been synchronized with the tuned circuit under test, which has absorbed some energy from the oscillator and caused the meter to dip. The frequency of the tuned circuit under test is then read off from the calibrated dial of the master control capacitor \( C \). (The term "grid" in grid-dip meter is a bit of a misnomer. It refers back to the days when these instruments used thermionic valves, but people still talk of the transistor version as a "grid-dip" meter, although the grid has disappeared along with the valve of which it formed part!)

Heterodyne Frequency Meter.—Until the recent large-scale increase in the use of counter-type frequency meters, accurate measurements of the frequency of an r.f. signal source were most often carried out by the heterodyne or zero-beat method. This depended on the fact that when two signals of different frequencies are mixed in a non-linear circuit, the output contains a signal at a heterodyne or beat frequency equal to the difference between the two original signals. The heterodyne frequency meter is in effect a standard signal generator fitted with provision for feeding the unknown signal into a mixer along with the internally generated standard frequency signal. The internal generator is then adjusted until the beat frequency is heard on the headphones and the dials are adjusted so that pitch of the beat note progressively decreases until it becomes inaudible. The setting of the heterodyne frequency meter dials then gives the exact frequency of the signal being measured.

A very well-known version of the heterodyne frequency meter is the BC-221 shown in Fig. 74. This
Fig. 74. BC-221 heterodyne frequency meter widely used by the Forces in World War II and readily available on the surplus market.

Fig. 75. Modern high performance commercial counter-timer frequency meter (Marconi TF2401) capable of counting up to 500 Mc/s with absolute accuracy of better than 1 in 10^7.

was widely used by the Armed Forces during the last war as a frequency standard covering 125 kc/s to 20 Mc/s in two ranges. The tuning control is geared to obtain a most precise slow motion of the dial. The setting can be read to five figures, which can then be translated to the exact corresponding frequency by the use of the calibration chart which can be seen in the illustration just below the front panel.

Good heterodyne frequency meters (such as the BC-221) incorporate an internal crystal calibration oscillator against which the variable frequency oscillator can be adjusted at a series of check points by means of a small vernier control. With this facility, the readings of the BC-221, for example, can be made accurate to 0.01% (1 in 10^4). However, the BC-221 is capable of an accuracy of better than ±30 c/s over most of the 125 kc/s to 20 Mc/s range.

Counter-type Frequency Meters.—Digital counting techniques have advanced so much over the past ten years that counter-type frequency meters are available which can measure accurately and display numerically frequencies well into the u.h.f. range. A good example of such a meter is the Marconi Type TF2401 illustrated in Fig. 75. I dealt with the principles of operation of this type of frequency measuring equipment in part 10 of "Elements of Transistor Pulse Circuits" (W.W., November 1964).

AF measurements

Some methods of measuring radio frequency discussed above can also be used at audio frequencies. For example, the counter-type frequency meter can equally well be used for audio frequency measurements of very high accuracy, although in an ordinary laboratory such measurements by themselves would hardly justify the considerable expense of a v.h.f. counter-timer to be used at a.f.

For audio work up to 20 kc/s, the slower dekatron counters, often still found around laboratories, can be used satisfactorily for many purposes. I myself have used a Labgear Fast Dekatron Counter Type D4131 for measuring the precise frequencies required to an accuracy of 0.01% (i.e. 1 in 10^4) in electronic organ tuned circuits, and found it quite adequate when used with the ancillary crystal-controlled frequency source and timing unit available.

Bridge Measurements.—In the audio frequency range relatively simple resistance-capacitance circuits have such time constants as to be frequency sensitive. This gives rise to a range of resistance-capacitance bridge circuits which can be used with suitable calibration to measure audio frequencies.

The Wien bridge, which has only two simultaneously variable components, is often used for this purpose, particularly as it has a very wide frequency range with one swing of the control. This bridge is a venerable one which some readers may be interested to trace.

Fig. 76. Typical circuit of Wien-bridge type audio-frequency measuring bridge.

Accuracies of about 1 in 10^4 are quoted for some frequencies in "Get More from LM and BC-221 Frequency Meters" by G. Jennings, Radio-Electronics, August 1962, p. 63.
†The series of articles is now available as a book.—Ed.

Fig. 76 gives a typical circuit of an audio-frequency measuring bridge working on the Wien bridge principle. In this, the two 10 k variable resistances are ganged sections of a double potentiometer, and are so arranged that the resistances of the two arms of the bridge in which they are connected are equal at all settings. The linear potentiometer at the opposite end of the bridge is a balance resistance that compensates for small differences in tracking between the two 10 k sections of the main variable control resistance. This ganged variable resistance is the principal control on the bridge and is fitted with a calibrated direct-reading dial of frequency. Switched series and parallel capacitors for different frequency ranges will be noted. Those in position (1) are for 20-200 c/s, in position (2) for 200-2,000 c/s, and position (3) for 2,000-20,000 c/s. The dial is calibrated in the first instance against a standard signal source, the setting at each frequency being adjusted for minimum signal in the bridge detector headphones. Once calibrated, the bridge can be used to measure exactly any audio frequency in the range 20 c/s to 20,000 c/s.

The Wien bridge is not a very accurate frequency measuring instrument when compared with the 1 in 10⁶ or better accuracy of economical portable transistor counter-type frequency meters capable of giving an instantaneous direct digital readout display of frequencies up into the u.h.f. range, some of which can be obtained in this way for audio frequencies (or even low r.f., depending on the timebase maximum speed).

V.H.F./U.H.F. measurements

Measurements of very high frequencies follow much the same pattern as r.f. measurements, except the various equipments may take special forms. For example, the simple absorption wavemeter described earlier will, in the u.h.f. range, take the shape of a pair of Lecher wires, or a calibrated cavity resonator, or a slotted line.

As mentioned before, standard frequencies in these ranges are derived by multiplier circuits (usually triggered astable multivibrators or tuned frequency harmonic multipliers) from r.f. standards. Tuned Class C thermionic valves can be pushed out in this way to a few thousand megacycles and klystrons to 25,000 Mc/s. Microwave and variable capacitance diodes are also used for frequency multiplication into the microwave frequency range.

We have taken a look at most of the instruments used in laboratories to measure frequency. Although these have been widely relied on in the past, the development of economical portable transistor counter-type frequency meters capable of giving an instantaneous direct digital readout display of frequencies up into the u.h.f. range, must mean that in the years to come many of the instruments described in this article must become lab. curiosities. However, the slow natural term of obsolescence of electronic instruments means that readers may still have to know how to handle them and understand their principles for some time to come.
ECONOMICAL LOGIC

Advantages of NAND/NOR logic and techniques for using it—with particular reference to minimization of networks by topographical methods

By H. R. HENLY,* A.M.I.E.E.

The tremendous developments in semiconductor technology in recent years have made possible the design of logic circuit elements which are reliable, efficient and suitable for mass production. In particular the combination of diodes and/or resistors with transistors to produce NAND and NOR elements has revolutionized the design of computer and process control logic.

As the following discussion will show, the application of NAND/NOR logic techniques to the realization of logic circuits results in a number of distinct advantages, both economic and in circuitry, over those elements representing the basic Boolean connectives AND and OR. A reminder of the logic systems and terms in common use is given in the box, right. (Unless otherwise stated, positive logic will be used throughout the article. On graphical symbols, the recommendations of BS530 are considered to be perfectly adequate and will be used throughout.)

The design philosophy based on AND and OR connectives has the advantage that, apart from the emitter followers, the elements represent fundamental Boolean connectives. With suitable choice of diodes, high operating speeds may be realized at comparatively low cost. However, this must be weighed against the degradation of signal levels, which may worsen with age. Also, the use of these circuits does not necessarily produce cheap and simple in construction but suffer from the disadvantage that no active device is included, resulting in a power loss at each stage of gating. The result is a gradual deterioration of signal levels which is overcome in practice by the inclusion of emitter followers at strategic points in the circuit. The NOT operation is performed by the common-emitter stage (below) which provides both inversion and power gain and may be used instead of emitter followers where rearrangement of the circuit equations permits.

AND/OR/NOT Logic Realization

The truth values 1 and 0 are represented electronically by two discrete voltage (or current) levels, one of which is generally (but not necessarily) zero (earth) potential. Two logic systems may be defined:—

(1) **Positive Logic** in which the truth or 1 value is represented electronically by the more positive of the two levels chosen.

\[ \text{e.g.: } 6 \text{ volts } = 1 \]
\[ 0 \text{ volts } = 0 \]

(2) **Negative Logic** in which the truth or 1 value is represented by the more negative of the two levels chosen, e.g.:

\[ -6 \text{ volts } = 0 \]
\[ 0 \text{ volts } = 1 \]

The fundamental Boolean connectives are realized electronically by diode gates (below). These are

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*Post Office Engineering Department.*
the most economic realization of a given circuit equation in terms of electronic components. This is particularly true now the price of transistors, diodes and high-stability resistors are of the same order.

The NAND and NOR elements are simply developments of the NOT element, comprising in the simplest form the common-emitter circuit of Fig. 1. A number of inputs are provided via resistors $R_I, R_2, R_3, \ldots , R_n$, to the transistor base. These are so chosen that with all inputs at zero potential relative to the emitter (i.e. 1 level) the potential divider formed with the base resistor $R_b$ across the positive supply $V_o$ cuts off the transistor. Under this condition the output is approximately $-V$ volts (0 level). The operation, assuming three inputs, is clearly $Z = ABC$, i.e. $= NOT \cdot AND$ or NAND.\hspace{1em}(1a)$

If the p-n-p transistor of Fig. 1 is replaced by an n-p-n type, as in Fig. 2, then with the same logic levels we have the following operation: $\hspace{1em}Z = A + B + C \hspace{1em}(2a)$

Alternatively, we may use a diode gate followed by inversion, which would be more reliable using silicon devices.\hspace{1em}(2b)$

In order to ease the tolerancing problem and increase the operating speed, the alternative circuits of Fig. 3 may be used. These utilize diode gates followed by inversion. Although the overall cost is higher, the reliability (especially using silicon devices) is greater. Furthermore, the NOR circuit may be designed to allow the interconnection of NAND with NOR circuits.

The NAND and NOR circuits described may be designed as a standard element so that any element is capable of driving a certain number (typically 5) of identical elements. This enables the system designer to implement a logic circuit using one standard circuit element throughout, provided care is taken to ensure that the loading restrictions for the element are followed. Where it is essential to exceed the driving capabilities of the simple element, several may be combined (effectively paralleling the transistors) or another standard circuit designed with a larger driving capacity.

Thus even in its simplest form, Fig. 2 represents a very powerful logical element—a fact which has been exploited to advantage by manufacturers in the computer and automation fields.

In terms of the basic connectives we may derive the equivalent circuits of these elements by making use of equations 1 and 2. These are shown in Fig. 4 and it is seen that the elements may be considered simply as combinations of AND and OR gates with inverters.

Table: Equivalent Circuits of NAND and NOR

<table>
<thead>
<tr>
<th>FUNCTION</th>
<th>INTERPRETATION IN BASIC CONNECTION</th>
<th>NAND EQUIVALENT CIRCUIT</th>
<th>NOR EQUIVALENT CIRCUIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Z = ABC$</td>
<td>$A + B + C$</td>
<td>$\overline{A} \cdot \overline{B} \cdot \overline{C}$</td>
<td>$A \cdot \overline{B} + B \cdot C + C \cdot A$</td>
</tr>
<tr>
<td>$Z = A + B + C$</td>
<td>$A \cdot B \cdot C$</td>
<td>$\overline{A} + \overline{B} + \overline{C}$</td>
<td>$A + B + C$</td>
</tr>
</tbody>
</table>

Fig. 4. Symbolic interpretation of equations (1) and (2).
After the substitution the circuit is examined for redundant elements, e.g. two NOT elements in cascade. The resulting circuit is not necessarily the minimal form (assembled from the smallest possible number of elements) even though the original Boolean expression may have been.

The derivation of the equivalent circuits does yield one useful fact, of which we shall make use later. It is seen in Fig. 5 that if an OR equivalent circuit follows an AND equivalent circuit (in the case of NAND elements) two single-input elements are saved per OR input. A similar situation occurs with NOR elements when an OR circuit is followed by an AND circuit.

To exemplify this technique and to introduce other ideas we shall consider the Exclusive OR circuit. The Truth table is given above, from which we obtain the function:

\[ f = A \overline{B} + \overline{A}B \]  

If this is implemented in the basic connectives it requires two AND elements for the product terms, an OR element for the output gate and two inverters. The circuit is shown in Fig. 6(a). Substituting the appropriate NAND equivalent circuits in 6(a) and removing redundant elements yields the circuit of Fig. 6(b). This uses five elements and eight inputs, so a simpler solution is sought. Returning to equation 3, by the distributive laws we can write:

\[
\begin{align*}
  f &= (A \overline{B} + A)(\overline{A}B + B) \\
  &= (\overline{A} + B)(\overline{A} + B) \\
  &= (A + B)A + (A + B)B \\
  &= A + B \\
\end{align*}
\]

Now the equation is in the form AND-OR-AND, with a common factor \((A + B)\). The NAND implementation is shown in Fig. 7, requiring only four elements and eight inputs, and has been shown to be the minimal form. This brings out the important point that although the substitution method yields useful results the circuit is not necessarily the minimal form. It may be necessary to rearrange the circuit equations into a form which represents the output of NAND/NOR elements. It should also be noted that equation 4 yields the minimal circuit in basic connectives by writing it as:

\[
  f = \overline{A}B(A + B)
\]

requiring only three elements and one inverter—a saving of one inverter.

It is instructive to take this example a stage further and consider the NOR form. From equation 4 we have:

\[
  f = (\overline{A} + \overline{B})(A + \overline{B})
\]

but instead of partially multiplying out to obtain the sum-of-products form we retain the product-of-sums form, from which the NOR form is obtained directly, Fig. 8. This is the minimal NOR form requiring five elements and eight inputs and is therefore less economic than the NAND version.

It is important to note that here we sought an equation which required the output to perform an AND function whereas for the NAND version we made the output gate perform an OR function. Let us consider this point more closely. Referring to the circuits of Fig. 4, it can be seen why these arrangements are desirable.

First consider the case of two NAND elements feeding an output NAND gate, Fig. 9(a). Analysing this in terms of the basic Boolean connectives, we arrive at Fig. 9(b), remembering that De Morgan’s theorem gives two alternative forms for a NAND function. It is seen that the complementations occurring in the penultimate stages of gating are cancelled in the last stage.

(continued on page 521)
Fig. 9. (a) Analysis of NAND circuit; (b) analysis of (a) in terms of basic connectives.

Fig. 10. General NAND circuit, indicating three levels of gating.

It is conventional to number the stages of gating from the output, i.e. the output stage is the first stage, all stages driving it constitute the second stage and so on.

The above exercise can be repeated using NOR elements, and a similar analysis results. The output function would be the dual of Fig. 9(b), since dual elements would be used. Again by using the appropriate equations (from De Morgan's theorem) terms complemented in the second stage of gating would be complemented again in the first (output) stage. In general it can be concluded that variables entering at the first stage appear complemented at the output whereas those entering at the second stage appear uncomplemented at the output. This conclusion will now be developed into a general theory.

Consider Fig. 10, which shows part of a larger circuit involving three levels of gating. Here it is seen that terms entering at odd levels (1 and 3) appear complemented at the output, whereas variables entering at the even level (2) are unchanged at the output. It is left to the reader to establish the same rule for NOR elements.

From the foregoing results, general rules for the implementation of NAND/NOR logic can be formulated. These follow identically the rules devised by Maley and Earle and provide an extremely powerful tool for the logic designer.

Rules for implementing NAND/NOR logic

1. Write the equations in a minimal form, suitable for the type of element it is proposed to use (i.e. in the Sum-of-Products form for the implementation in NAND elements).
2. Draw the circuit using the basic Boolean connectives.
3. Replace each element with a NAND (or NOR) element and complement terms entering at odd levels which are required uncomplemented in the output. Where possible the original equation should be rearranged so that terms to be complemented at the output enter at odd gating levels, thus saving inverters.

As an example of the technique consider the function $f = AB + BC$. This is already in a suitable form for NAND logic, i.e., a sum-of-products form, so we can immediately draw the Boolean circuit of Fig. 11(a).

From this follows Fig. 11(b), in which each element is replaced with a NAND block, including the inverter to give B.

In order to implement the same function using NOR elements it is necessary to rewrite the original equation in the product-of-sums form, i.e. $f = AB + BC = B(A + C)$ by simple factorization. The two stages of implementation are shown in Figs. 12(a) and 12(b). In this case B is inserted at the first gating level to produce B at the output.

In this example the NOR configuration produces the more economic circuit, in terms of components, since it involves only two elements and four inputs in contrast to four elements and seven inputs for the NAND version (Fig. 11).

It is important to note the above rules result in no loss of minimality, i.e. the NAND (or NOR) form obtained by these rules will be no less minimal than the original Boolean form.

Minimization

The techniques discussed above provide a ready means of implementing a function in NAND/NOR logic after it has been reduced to its minimal form by the various minimization techniques.

Since the problem of minimization represents a large and often tedious part of the design, I will discuss certain techniques which are considered to be best suited to the design of circuits involving only a few variables (up to 6 or 8). Minimality is not an invariant property of a function since it depends entirely upon the type of circuit element to be used. For the present purposes we need only consider elements using diodes and transistors.

Where diode logic is concerned, each term (sum or product) involves one diode for each literal of the term. Complemented terms require inverters involving transistors.

For circuits using NAND/NOR logic each term requires a transistor and each literal of the term requires an input resistor. Where the circuits used are tailor-made, i.e. inputs are provided only as required, it is clearly desirable...
to minimize the number of literals as well as the number of terms. However, it is common practice to use standard elements which are produced by many manufacturers for this purpose and take one of two forms. The most popular at present is the type using discrete components, encapsulated in an epoxy-resin and designed for maximum reliability. The second and more recent form is the integrated circuit or micro-logic element. In these elements complete NOR circuits are made from a single chip of silicon, resulting in one or more logic elements condensed into a very small package (typically a TO5 transistor case).

The use of these elements eases the minimality requirements to that of reducing the number of terms required and keeping the number of inputs to an element within the number provided. Furthermore the output loading restrictions on the elements must also be observed.

Integrated circuit techniques have developed even further, to the stage where complete logical functions can be constructed on one "chip" of silicon. This completely changes the minimality criteria and makes the direct application of these techniques difficult. Although redundancy is still undesirable it has often to be accepted in these circuits in order to ease the problems of layout and input/output connections to the circuit. This problem has been discussed recently by J. Earle.

The problem of minimization may be tackled in many ways, e.g. algebraic, tabular or map methods. All make use of the axioms $A + A = A$, $A + A = 1$, $A A = 0$, and $A + A B = A$, to reduce the original canonical form to one involving only those terms required to completely describe the function. These terms are called prime implicants. It is proposed to discuss below the Karnaugh map method due to M. Karnaugh. This is a development of the Veitch map, which, with binary ordering of the axes, is considered by the author to be superior to other methods (for problems involving six to eight variables).

The map for $n$ variables comprises $2^n$ cells arranged in either a plane or three-dimensional array. One cell is assigned to each of the $2^n$ canonical product terms. Examples of two and four-variable maps are shown in Fig. 13. The axes are labelled according to a reflected binary (Gray) code which represents the various combinations of the variables assigned to that axis (e.g. for variables $A, B$ the term $A B$ is represented by 01). The advantage of the reflected binary ordering of the axes lies in the fact that adjacent cells differ in one variable only. For example, in the two-variable map of Fig. 13, the cell labelled 2 represents the term $A B$ since it lies at the intersection of $A = 0$, $B = 1$. Similarly in the four-variable map the cell marked x represents the term $A B C D$, that is, $A = 0$, $B = 1$, $C = 0$, $D = 1$. Furthermore the cell y represents $A B C D$, and it differs from the adjacent cell x in the variable $C$ only.

The map for a given function is drawn up directly from the truth table by entering a "1" in each cell for which the output is desired to be "1." The function is then the sum of all the terms for which a "1" is entered on the map. Furthermore any terms occupying adjacent cells in the map may be combined to remove one redundant variable, i.e. that one in which the terms differ. For example in Fig. 13, terms x and y differ in the variable $C$ and the result of combining these terms is $A B D$. Terms which may be combined in this way are indicated by looping together on the map, as shown in Fig. 14, which is a map for four variables. Loops 1 and 2 each involve two terms only, and it will be observed that loop 1 involves terms on opposite edges of the map; this is consistent since these cells also differ in one variable only.

Loop 3 involves four terms, the argument used here is simply an extension of that used above. Loop 3 may be considered as four local loops. This yields:

$$Z = A B C + A C D + A B C + A C D$$

$$= A C (D + D) + A C (B + B)$$

$$= A C + A C$$

The problem of moving horizontally and vertically across adjacent cells (B and D in this case).

Furthermore, terms may be included in more than one
loop, since \( A + A = A \), but this should not be done
carelessly since it can result in unnecessary terms being
included.

In the four-variable map of Fig. 14, it will be observed
that two variables are assigned to each axis. This is not
mandatory and the variables may be assigned in any
desired fashion. However, one complication arises where
the binary coding involves more than two variables—
that is, the cell adjacencies. In the case of two variables,
only adjacent cells differ in one variable; with more than
two variables there will also be non-adjacent cells which
differ in one variable. For example, consider the three-
variable code:

\[
\begin{array}{ccc}
A & B & C \\
0 0 0 & 0 1 0 & 1 0 0 \\
0 0 1 & 0 1 1 & 0 1 1 \\
0 1 0 & 0 1 0 & 0 1 0 \\
0 1 1 & 1 1 1 & 1 1 1 \\
1 0 0 & 1 0 1 & 1 0 1 \\
1 0 1 & 1 0 0 & 1 0 0 \\
\end{array}
\]

Apart from the ordinary adjacencies there are two
additional terms which should also be considered "adjacent";
these are shown bracketed. If this code were
used for one axis of a four-variable map (for example,
with a simple one-variable code on the other axis), then
these additional adjacencies must not be overlooked.
The problem would not arise if the simpler, two-variable
codes were used (i.e. one for each axis).

Maps may of course be constructed for any number of
variables, although above six they tend to become un-
weildy. For five variables the number of cells is large
(256) and the adjacencies are less obvious. For five variables
it is advantageous to draw two four-variable maps,
as in Fig. 15. Then clearly loops may exist on either map 1,
which may be indicated by loop 2. In this example
\( Z = A.B.C + A.C.D.E \). Alternatively the maps may be considered as lying one above
the other, as shown in Fig. 16.

In the examples so far there has been no difficulty
in selecting loops on the map. However, in general there
is usually a number of ways in which the ones may be
looped and it is essential that the combination yielding
the minimum number of loops be chosen. Consider
Fig. 17. There are many possible loops of two terms;
but there are two possible loops of four and the question
arises—which combination to choose? Fig. 18 shows
three possible combinations. The first (a) is obviously
not the best choice since it involves five terms plus an
output gate. Combination (b) is an improvement, but
(c) has fewer terms complemented. The unnecessary
terms and literals in the first two arose because the loops
chosen were not as large as they could have been.

\( Z = \overline{A.B} + B \overline{C} \)

\( Z = \overline{A.B} + A \overline{D} \overline{C} + B \overline{C} + A \overline{D} \)

\( Z = A \overline{B} + B \overline{C} + \overline{A} \overline{B} \overline{D} + A \overline{B} \overline{C} \)

The guiding principle in selecting loops is to first select
loops of single ones which cannot be combined to make
loops of two. Then make those loops of two ones which
will not make loops of four; then loops of four which will
not make loops of eight, and so on.

This procedure is continued until all "1's" have been
looped at least once. Where more than one combination
of loops is possible each must be tried and the final selection
made on the basis of the number of loops and literals
involved (including the number of complemented terms).

Of course, we are not restricted to using the "1's"
on a map; the zeros represent product terms for which
the output is zero. Consider the function dealt with earlier
\( f = A.B + B.C \). The map for this function is

\( f = B + \overline{A}.C \)

\( f = B + \overline{A}.C \)

\( = B (\overline{A}.C) \) by De Morgan

\( = B (A + C) \), the original function.

Here we have merely shown that the zeros of the map
produce the same result as the ones. Thus in minimizing
a function we may also consider looping the zeros and
select the looping which yields the minimal covering
(i.e. the smallest number of prime implicants).

The above discussion, of course is by no means an
exhaustive treatment of the methods by which the minimal
form of a logical function may be determined.

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and encouragement of my colleagues in its preparation.

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Keeping the Radio Peace

CENTENARY OF THE INTERNATIONAL TELECOMMUNICATION UNION

ALMOST as soon as wireless telegraphy proved itself to be a practical means of communication the need for rules and regulations became evident; clearly, anarchy would lead to chaos. Apart from that, the new form of telegraphy might well constitute a threat to established state monopolies in communication. So it was that quite early in the present century many countries enacted laws to control radio. The first British Wireless Telegraphy Act was passed in 1904. Even before then, as ranges of signalling increased rapidly from tens to hundreds of miles, it became obvious that domestic control was not enough. In 1903 the German government called a conference to undertake preliminary studies for the international regulation of radio. This was largely by way of protest against the refusal of Marconi-controlled stations to communicate with other "systems." Delegates from nine nations attended. Though little was actually accomplished, useful groundwork was done for the first real international conference, held in Berlin in 1906.

Fortunately, machinery for co-operation in radio communication between the nations already existed, almost ready made, in the form of the International Telegraph Union. For 41 years the I.T.U. had proved itself to be highly successful in organizing the exchange of telegraphic and later telephonic communications across national frontiers.

"Semaphore to Satellite"

This year the I.T.U. celebrates its centenary and, to mark the occasion, has issued a lavishly illustrated book on its wire and wireless activities over 100 years, with short histories of the various forms of communication. The I.T.U.'s Centenary Conference opened in Geneva on 14th September.

Apart from its more serious content and the great historical value of the excellently reproduced illustrations, the book throws light on many lesser happenings in international communication history. For instance, few of us will know that Britain did not qualify for admission to the Union when it was formed in 1865; her telegraph system was then privately owned. She joined in 1871, after the telegraphs had been nationalized by Disraeli. The U.S.A. did not adhere to the Convention until 1932 though she had been a kind of honorary member long before then. Her earliest radio laws, passed many years after those of the other great nations, were largely in conformity with I.T.U. principles. Naturally, a fair amount of space is given in the book to successive radio conferences. The first, that held in Berlin in 1906, was in some ways the most significant of all as it set the pattern for the future international use of radio for the benefit of all. Frequencies were allotted for specific uses and rules were framed for procedure and priorities in the exchange of telegrams. Delegates from 29 countries attended and they agreed that the I.T.U. should act as the central administrative organ.

Frequency allocation was then a delightfully simple matter; anyone could carry the complete list in his head. The I.T.U. organization

Subject matter of subsequent conferences became too complex for even a brief survey here, but some of the decisions produced profound changes in the I.T.U. itself. In 1932 wire and wireless, sinking old rivalries, came together; the I.T.U. became the International Telecommunication Union and joint committees were set up. In 1947 the I.T.U. became a specialist agency of the United Nations. Sweeping changes were made and it was constituted as a truly international body with no national obligations. Hitherto the staff had been Swiss, appointed by the Swiss government. The Union's permanent Bureau had been set up in Berne as long ago as 1868 in order to distribute statistical and tech-

(Continued on page 525)
 worked out in power supplies and covers the syllabus of Pt. II electronics and a portion of Pt. II electrical theory and measurement.

The authors have used actual examination questions from the past few years, and in preparing the answers have outlined basic methods before giving a general solution. Vol. I "problems in electronics" deals with 70 problems under the headings general circuit theory; coupled circuits; electron ballistics; valve parameters and equivalent circuits; voltage amplifiers; power amplifiers; oscillators and variable frequencies; and power supplies and filters. Vol. II "problems in electronics theory and communications" deals with 47 problems under electric and magnetic field theory; transmission lines; electro-acoustics; transients; harmonics; and illumination. Vol. 1, pp. 209; Figs. 121. Price 25s. Vol. 2, pp. 134, Figs. 71. Price 22s. 6d. Iliffe Books Ltd., Dorset House, Stamford Street, London, S.E.1.

Dictionary of Electronics, Communications and Electrical Engineering. Volume II German-English, edited by H. Werzicke. The author is head of the translating department of the West German company of Rohde and Schwarz. Volume II contains approximately 66,000 words (6,000 more than the English-German volume issued previously), and includes not only the English equivalents of German words but also of abbreviations. Pp. 576. H. Wernicke, 8024 Deisenhofen, Munich. Available in U.K. price 56s. from Aveley Electric, South Ockendon, Essex.

Electronics Buyers' Guide. The 1965 edition of this comprehensive and invaluable directory of the American electronics industry consists of three sections:— a 450-page buyers' guide with over 3,600 product headings (from abrasives to zirconium); an alphabetical index to manufacturers and their branch offices and, in some cases, overseas agents; and 400 pages of manufacturers' announcements. It weighs 5 lb. Pp. 1,138. Issued free to subscribers to Electronics, McGraw-Hill Publishing Inc., 130 West 42nd Street, New York.

Books Received

The Dynamics of Linear and Non-linear Systems, by P. Naslin. An English edition, translated by the author, of the original book "Les regimes variables dans les systemes lineaires et non lineaires." Intended for electrical, mechanical and control engineers, the work is an exhaustive, detailed analysis of control systems. In the introduction, the system concept and general cover of linear and non-linear systems are defined. Graphical and numerical methods of analysis follow, demonstrating the analogies between different types of system. Further deeper analysis employs transform methods, stability and damping criteria, phase-plane and phase-safe topological methods, and numerical and graphical computation of transients. Pp. 586; nearly 520 Figs. Price £5 5s. Blackie & Sons Ltd., 5 Fitzhardinge Street, Portman Square, London, W.1.


Design and Construction of Transistor Superhets, by R. H. Warring. Intended for amateur-radio enthusiasts, the book is essentially practical in treatment. After a simple introduction to the principles of the superhet, an explanation of transistors and printed circuit assemblies is given. Stages of the superhet are then covered in more detail prior to a description of professionally designed circuits. The final chapters deal with constructor kits, testing and alignment. Pp. 104; Figs. 70. Price 17s 6d. Museum Press Ltd., 26 Old Brompton Road, London, S.W.7.

The Elements, by S. Ruben. A short, well arranged reference book of interest to both students and engineers, detailing the chemical and physical constants of 103 elements. Although not applicable to each element, 23 constants are covered, and each element is presented on an individual page. Price 15s. W. Foulsham and Co. Ltd., Yeovil Road, Slough, Bucks.
THE latest addition to the Marconi International Marine Company's range of echo-sounders is the Contour, a precision instrument giving a resolution of up to 0.2 in/ft. The new recorder uses a servo-controlled ceramic pen, heated by a 6V coil, and which writes on heat-sensitive recording paper.

A linearly-increasing voltage (with time) provides a voltage proportional to depth and this is quantized and applied to an integrator which allows only the strong seabed echoes to register and ignores weak echoes from fish, etc. The desired signals are then passed through a d.c. chopper amplifier to a phase-shifting stage. The phase-shifted signal and a local reference signal are then fed to a two-phase motor, in a balanced bridge, which drives the pen.

The transmitter provides about 1 kW peak power at about 50 kc/s and pulse duration is 200 μs, 1 ms or 2 ms, depending on the range of operation. Soundings can be made at the rate of 40 to 100 per minute. The three depth ranges are 2.5-30 ft, 2.5-30 fathoms and 25-300 fathoms, and the range in use is indicated automatically at the recorder. The recording paper is 7 in wide and maintains a constant speed of 0.5 in/min, giving 24 hours recording time from one roll of paper, which incidentally has an indefinite shelf life.

The four MIMCO "Contour" recorders shown in the illustration are installed aboard Shell's Philine tanker giving fore, aft and two amidships depth soundings, in order to obtain a clearer picture of hull clearance in very shallow water.

The address of the Marconi International Marine Co. Ltd. is Elettra House, Westway, Chelmsford, Essex.

COMMUNICATIONS RECEIVER

DESIGNED for general purpose telephony, telegraphy and facsimile reception in the 13 kc/s to 28 Mc/s range is the R408 communications receiver from Redifon Ltd., of Broomhill Road, London, S.W.18. Transistors are used throughout this set, which has been type approved by the G.P.O. and is suitable for marine use. Fourteen switched ranges are provided to give continuous coverage and an extra position is included on the waveband switch to bring in the pre-tuned 500 kc/s marine distress and calling frequency.

For frequencies below 650 kc/s, the intermediate frequency is 80 kc/s and above this double conversion is employed. While the second i.f. remains constant at 80 kc/s, the first changes as the signal frequency increases; starting at 470 kc/s, then 1.5 Mc/s and finishing at 4.5 Mc/s. The modes of operation include a.m., c.w., s.s.b. (pilot or suppressed carrier) and i.s.b. (switch selection of upper or lower sidebands).

A feature of the R408 is that the a.g.c. system is selectable, with delay times of up to 10 seconds and attack times of up to 5 milliseconds. Minimum times are 1 second and 100 msec respectively. Another feature is continuously variable bandwidth, from 800 c/s to 8 kc/s for a.m. and c.w. working and from 800 c/s to 4 kc/s on s.s.b. For c.w. the bandwidth can be narrowed by means of a crystal filter which reduces it to 160 c/s. Audio, line i.f. and a.g.c. outputs are provided.

The standard R408 will operate from either 100/125 or 200/250 volt a.c. (50/60 c/s) supplies. Also available is a version for 24 volt d.c. operation, and an adaptor to allow this version to be driven from either 110 volts or 220 volts d.c.
CRYOGENIC MICROWAVE CIRCULATOR

ABLE to operate at temperatures as low as that of liquid helium, the new cryogenic stripline circulator developed by the Marconi Company, of Chelmsford, should be of interest to those designing low-noise amplifiers for satellite receiving systems.

The circulator is a four-port device suitable for use in the frequency range 3.6 to 4.3 Gc/s with possibilities of use at even higher frequencies. It employs a ferrite material whose cryogenic properties are similar to those of normal ferrite at room temperature. Excellent results have been obtained from this material over a wide range of low temperatures, including liquid helium (−269°C) and liquid nitrogen (−196°C). It will also operate at room temperature at reduced performance. This feature is worth noting as the equipment may be tested before refrigeration, and of course operated at reduced performance should the refrigeration plant break down while in service.

WW 303 for further details

AUTOMATIC WEATHER CHART RECORDER

ALTHOUGH designed for shipborne installations, the D-900-T series of automatic weather chart recorders made by Muirhead is also suitable for small airfields and airstrips. The recorder comprises a radio receiver, f.m./a.m. converter and facsimile unit. Any eight of the many World Meteorological Organization's Radio-Fax transmissions in the frequency range 1.5 to 25 Mc/s may be received once the pre-tuned r.f. units and crystals have been fitted. An adjustable beat frequency oscillator and a monitoring oscilloscope are incorporated to allow the operator to check that the correct frequency is being obtained (and maintained) from the f.s.k. transmissions.

The equipment is semi-automatic, the helix speed and index of cooperation (product of the drum diameter and number of lines per inch) being selected manually prior to recording. The equipment will then start and stop automatically on receipt of the appropriate W.M.O. control signals, but can be controlled manually by the operator if required. Recording is on standard 200 ft rolls of 9-in Mufox electrosensitive paper.

Brief details from the specification include helix speeds of 60, 90 and 120 r.p.m.; scanning density of 98 or 196 lines/in; and power consumption of 100 watts. The D-900-T operates from 105/125 or 200/240 volt, 50/60 c/s supplies.

The address of Muirhead & Co. Ltd. is Beckenham, Kent.

WW 304 for further details

Frequency to D.C. Converters

A RANGE of frequency detectors covering 0 to 50 c/s to 0 to 20 kc/s (nine different ranges, and units to cover higher frequencies to special order) is being offered by the Seminole Division of Airpax Electronics Incorporated, of Fort Lauderdale, Florida. These units, known as Magmeter detectors, provide a d.c. output directly proportional to input frequency and have a quoted accuracy of better than 0.25% on frequencies up to 100 kc/s. The standard output is 0 to 1 mA into a 325Ω external load (internal output resistance is approximately 5 kΩ).

Three different versions are available to cater for valve circuits and 12 or 24-volt transistor circuits. Each version is available in either an octal plug-in base or a "bolt-down" 1½×1½×⅓ in case. The height of the octal unit is 1½ in.

WW 305 for further details

D.C. Inverters

A RANGE of d.c. to a.c. inverters has been introduced by Synchro Developments (London) Ltd., of Dover Street, W.l. Known as the Porta Power range, it offers square wave outputs of 110, 240, 260 and 280 volts. Power ratings of 200, 500, 750 and 1,000 VA, are quoted for input voltages of 12, 24, 36 or 50 volts d.c. respectively.

Manual and automatic units are available, the latter incorporating self-operating changeover relays. The output frequency is within ±2% of 50 c/s.

WW 305 for further details

Wireless World, October 1965
Audio Response Unit

Nine separate controls are provided on the Astronic A1646 a.f. response unit from Associated Electronic Engineers Ltd. and allow the level of audio signals to be varied in octave steps (in multiples of two) from 40 to 10,240 c/s. Each of the nine controls is continuously variable and allows adjustment of +13 dB to −13 dB. On the standard model, the octave controls are illuminated and their settings are displayed in graphical form above the controls on the front panel.

At 0 dB level the input and output impedances are 600 Ω, with zero insertion loss. The overall response is within ±2 dB from 20 c/s to 20 kc/s and the noise level is quoted as −80 dB. Overload level is +18 dBm. An “in-out” switch and an overall gain control is provided.

The standard model is housed in a metal case designed for bench use. Other models are available for rack mounting and with alternative input and output arrangements. The price of the standard model, the A1646, is £66. The company’s address is Dalston Gardens, Stanmore, Middx.

WW 337 for further details

German Solid Tantalum Capacitors

A range of solid tantalum capacitors made by Standard Elektrik Lorenz, of West Germany, have recently been introduced into the United Kingdom by Standard Telephones and Cables Ltd., an associate company. The capacitance range offered is from 0.1 to 50 µF, with working voltages from 3 to 35 V d.c. Capacitance tolerance is ±20% and temperature range is from −40°C to +85°C.

The internal construction of the new series is similar to the established DEF 5134 patterns, but the capacitors are dipped in a moisture-resistant resin to give added mechanical protection. These capacitors are available from S.T.C.’s Capacitor Division, Brixham Road, Paignton, Devon, or the London Sales Office, Footscray, Sidcup, Kent.

WW 339 for further details

Portable Dual-Trace Scope

Introduced primarily for the field service engineer of high-speed, solid-state computers is the Type 453 dual-trace oscilloscope from Tektronix UK Ltd., of Beaverton House, Station Approach, Harpenden, Herts. This instrument has a 50 Mc/s bandwidth and uses a new Tektronix four-inch tube which provides the high writing rate and brightness required when used under high ambient light. Ten 0.8 cm divisions appear on the graticule.

Maximum dual-trace sensitivity is 20 mV/div at 50 Mc/s, 5 mV/div at 40 Mc/s, and the channels may be cascaded to obtain 1 mV sensitivity at 25 Mc/s, single-trace. Facilities are provided to delay signals for the viewing of the leading edge of the triggering waveform.

Horizontal deflection facilities include calibrated sweep delay, which is particularly useful when measuring pulse-to-pulse intervals, the amount of jitter on any train of pulses, time differences and phase angles. Calibrated sweeps extend from 5 sec/cm to 0.1 nsec/cm, with a 10X magnifier extending the fastest sweep to 10 nsec/cm.

This instrument measures 19 X 10½ X 6½ in and weighs 28 lb.

WW 338 for further details

Harmonic Distortion Meter

Included in the Model IM-12U harmonic distortion meter from Daystrom Ltd., of Gloucester, is a valve voltmeter section comprising a twin triode amplifier with negative feedback. It has four ranges from 0-1 to 0-30 volts.

The distortion meter has five ranges (0 to 1%, 3%, 10%, 30% and 100% full scale) and an accuracy of ±5% plus 0.1%. The additional 0.1% is added to cover any hum, noise and distortion in the instrument itself.

The instrument indicates the residual components of the signal under test after the fundamental frequency has been removed as a percentage of the signal. In addition to harmonics, the residual signal contains any hum and noise present on the test signal at all frequencies in the audio range. The frequency coverage of the instrument is from 20 c/s to 20 kc/s, in three ranges.

This Heathkit instrument is available in kit form priced £24 15s. Assembled the price is £34.

WW 310 for further details

Tantalum Electrolysics

The “Castanet” range of tantalum electrolytic capacitors available from the dielectric and magnetic division of Plessey-UK Ltd., Towcester, Northants, has been extended by the introduction of the Type S which has specified impedance figures for capacitance values above 0.33 µF, and is marketed in four case sizes A, B, C and D. Maximum impedance limits for the case sizes are, respectively: 5Ω + Xc; 2Ω + Xc; 1Ω + Xc; and 0.5Ω + Xc, where Xc is the calculated reactance at 100 kc/s for the nominal capacitance value. It should be noted that the impedance limits obtained by the direct addition of the real and reactive terms comply with the requirements of the proposed S.B.A.C. specification for high-quality solid tantalum capacitors.

WW 311 for further details
Low-Leakage Diodes

THREE new series Sylvania silicon-alloy diodes (D6623, D6624 and D6625) are being offered by Thorn-ASE Radio Valves and Tubes Ltd., of 155 Charing Cross Road, London, W.C.2. These diodes have been introduced for use in military and industrial computers and have very low current leakage characteristics—at a reverse voltage of 175 V, the D6625 measures 5 nA and the “A” version of this type only 1 nA. The first example shows an improvement of five times over currently available types and the latter 25 times.

Another feature of the new diodes, due to a new manufacturing process, is that they are suitable for high-temperature work in general purpose applications.

Magnetic Switch

POWER handling of up to three amps at 120 volts is claimed for the new hermetically sealed magnetic switch developed by Sylvania Electric Products Incorporated, U.S.A. The normally closed contacts operate in a complete vacuum, making the unit suitable for use in places where arcing must not occur. Switch speed is quoted as 4 milliseconds and the operating temperature range from −54°C to +200°C.

The dimensions of the switch are 13/4 in long by 1/4 in diameter. Any electromagnet with a minimum of 250 amp-turns will operate the switch, but the suggested reference magnet is Alnico V: 1.25 x 0.522 x 0.158 in.

These magnetic switches are available in the United Kingdom through Thorn Special Products Ltd., Great Cambridge Road, Enfield, Middx.

TWO- PEN RECORDER

TWO pens independently controlled in the left-to-right direction and synchronized in the top-to-bottom axis are fitted to the x-y recorder Model 2FA from the Moseley Division of the Hewlett-Packard, of Dallas Road, Bedford. This recorder is a bench-type instrument and has a plotting area of 11 by 17 in. There is a 0.1 in horizontal separation between the pens attached to the moving arm (seen in the illustration) to allow the pens to cross. An additional pen may be added to this instrument to produce identification marks at significant points in a recording.

Each axis of the 2FA has 11 calibrated d.c. input ranges with sensitivities from 500 µV per inch to 50 volts per inch travel. The four most sensitive ranges may be converted for potentiometric input, should this facility be required. Input resistance on all calibrated ranges is 1 MΩ at null point.

A five-range timebase is provided giving sweeps from 0.5 seconds per division to 50 seconds per division; which represents full sweep speeds of 7.5 to 750 seconds. An accuracy on all ranges of 2% is quoted for this instrument, which is priced at £1,293.

Portable Spot Welder

INTENDED for electronic and general laboratory applications the Electro-Magnetics “Porta-Weld” hand welding gun weighs less than 3½ lb. The gun contains an adjustable fingertip force control and a range of accessory tips is available. The resistance welding apparatus may be used to weld steel wire 0.002 in. dia., 20 a.w.g. tinned copper or larger sizes of higher resistance metals. Energy is provided by charged capacitors and a joulemeter is incorporated to enable energy levels of up to 100 joules to be pre-set.

Ni-Cd batteries may be used with the welder and will allow up to 1,000 welds, depending on welding time, without recharging. A recharging facility is provided on the standby function of the power supply unit. The power unit weighs 12 lb.

The welder is available from the Export Department of EMEC Inc. of 160 Terminal Drive, Plainview, Long Island, New York.

POLYESTER CAPACITORS

TWO new ranges of metallized polyester capacitors have been introduced by LEMCO. (London Electrical Manufacturing Co. Ltd., Bridges Place, Parsons Green Lane, London, S.W.6) The ranges differ in size and finish, one being fully moulded and the other resin coated. The moulded variety incorporate an anti-moisture trap in the capacitor base. Wire leads are solder coated and the capacitors stabilized by heat treatment.

A range of values based on the preferred logarithmic scale is available with standard tolerances of ±5%, ±10% and ±20% in values from 0.01 µF to 0.22 µF. Direct working voltage is 160 V and temperature range is −55°C to +85°C. At +20°C the insulation resistance is 300 GΩ and the power factor at 1 kc/s is less than 0.0075.
INTEGRATED CIRCUIT HOLDER

SPECIALLY designed to accept integrated circuits in eight-lead TO-5 encapsulations is the Model S8 connector from Ferranti Ltd., of Kings Cross Road, Dundee, Scotland. Although primarily intended for use on printed circuit boards, this connector has been found particularly useful in prototype work where equipment is still under development.

The Model S8 connector is moulded in glass-filled nylon and its eight beryllium copper contacts have a 0.0002 in (5 µ) thick gold plating. To facilitate correct insertion, a projection is provided on the rim of the body of the connector to which the tongue of the TO-5 is aligned.

Contact resistance, including 10 mΩ contributed by the leads of the integrated circuit, is in the order of 40 mΩ and insulation resistance is quoted to be 10kΩ. Self inductance of each contact is 0.001 µH and capacitance between adjacent contacts is 0.2 pF. Insertion force is 600 gm and temperature range is -55°C to +120°C.

The weight of the S8 connector is only 1 gm.

WW 317 for further details

Thermal Wire Strippers

TWO new thermal wire strippers have been added to the Adamin range of soldering equipment produced by Light Soldering Developments Ltd., of 28 Sydenham Road, Croydon, Surrey.

Basically the two units are similar, but differ in wattage ratings. The Model 2B24 has a power consumption of approximately 50 watts and is specifically designed for p.t.f.e. work, while the Model 2B6 has a lower power rating and is suitable for use on p.v.c. and similar materials.

As can be seen from the illustration, the strippers can be operated by one hand. Two or three seconds should be allowed for the stripper to soften the covering to be removed. Heating is by means of an element in the shaft of each limb; directly beneath the blade unit.

Model 2B24 is available for 24 volts only and the Model 2B6 is suitable for operation from either 12 or 24 volts.

The price of the 2B24 is £3 15s and the 2B6 is £3 10s. Three step-down transformers are offered. The MT24 costs £3 15s and is suitable for both models; the LT12 and LT24 each cost £2 2s and are suitable for the 12 and 24 volt versions of the 2B6.

WW 311 for further details

POWER SUPPLY UNIT

A REGULATED power supply, designated Model 780, is available from Precise Electronics and Development Corp., Long Island, New York. This unit supplies two continuously variable direct regulated voltages of 0 to +400 V (ripple less than 3 mV r.m.s.) and 0 to -150 V. Output levels are set by the adjustment of two front-panel controls. A maximum current of 2 mA can be drawn from the negative supply but load current from the positive supply is specified at half and full values of output voltage, i.e., at 200 V, a continuous current of 100 mA or intermittent current of 150 mA is available; at 400 V continuous current is 150 mA. Regulation up to 100 mA is better than 0.3% or 0.3 V (whichever is greater). Two 6.3 V a.c. supplies—one centre-tapped—rated at 3 A each are also available and can be interconnected to provide either 6.3 V at 6 A or 12.6 V at 3 A. All output connections from the unit are made by terminals on the front panel, and voltage and current can be monitored on separate meters. The dimensions of the unit are 9 x 14½ x 7¾ in.

WW 319 for further details

High-temperature Furnaces

VERTICAL high-temperature furnaces have been added to the Johnson, Matthey range of laboratory furnaces. There are eight models, four with a maximum temperature of 1,350°C, the remainder operating at temperatures up to 1,500°C.

Four diameters of furnace are offered ranging from 1½ to 2½ in. Each furnace has two thermocouples for use with a temperature controller and an over-temperature protection device. The thermocouples are embedded in the refractory, leaving the furnace chamber completely unobstructed. The overall dimensions vary according to model, the smallest being 21½ x 12½ x 11½ in and the largest being 26½ x 18½ x 18 in. They all operate from a single phase 105 volt a.c. supply.


WW 320 for further details

INFORMATION SERVICE FOR PROFESSIONAL READERS

To expedite requests for further information on products appearing in the editorial and advertisement pages of Wireless World each month, a sheet of reader service cards is included in this issue. The cards will be found between advertisement pages 16 and 19.

We invite professional readers to make use of these cards for all inquiries dealing with specific products. Many editorial items and all advertisements are coded with a number, prefixed by WW, and it is then necessary only to enter the number(s) on the card.

Postage is free in the U.K. but cards must be stamped if posted overseas. This service will enable professional readers to obtain the additional information they require quickly and easily.

WW 308 for further details
microwave modulations of light

TWO microwave light modulators for coherent and incoherent light beams are now available from Sylvania International, a division of General Telephone and Electronics International S.A. of Switzerland. These are the SYO-4470 for modulation at S-band frequencies and the SYO-4460 (illustrated) for X-band frequencies. Modulators for L-band and C-band frequencies have been available for some time.

The linear electro-optic effect in a potassium dihydrogen phosphate (KDP) crystal bar is utilized in these units. An electric field applied parallel to the long optical axis varies the indices of refraction for axes 45° either side of the perpendicular. The electrical field is developed within a cylindrical microwave cavity, along the centre of which is suspended the KDP crystal. Adjustable input and output light polarizers and a quarterwave plate are built into the modulators. Through setting these in different combinations it is possible to amplitude, frequency or phase modulate light beams. It is also possible, after modification, to adapt for s.s.b.

Used in conjunction with the Sylvania series of microwave photo-travelling-wave tubes for the detection of modulated light, it is possible to build a complete microwave communications system with laser light as the transmission medium.

The address of Sylvania International is 21 rue du Rhône, Geneva, Switzerland.

A.C. to D.C. Converter

CONVERTING a.c. voltages linearly into d.c. voltages, the Model 710A from Ballantine Laboratories, of Boonton, U.S.A., should be of interest to owners of digital voltmeters. This instrument will accept a.c. voltages from 1 mV to 1 kV (in decade steps) at any frequency between 30 c/s and 250 kc/s. Accuracy of conversion is claimed to be better than 0.25% from 1 mV to 250 V at mid-band frequencies (50 c/s to 10 kc/s). Accuracy deterioration to 1.25% as the frequency band increases and voltage increases (250 to 1,000 V).

The d.c. output, which varies from 1 to 10 volts, is proportional to the average value of the input waveform for sine waves and distorted waveforms with up to 30% total distortion, and has an impedance of approximately 25 kΩ. Input impedance is 2 MΩ shunted by 15 pF, except on the 1 mV to 10 mV range where the shunt capacitance is 25 pF.

Priced at £230 excluding duty, the Model 710A is available in the United Kingdom through Livingston Laboratories Ltd., of 31 Camden Road, London, W.1.

Flexible Multiway Cable

ABOUT the thickness of a postcard, the new flexible multiway cable called Biccastrip, consists of flat rectangular conductors positioned side by side and hermetically sealed in polyester resin insulation. A range of screened, semi-screened and unscreened cables is now available from British Insulated Callender’s Cables Ltd., of 21 Bloomsbury Street, London, W.C.1. The screened versions of Biccastrip employ rolled copper foil embedded in insulation above and below the main conductors with earth continuity conductors at the sides in contact with the foil (as can be seen in the illustration). The foil is on one side only of semi-screened cables.

Wireless World, October 1965
"Science appears as what in truth she is

Not as our glory and our absolute boast,
But as a succedaneum and a prop
To our infirmity."

The Prelude; Wm. Wordsworth

EACH of us, I suppose, has a pet hobby-horse upon which he is wont to ride at the slightest excuse, or even with no excuse at all. As a rather way-out instance of this, a friend of mine is absolutely convinced that there is a correlation between the taking of baths and scientific inspiration. He says that ever since the day when Archimedes sprang stalkers from his tub and hared through the assembled populace yelling "Excelsior!" (or whatever it was) the bath has been the traditional home of deep thinking.

He (my friend, not Archimedes) has not been content to let the matter rest within the realm of mere opinion. He has prepared graphs which he believes prove his point. One curve, plotted through from pre-Roman times to the end of the nineteenth century, shows the vicissitudes of the bath-taking habit over the centuries, while a second, drawn to the same time-scale, purports to give the fat and the lean periods of discovery in science. My friend is not too specific as to how his data are prepared, but I do know that prolonged periods at the British Museum and much intricate work with a slide rule are essential adjuncts—and these are two institutions with which one does not argue lightly. And, although I am not wholly convinced of the validity of the comparison, common fairness compels me to admit that the two graphs follow astonishingly parallel paths.

They clearly prove (asserts my friend) that it was the Roman addiction to baths which made them so great as engineers and so clever at conquering countries. And he points with pride to where both curves take a sharp dip at the period when the legions got thoroughly fed-up with the British climate and pulled out. Between that time and the sixteenth century the troughs are deep indeed; then both tend to rise until they reach the maxima toward the end of the nineteenth century.

"Sought out many inventions"

Naturally, I have pointed out that the Victorians were not noted for their fondness for baths; but he believes that he has the answer to that one. His researches have shown, he says, that in those days the young, instead of being permitted to chew Purple Hearts and tomcat around the territory on motor-scooters, were religiously dunked in cold tubs by their elders (and at very frequent intervals, too) in order to subdue the desires of the flesh. The net result was that at every available opportunity the young Victorians would dash off to the potting shed and invent things right, left and centre. They had to do something or burst. Or so my friend says.

I mention all this because it is relevant to the desperate predicament in which I now find myself. My statistically minded acquaintance is anxious to bring his graphs up to date as a prelude to delivering a learned paper upon the matter and he recently bludgeoned me into gathering data relating to the major electronic inventions of this century.

Now at the time of this coercion I must admit that neither of us had any doubts regarding the outcome, knowing as we did that (a) there are now far more bathrooms to the square rod, pole or perch than ever before and that (b) we are spending more millions of pounds on electrical research this century than our ancestors spent shillings during the previous nineteen. My modus operandi was simple and, I thought, foolproof. I merely sat down and made a note of the master inventions which we are accustomed to regard as of recent, or at least, of twentieth century origin, fully expecting to find the majority clustering in the period from 1939 onward when the research effort began to wax and grow exceeding fat. Alas! What a great setting forth on little horses!

Red herrings!

Sound broadcasting gave me my first jolt, for the first broadcast of speech and music occurred, not around 1920 as I was positive it had, but as long ago as 1906.

Television served me no better; the mechanical system, which consistently made the headlines as the marvel of the age in the 1920s and early 1930s, was, I discovered, invented in 1884, while the all-electronic system in use today was conceived by Campbell-Swinton in its essentials in 1908.

What is now known as radar was born in 1935. But Herzl was using centimetric waves in 1888 and was demonstrating that they could be reflected and refracted.

The cathode-ray tube in its present high-vacuum form dates from 1929, but the instrument was invented in 1897, nine years before the thermionic triode.

The semiconductor properties of certain metallic sulphides were demonstrated in 1874. Semiconductor diodes have, I found, been in use since 1906. Oscillating crystals, suspiciously like tunnel diodes, date from 1911. (In 1924-25 interest was resurrected in these and W.W. ran several articles dealing with the subject.)

The transistor is generally supposed to have been invented in 1948, but a cutting now in front of me—for which I am indebted to reader E.R.H. of Blackpool—gives details of what seems to be an n-p-n transistor which was patented in Canada in 1925.

The optical maser arrived in 1960 (Hurrah! Success at last!) The snag is that the principle underlying the stimulated emission of radiation was stated by Einstein in 1917.

The transmission of telephony along a light beam goes back, I find, to 1878, when Graham Bell and Sumner Tainter not only took out patents and successfully demonstrated it, but in addition, are stated to have shown 49 other possible ways of doing it.

There were, I regret to say, many other similar red herrings; for example, facsimile transmission, and the tape recorder. I abandoned the former when I got back to a reference in 1847 and the latter when I discovered that it was one of the hits of the Paris Exhibition of 1900.

So, to cut a long story short, the 1965 end of my graph, apart from the innovation of integrated circuits, has little or no representation at all; it has taken an aversion to its companion curve in no uncertain manner, drooping woefully where it had been expected to climb.

You can see, I hope, something of the devilish situation in
which I have unwittingly landed myself. My friend—or, more correctly, my erstwhile friend—has laid the blame entirely at my door, charging me with suppressio veri, malice aforethought and grievous bodily harm to his precious theory. I hasten to make clear, however, that I am not nearly so much concerned with the dissolution of the bathtub hypothesis as with the thought that I have inadvertently let the side down by exposing modern electronics research to the charge that it has bred a race of improvers rather than originators.

Re-search or invention?

In my less despondent moments I try to tell myself that research means re-search, and this is precisely what it is doing with success if one compares, for instance, the performance of the original Braun c.r.t. with its modern counterpart. But, lucrative as it has been to pick over the scrap-heap, the time must come when everything valuable has been removed, and then what? Research laboratories are as the sand on the seashore for multitude but does anyone know of the existence of an Invention laboratory?

In the hope of disproving my findings, my sometime friend has carried out an investigation of his own into other branches of engineering with, it seems, not dissimilar results. He is now, I understand, trying to reconcile his wretched graphs on the Mohammed and the mountain principle by seeking to introduce a corresponding downward trend in his ablationary curve. To this end he is investigating three possibilities, namely (a) that modern bathrooms are merely status symbols, not to be sullied by usage, (b) that impurities in the Victorian water supplies, like impurities in semiconductors, were responsible for making the whole thing work, or (c) that the secret lies in temperature difference, remembering the era of modern predilection for the hot bath in contrast to the spartan Victorian cold tub.

I can only say that (a) is a hypothesis that I personally would refuse to countenance at any price. If (b) is the solution, then it should be a fairly simple matter to restore the status quo by introducing the requisite number of tadpoles and other foreign bodies into the water mains.

My money, however, is on (c) which I consider holds fascinating possibilities. If this is indeed the correct answer, then we may well be on the brink of a major breakthrough in the field of significant invention. By cooling our leading scientists to liquid helium temperatures they should respond Maser-fashion to the treatment, with their respective signal-to-noise ratios improved out of all recognition.

Wireless World, October 1965

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FOR FULL DETAILS SEE CATALOGUE 204/C

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WHEN IT BLOWS IT GLOWS

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COMMERCIAL LITERATURE

"Hi-Fi-Stereo" is the title of a 34-page brochure Telefunken have issued on their audio equipment, which ranges from record players to loudspeaker systems. Copies are obtainable from the Weltec Corporation, 27 Chancery Lane, London, W.C.2.

WW 326 for further details

A "Selection Guide for Motorola Silicon Annuar Transistors" is now available from the United Kingdom stockists of Motorola Semiconductor Products,—Celdis Ltd., Trafford Road, Richfield Estate, Reading, Berks.

WW 327 for further details

Tape Recorder Maintenance Ltd. announce that their latest pre-packed spares catalogue is now available from 323 Kennington Road, London, S.E.11. It lists an assortment of fuses, plugs and sockets, connectors and drive belt sets.

WW 328 for further details

The latest catalogue and price list of Stenam potentiometers (Berlin) has been received from F. W. O. Bauch Ltd. of "Chaddlewood," Cockfosters Road, Cockfosters, Barnet, Herts. The 1965/66 edition outlines in 16 pages the complete range of potentiometers and variable resistors, which includes miniature, twin, ceramic, button-type and printed circuit potentiometers. Details of the available track-laws, power ratings, tolerances, dimensions and other relevant information are given.

WW 329 for further details

Also available from F. W. O. Bauch is a 16 page booklet describing Sommesein (Hessen) Dryfit dry accumulators and chargers. Characteristics of the range of batteries is presented along with six graphs.

WW 330 for further details

Three types of automatic code generators are described in Pamphlet 1428a obtainable from Barr and Stroud Ltd., of Caxton Street, Anniesland, Glasgow, W.3. These generators are capable of producing a short morse code message and of keying a radio transmitter.

WW 331 for further details

H. F. PREDICTIONS—OCTOBER

The effects of sporadic-E ionization are becoming less significant as winter conditions set in, and this month it is unlikely that sporadic-E will permit operation above the MUF. The seasonal changes in shape of the MUF curve is becoming apparent. The very flat curve of the summer months is slowly being replaced by the slightly higher, more peaky, curve characteristic of the winter months.

The prediction curves show the median standard MUF, optimum traffic frequency and the lowest usable frequency (LUF) for reception in this country. Unlike the standard MUF, the LUF is closely dependent upon such factors as transmitter power, aerials, and the type of modulation. The LUF curves shown are those drawn by Cable and Wireless Ltd. for commercial telegraphy and assume the use of transmitter power of several kilowatts and rhombic type aerials.

This signal source calculator is obtainable from Marconi Instruments Ltd., of St. Albans, Herts. Directions are given on the back for the conversion of volts to dBm or dBi in a given load; watts to dBm or dBm across a given load; volts to watts or dBm to dBm; and e.m.f. to p.d. across load.

WW 332 for further details

"Power Control for Industry" is the title of a Mullard catalogue covering thyristor and diode stacks and assemblies with d.c. outputs up to hundreds of kilowatts. Thermal performance of the Mullard range of heatsinks is also included in this 122-page publication, which is obtainable from the Industrial Markets Division, Mullard House, Torrington Place, London, W.C.1.

WW 333 for further details

Home Radio, of Mitcham, have revised and reprinted their "Components Catalogue." It now runs to 200 pages and contains information on a variety of components and equipment they stock. This ranges from aerials and audio amplifiers to volume controls and Zener diodes. Some 150 technical books are also listed in this publication which is available, price 7s 6d, from Home Radio (Mitcham) Ltd., 187 London Road, Mitcham, Surrey. The cost of the catalogue can be recovered on orders; at one shilling in the pound.

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WW—004 FOR FURTHER DETAILS.
SERIES Y RECORDERS

YD5 SINGLE CHANNEL RECORDERS

<table>
<thead>
<tr>
<th>Model</th>
<th>Tape Speeds</th>
<th>Voltage</th>
<th>Frequency</th>
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<tr>
<td>YD5A</td>
<td>7½, 9½ and 1½ i.p.s.</td>
<td>100/250V</td>
<td>50 c.p.s.</td>
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<td>YD5AH</td>
<td>15 and 7½ i.p.s.</td>
<td>100/250V</td>
<td>50 c.p.s.</td>
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<td>YD5B</td>
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<td>100/250V</td>
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<td>YD5BH</td>
<td>15 and 7½ i.p.s.</td>
<td>100/250V</td>
<td>50 c.p.s.</td>
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*60 c.p.s. to order

Y500 DOUBLE CHANNEL RECORDERS

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<tr>
<td>Y532A</td>
<td>7½, 9½ and 1½ i.p.s.</td>
<td>117V</td>
<td>60 c.p.s.</td>
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<tr>
<td>Y532E</td>
<td>7½, 9½ and 1½ i.p.s.</td>
<td>110V</td>
<td>50 c.p.s.</td>
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<tr>
<td>Y522UH</td>
<td>15 and 7½ i.p.s.</td>
<td>200/250V</td>
<td>50 c.p.s.</td>
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<td>Y522HA</td>
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<td>117V</td>
<td>60 c.p.s.</td>
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<tr>
<td>Y522HE</td>
<td>15 and 7½ i.p.s.</td>
<td>110V</td>
<td>50 c.p.s.</td>
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<tr>
<th>Model</th>
<th>Description</th>
<th>Price</th>
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<tbody>
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<td>AG-9U</td>
<td>V/7A</td>
<td>Deflected Teras available on all orders above £10</td>
</tr>
<tr>
<td>AMERICAN HEATHKIT SINGLE SIDE BAND EQUIPMENT. For direct delivery from U.S. Plant. Send for details of American Heathkit.</td>
<td></td>
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</tr>
<tr>
<td>VALVE VOLTMETER KIT. Model V-7A. 7 voltages ranges 0.1 V to 1,500,000 V, 500-2,000,000 V.</td>
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<tr>
<td>R.F. SIGNAL GENERATOR KIT. Model RF-1U.</td>
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<tr>
<td>GRID-DIP METER KIT. Model GD-1U.</td>
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<td>DECADE RESISTANCE BOX KIT. Model DR-IU. Range 0.1 to 99,999,999 ohms.</td>
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<tr>
<td>DECADE CAPACITOR KIT. Model DC-IU.  Covers 100,000 pF to 0.111 μF, 100μF step.</td>
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<tr>
<td>G MULTIPLIER KIT. Model QPM-I.</td>
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<td>AMERICAN HEATHKIT GRID-DIP METER.</td>
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<td>AMERICAN HEATHKIT SINGLE SIDE BAND RECEIVER KIT. Model DG-233BE.</td>
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<tr>
<td>GENERAL COVERAGE COMMUNICATIONS RECEIVER KIT. Model RG-1.</td>
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<td>AMATEUR BANDS RECEIVER KIT. Model RA-I. 10-160 m. Half-rattice crystal filter.</td>
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<td>MOHICAN GENERAL COVERAGE RECEIVER KIT. Model GC-IU.</td>
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<tr>
<td>AMATEUR TRANSMITTER KIT. Model DX-100U. 150 W.D.C. input. Covers all amateur bands from 160-10 m. Self contained.</td>
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<tr>
<td>BOX -40U.</td>
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<tr>
<td>VARIBLE FREQUENCY OSCILLATOR KIT. Model VF-IU.</td>
<td></td>
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</tr>
<tr>
<td>TRANSISTOR PORTABLE RADIO KIT. Model UX-R1. Pre-aligned T.F. transformers printed circuit and a 7 x 4 in. high-gloss speaker. Real hide case.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRANSISTOR INTERCOM KITS. Models XI-IU and XIR-IU. Ideal for home or business use.</td>
<td></td>
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</tr>
</tbody>
</table>
INCREASE THE SENSITIVITY OF YOUR OSCILLOSCOPE, VOLTOMETER OR COUNTER

The TA401 is similar to the TA601 as illustrated.

**TA605 ACTUAL SIZE**

---

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th></th>
<th>TYPE TA401</th>
<th>TYPE TA601</th>
<th>TYPE TA605</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GAIN</strong></td>
<td>40dB ± 0.1dB</td>
<td>60dB ± 0.1dB</td>
<td>20, 30, 40, 50 and 60dB</td>
</tr>
<tr>
<td><strong>BANDWIDTH ±3dB</strong></td>
<td>1c/s-3Mc/s</td>
<td>3c/s-1.2Mc/s</td>
<td>20-40dB, 1c/s-3Mc/s; 50dB, 2c/s-2Mc/s; 60dB, 3c/s-1.2Mc/s</td>
</tr>
<tr>
<td><strong>BANDWIDTH ±0.3dB</strong></td>
<td>4c/s-1Mc/s</td>
<td>10c/s-500kc/s</td>
<td>20-40dB, 4c/s-1Mc/s; 60dB, 10c/s-500kc/s</td>
</tr>
<tr>
<td><strong>INPUT IMPEDANCE</strong></td>
<td>&gt;5MΩ, &lt;40pf</td>
<td>&gt;1MΩ, &lt;50pf</td>
<td>&gt;5MΩ, &lt;40pf</td>
</tr>
<tr>
<td><strong>INPUT NOISE</strong></td>
<td>15µV, zero source</td>
<td>&lt;12µV, zero source</td>
<td>As TA401 and TA601 at 40dB and 60dB</td>
</tr>
<tr>
<td><strong>POWER SUPPLY</strong></td>
<td>PP3 battery, life 100 hours</td>
<td>PP9 battery, life 1,000 hours</td>
<td></td>
</tr>
<tr>
<td><strong>AVAILABLE OUTPUT</strong></td>
<td>1V up to 1Mc/s, 300mV at 3 Mc/s, into load of 100KΩ and 50pF</td>
<td>1 V up to 3Mc/s into 100KΩ and 50pF. Output impedance 150Ω in series with 6.4 mfd. µf.</td>
<td></td>
</tr>
<tr>
<td><strong>SIZE &amp; WEIGHT</strong></td>
<td>3in. x 1in. x 1½in. 7 oz.</td>
<td>2½in. x 4in. x 5½in. 2½ lbs.</td>
<td></td>
</tr>
<tr>
<td><strong>PRICE with battery</strong></td>
<td>£17 0 0</td>
<td>£17 0 0</td>
<td>£27 0 0</td>
</tr>
</tbody>
</table>

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H2102 double diversity i.s.b. or s.s.b.
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NO TUNING SCALES

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60% space saved by much smaller equipment and back-to-back and side-by-side installation.

Marconi telecommunications systems

The Marconi Company Limited, Communications Division, Chelmsford, Essex, England

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—the first in the world to be station planned from input to output

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An h.f linear amplifier transmitter for high-grade telecommunications.
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Output power: 7—8 kW p.e.p, 5—6 kW c.w.
The H1100 series meets all CCIR Recommendations.

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Manually tuned versions, types H1100 and H1102, are available which, when fitted with built-in drive units, become entirely self-contained transmitters for four spot frequencies and all types of modulation.
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<table>
<thead>
<tr>
<th>Type No.</th>
<th>Voltage Range</th>
<th>Current Rating</th>
<th>Price</th>
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<td>PM1</td>
<td>7-15V</td>
<td>1 Amp</td>
<td>£26</td>
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<tr>
<td>PM2</td>
<td>15-30V</td>
<td>1 Amp</td>
<td>£28</td>
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<tr>
<td>PM3</td>
<td>30-50V</td>
<td>1 Amp</td>
<td>£30</td>
</tr>
<tr>
<td>PM4</td>
<td>7-15V</td>
<td>3 Amp</td>
<td>£32</td>
</tr>
<tr>
<td>PM5</td>
<td>15-30V</td>
<td>3 Amp</td>
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<tr>
<td>PM12</td>
<td>30-50V</td>
<td>10 Amp</td>
<td>£88</td>
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  - 10,000pF: 0.20in (5.10mm)

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*All ANTEX Irons are fitted with "Ferraclad" long-life bits.

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WW—627 FOR FURTHER DETAILS.
Routine Maintenance Checks
FOR V-H-F/U-H-F F-M RADIO EQUIPMENT

A.W.A.
V-H-F/U-H-F F-M RADIO EQUIPMENT
TEST SET A410

FEATURES
The AWA A410 VHF/UHF FM Radio Test Set is a portable, lightweight fully transistorised instrument for the field testing of frequency modulated transmitters and receivers operating in the VHF and UHF bands.

The A410 Test Set will measure FM Receiver r-f sensitivity, i-f sensitivity, noise quieting, discriminator linearity (with the use of an external voltmeter) and audio power output; FM Transmitter deviation and r-f power output. The built-in 30 watt dummy load can be used for powers up to 50 watts, for short duration checks used under specified conditions.

The weight of the A410 is 17 lb and measures 14 inches long by 8 inches high by 8 inches in depth. Built on a modular basis, it consists of a high stability FM signal generator, a crystal controlled i-f signal generator, r-f power meter and deviation monitor, a low distortion a-f signal generator for modulating a FM transmitter, a piston attenuator with a "set level" control for the r-f signal generator output.

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WW-028 FOR FURTHER DETAILS
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BUT THE RESULT WILL GO ON THE BACK OF A POSTAGE STAMP!
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Lighter cartridges have permitted revision of the balance system. A shorter main-weight and movable end-cap (illustrated) will balance all cartridges from 3-17 grams in either S.M.E. shell without accessory weights. Conversion parts available for earlier Series II arms.

Only S.M.E. Precision Pick-up Arms offer all these features:
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FOR QUICK AND CLEAN HOLES

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Holes are punched cleanly and accurately—No filing is necessary

SIZES:
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- Square: 1/16, 1/8

Patent Nos. 619176 & 938098

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m-e-c

WW—036 FOR FURTHER DETAILS.

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WW—037 FOR FURTHER DETAILS.
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**ELECTRICAL INSTRUMENTS LTD.**
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WW-038 FOR FURTHER DETAILS.
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The new ADAMIN thermal wire strippers allow one-handed operation, using a simple tweezer action. They strip coverings of up to about 7/8 in. dia. with absolutely no risk of damaging the conductors.

FOR PTFE INSULATION

use Model 2B24 (illustrated), available for 24 volts only.

FOR PVC INSULATION

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WATERPROOF
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Andre Rubber Co. Ltd. is another Silentbloc Company. Silentbloc products are also manufactured by Silentbloc (Australia) Pty. Ltd., Melbourne

WW—64 FOR FURTHER DETAILS.
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COILS AND I.F. TRANSFORMERS IN LARGE-SCALE PRODUCTION FOR RECEIVER MANUFACTURERS

P.9 SERIES
10 mm. x 10 mm. x 14 mm. Ferrite cores 6 mm. 472 kc/s operation. Single-tuned I.F.s and Oscillator Coils.

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T.41 SERIES
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These ranges are available to manufacturers in versions suitable for most of the popular types of Transistors. The Oscillator coils can be modified to enable specific tuning capacitors to be used provided that bulk quantities are required.

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MV-28B
R.F. Microvoltmeter. 1 mV, f.s.d.-1000v. Frequency range 20 kc/s-1000 MHz. Basic f.s.d. (8 ranges). Recorder output, temperature compensated probe. Linear scales £170

MV-07C
D.C. Micro-Volt-Ammeter. F1 voltage ranges 10µV, 100µV, 1mV, 10mV, 100mV, 1V, 10V. F2 current ranges 10µA, 100µA, 1mA, 10mA, Electra-zone meter. Floating input. Recorder output. Basic accuracy ±1% volts, ±2% amps £125

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The Mullard Technical Handbook contains Data Sheets on all Mullard semiconductors, valves, tubes, electronic and magnetic components in current production. Available on a subscription basis, this six volume loose-leaf publication is kept perpetually up-to-date by the issue of supplementary data sheets. Subscribers automatically receive the revised sheets as they are introduced. The information includes ratings, characteristics, recommended operating conditions and performance figures for various applications, and curves and outline diagrams.

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WW—046 FOR FURTHER DETAILS.
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 includes Pattern RFG2, which covers general purpose metal oxide only. Needless to say the Electrosil TR range has also received approval to this Pattern.

Electrosil limited

<table>
<thead>
<tr>
<th>Type</th>
<th>Reference</th>
<th>Ratings (Watts 70°C)</th>
<th>Approved Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>TR4</td>
<td>RFG5-F</td>
<td>$\frac{1}{1}, \frac{1}{3}, \frac{1}{6}$</td>
<td>51 ohms-47K</td>
</tr>
<tr>
<td>TR5</td>
<td>RFG5-E</td>
<td>$\frac{1}{9}, \frac{1}{6}, \frac{1}{3}$</td>
<td>20 ohms-470K</td>
</tr>
<tr>
<td>TR6</td>
<td>RFG5-D</td>
<td>$\frac{1}{3}, \frac{1}{6}, 1$</td>
<td>20 ohms-1 meg</td>
</tr>
</tbody>
</table>

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

Triple Rating means Triple Economy

Industry too, can benefit from the Triple-rating concept. Ask Electrosil today for full details; a leaflet is being prepared listing the relevant Nato stock numbers.

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**MIGHTY MIDGET**

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Supplied as standard or latching type, single or double winding. Size 3 in. cube, weight 0.8 oz.

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Extract from TEST REPORT — June 1965

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"...most of us use our loudspeakers to listen to music and this is certainly a very musical loudspeaker and one for which I am sure Celestion will be long remembered".

Extracts from TECHNICAL REPORT — June 1965

Celestion Limited
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TELEPHONE: EMBERBROOK 9402/6

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(Incl. £2.14.10 P.T.)

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NOW -let the facts on The Ditton 10 speak for themselves...

Large Feroba magnet structure for high magnetic damping.

High hysteresis panel loading material to eliminate structural resonances.

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* Uniform H.F.

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* Low distortion

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DITTON 10

WW.055 FOR FURTHER DETAILS.
minitest IS PROVING ITSELF EVERYWHERE...

IN THE FIELD

Small instrument... fits in the pocket... tip-top performance. It's the Salford Minitest, a highly sensitive test meter for the measurement of A.C. and D.C. volts, current and resistance. Wherever there's a measuring job to do — you can rely on the Minitest. The clarity of the scale is exceptional and the knife edge pointer ensures accurate reading. Housed in a tough Melamine cover, the movement is built into a pressed steel case which effectively screens it from external magnetic fields.

MINITEST

D.C. Amps D.C. Volts A.C. Volts

Ohms
0 - 1 Amp. 0 - 1,000 0 - 1,000
0 - 100 mA. 0 - 250 0 - 250
0 - 2,000 0 - 10 mA. 0 - 100 0 - 100
0 - 20,000 0 - 1 mA. 0 - 25 0 - 25
0 - 3,000 0 - 50 uA. 0 - 5 0 - 5
0 - 30 Megohms

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IN THE LAB

...IN THE FIELD

L30

Overload and short circuit proof. Current restricting device automatically reset on removal of overload. Small and light. Large meter. Range 0-30V (Variable) 0.5A. Due to the amazing low price of this unit it is specially suitable for quantity use in educational establishments and for general use in research and development departments.

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WW—956 FOR FURTHER DETAILS.
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Frequency range 35 c/s—15,000 c/s.
Impedance 8/15 ohms.
Power Handling Capacity 15 watts (30 watts peak)
Size 25" x 20" x 6½"  Weight 31½ lb.
Finish zebrano, mahogany, walnut or teak veneers.

£25.10.0

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Free technical folder on the Dalesman from Dept. W

WW—058 FOR FURTHER DETAILS.
Magnoval/Novar

McMurdo make valveholders for Magnoval based valves with 0.05" diam. pins and Novar based valves with 0.04" pins both types on same pitch circle. Available for printed circuit or chassis mounting. The Novar valveholders are moulded in red to avoid confusion.

Radiomic—a completely portable microphone/transmitter
Transmitter slips into pocket

The Radiomic microphone/transmitter system has no wires, is very compact—the transmitter weighs only 6 ozs. and slips into a pocket. Complete with receiver, the Radiomic system is extremely efficient and reliable and has been type tested and approved by the G.P.O.

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Radiomic—a completely portable microphone/transmitter
Transmitter slips into pocket

The Radiomic microphone/transmitter system has no wires, is very compact—the transmitter weighs only 6 ozs. and slips into a pocket. Complete with receiver, the Radiomic system is extremely efficient and reliable and has been type tested and approved by the G.P.O.

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Transmitter slips into pocket

The Radiomic microphone/transmitter system has no wires, is very compact—the transmitter weighs only 6 ozs. and slips into a pocket. Complete with receiver, the Radiomic system is extremely efficient and reliable and has been type tested and approved by the G.P.O.

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<td>840C</td>
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HIRE PURCHASE TERMS

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The Mezzo is a full 15 Watt High Fidelity Loudspeaker System in the very attractive size of only 10⅜" x 18¾" x 8" deep. The styling has a restrained yet distinctive beauty making it a desirable and easy addition to any well-designed furnishing decor. It contains two new and specially developed loudspeakers, a robust 8" long throw bass and mid-range unit and a sealed back 3" treble unit. The L.C. crossover network operates at 2,200 c/s. The 8" bass unit is of very advanced design and construction, and is particularly notable for its very low distortion and extraordinary smoothness of performance. Goodmans acoustic engineers claim that it is in fact the smoothest bass reproducer of its size ever produced. The treble unit completes the quality picture to give an overall performance unrivalled in a reproducer of this size.

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mezzo
HIGH FIDELITY LOUDSPEAKER SYSTEM

*The "M" Series now embraces the MAXIM (Mini-System), the MEZZO (Bookshelf-model), and the champagne-class MAGNUM-K, each one providing the maximum performance possible for its size.

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Dimensions: 10⅜" x 18¾" x 8" deep
Frequency range: 40-20,000 c/s
Power handling: 15 watts
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Distortion: Less than 1½% total harmonic at 55 c/s and above, for sound pressure level of 80 db at 6 feet.

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Incorporating ALL these refinements:

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A fully illustrated leaflet quoting complete technical specification is available. We will be pleased to send it to you on request.
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The many proved features of Goldring-Lenco transcription units such as infinitely variable speed adjustment, pick-up lowering device, automatic idler wheel disengagement are retained on the GL 68, which is the first unit to incorporate the new G.65 arm. This is of low mass tubular construction with stylus pressure adjustment by sliding counterweight, and provision for height adjustment to suit any chosen cartridge. The interchangeable head slide (taking all cartridges with standard 1" fixing centres) makes use of self-cleaning wiper contacts. Swiss precision motor. Continuously variable speed adjustment. Less than 1% speed variation for 13% mains voltage variation. Adjustable click-in positions for the four standard record speeds. Pick-up raising/lowering device coupled to on/off switch. Automatic disengagement of idler wheel. Full 12" diameter turntable. Wired for stereo.

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- Pickering V15 (AM1 and AME1)
- Pickering 380A, Goldring CS90 & CS91E.

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- Weighting only 5 gm., these high output, high compliance stereo-mono cartridges are perfect for low mass arms. 15° tracking angle gives minimum distortion. Hermetically sealed. Replaceable push-in diamond stylus assembly, with retracting stylus arm for added protection to records. (0.000" tip radius for V15/AM1 and elliptical, with even higher compliance, for V15/AME1).

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V15/AME1 £13.15.0d. + £2.4.8d. P.T.

Pickering 380A Cartridge
- Moving-magnet for exceptional mono or stereo reproduction. Features the exclusive V-guard push-in diamond stylus unit which prevents damage through accidental dropping of arm on record. The Pickering 380A ensures high channel separation and virtually eliminates needle talk, hiss or distortion. Hermetically sealed, it tracks at 2 gm., faultlessly reproduces the most exacting records.

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- These are stereo ceramic cartridges with excellent frequency response and cross-talk separation. Low tip mass, replaceable diamond stylus (CS90 - 0.0005" or 0.0007" tip radius, CS91E - elliptical) coupled with high compliance enables these cartridges to be played at light tracking weights. CS 90 £4.4.0d. + £0.13.8d. P.T.
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- Only one selector switch
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Audio Frequency Response 45 - 20,000 c.p.s.
Compact, Elegant Design
Unique Integrally Constructed Drive System

The bass unit is five inches in diameter, the heavy moulded cone being suspended on an extremely flexible Neoprene surround resulting in the low free air resonance of 40 cps. The movement of the cone at low frequencies is thus controlled by the stiffness of the air in the enclosure, and is linear. An extra long voice coil is used to accommodate the necessary increase in cone excursion and the flux density of 14,000 gauss on a lin. pole is provided by a large ceramic magnet.

The system is unconventional in that the front panel of the enclosure is duralumin plate which is an integral part of the bass unit, and which supports the cone assembly. The magnet is suspended from stout pillars attached to the plate. In this manner the undesirable effects of the conventional chassis on the behaviour of the cone are eliminated, and chassis resonances are obviated.

The treble unit is a specially developed version of the 460T unit fitted with an extremely light suspension system. The crossover network has been developed to provide a smooth distribution of frequencies between the two units.

Standing waves within the enclosure are eliminated by the generous use of B.A.F. wadding. Patents applied for.

**SPECIFICATION:**

**PRICE**
£15.0.0. + £1.10s. 6d.

**For Further Details**
Richard Allan
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The protector will withstand momentary peak currents of about 20,000 amps and many hundreds of 100 Joule discharges. Prompt delivery can be offered, because demand from many parts of the world has proved so high that production capacity has been greatly expanded.

The protector is available in three breakdown voltage ranges:
- 150 — 350 d.c.
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- 500 — 900 d.c.
This new unit makes use of the high flux density available in the magnet system of the previous H.F. 1016 unit. A curved diaphragm is used with a rigid centre section coupled to the voice coil. The rigid coupling and the design of the cone termination give a balanced response over the whole audio range. The unit is specially suitable for use in the smaller type of enclosure having a volume of approximately 1 ft cubic feet.

Specification: Chassis—die cast aluminium; Cone—graded pulp cambric surround; Cone dia.—10 in.; Pole dia.—1 in.; Flux density—16,000 gauss; Total flux—61,000 maxwells; Impedance—15 ohms.

Price: £10. 7. 6

<table>
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<tr>
<th>Type</th>
<th>Flux Density</th>
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<td>10&quot; H.F.1012*</td>
<td>12,000 gauss</td>
<td>£5 1 3</td>
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<tr>
<td>8&quot; H.F.816*</td>
<td>16,000 gauss</td>
<td>£6 1 6</td>
</tr>
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<td>8&quot; H.F.812*</td>
<td>12,000 gauss</td>
<td>£4 4 3</td>
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<tr>
<td>8&quot; H.F.810</td>
<td>10,000 gauss</td>
<td>£3 2 9</td>
</tr>
<tr>
<td>T359 tweeter</td>
<td>9,000 gauss</td>
<td>£1 1 5</td>
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<td>T816</td>
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<tr>
<td>T12 tweeter</td>
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<tr>
<td>T10 tweeter</td>
<td>14,000 gauss</td>
<td>£5 2 0</td>
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*These three speakers incorporate a universal impedance speech coil.

CROSSOVER NETWORKS: CX3,000 £1.16.6
               CX1,500 £2.6.3 CX 500 £1.11.9

Weller Temperature Controlled Soldering Pencils

When prospective customers try out the Weller T.C.P. they write us sales letters. We admit the T.C.P. costs more than other soldering pencils and if you are interested in only short term benefits then it's not for you. However, companies seriously interested in examining their real costs in producing quality electronic equipment will already be aware of the benefits of longer tip life, less downtime, fewer dry joints, less damage to components and circuit boards, no time wasted waiting for warm up, one tool for all types of work, easy handling, high safety.

If you are interested in longer term advantages, write to us and we will send our No. 1 salesman for you to evaluate.

U.K. SALES AND SERVICE

Weller ELECTRIC CORPORATION
HORSHAM · SUSSEX · Tel. 60807

WW—091 FOR FURTHER DETAILS.
SUBMINIATURE CO-AXIAL CONNECTORS

TO PATTERN 17 OF DEF 5322-A & A-4

SPECIFICATION
- Designed to DEF 5322-A & A-4
- Max. frequency : 3 Gc/s
- Temperature category T6 (-55°C to +125°C)
- Humidity category H6
- 50 ohms impedance
- Field-serviceable, with improved cable clamping
- Push-on and screw-on types
- Captivated centre contacts

Space-saving, weight-saving Amphenol 'Subminax' RF Connectors are designed for easy fitting to cables 'in the field' without special tools. They feature a new cable clamping fitment to meet the higher pull-out strength now specified in DEF5322A & A-4. Centre contacts are mechanically retained in position and do not rely on a soldered joint to the centre conductor.

For full technical details, write to:

Amphenol-Borg

AMPHENOL-BORG (ELECTRONICS) LTD.,
Thanet Way, Tankerton, Whitstable, Kent. (Whitstable 4345)

OVERSEAS DISTRIBUTORS:

DENMARK
SYMPOL & MATHIASEN

FINLAND
NORES & CO. OY.

NORWAY
ULRICHSEN, A/S.

PORTUGAL
E. DIAS SERRA LDA.

SPAIN
ATACIO

SWEDEN
JOHN C. LAGERCRANZ

WW—091 FOR FURTHER DETAILS.
MEET THE BALUNs...

Designed to provide a simple and effective solution to the problem of matching unbalanced to balanced impedances of different values, Hatfield Balun Wideband matching units are employed in a wide field of applications and range from miniature types encapsulated in polystyrene, developed for use in printed circuits, to high power units for radio transmitters.

Units are available for standard impedance levels and with a choice of basic frequency ranges and terminations to suit most applications. Enquiries for specially developed types are always welcome.

HIGH POWER MATCHING UNITS
A range of high power impedance matching transformers is available, developed as a result of many years' experience, which incorporate the latest developments in high efficiency and low insertion loss. These types are specified by such companies as Redifon Limited, International Aeradio Ltd., and Airtech Ltd., while users include Governments at home and overseas.

ANTENNA MATCHING UNITS
A range of standard weatherproof units designed to match co-axial cables to open wire aerial feeders. Frequency range 1 to 30 mc/s. We are always pleased to quote for special requirements.

SERIES VT TRANSFORMERS
Designed to match balanced to unbalanced impedances in the frequency band 35 c/s to 2 mc/s. The balanced secondary windings are so arranged as to be a mirror image of each other and are thus symmetrical with respect to the primary winding. A patented, non-inductive screen is interposed between primary and secondary windings and this results in very small balance error and minimum leakage inductance.

HYBRID UNITS
Made in either Bridge or Transformer types, these units are suitable for a wide field of applications where one channel is to be supplied with minimum loss from a multiple number of other channels individually isolated from each other or vice versa. Two way mixers of the Bridge type are particularly useful for mixing TV sound and vision signals where high isolation is necessary. Both types can be used for operating one receiver from a number of antennae or alternatively where one antenna supplies a number of receivers.

The Hatfield Baluns are a growing family. Ask for full details of the range and let us keep you informed of new developments.

HATFIELD INSTRUMENTS LTD. Dept. WW, Burrington Way, Plymouth, Devon.

Telephone Plymouth 72773/4 Cables: Sigjen Plymouth
CERAMICS IS OUR BUSINESS

LET'S GET TOGETHER

Our extensive Research and Design laboratories are continuously and successfully engaged in developing new products and improved designs. If you would like to keep abreast of these exciting advances then please ask for our factually informative literature. We will also be delighted to supply you with samples for testing, and our technical representatives are always on call to discuss your problems with you in detail.

- New Alumina Ceramics
- Low Loss Ceramics
- Metallised Ceramics
- Hermetic Seals
- LT Insulators
- Ceramic Dielectric Materials
- Thread Guides
- Refractories and Foundry Products

If you are interested in any of the above, don't hesitate to write or telephone.

STEATITE AND PORCELAIN PRODUCTS LIMITED
Stourport-on-Severn, Worcestershire. Telephone: Stourport 2271

WW—095 FOR FURTHER DETAILS.
COMBINED ERASE HEAD AND OSCILLATOR COIL

The tendency towards transistor portable tape recorders has received our special attention as the necessity for improvements in heads for this application has been an obvious requirement.

"A most amazing component!" is the reaction of most people who test these, for in a space of only .3 in. diameter by .3 in. long, it contained a complete oscillator coil and erase head.

A simple oscillator circuit operates with a single OC81, or similar type of transistor, and requires only 30mA at 6V from the battery. As well as acting as an erase head, this component also provides the required bias supply to the recording head and (if required) HT for a recording level indicator of the DM70, or similar type. Although DC flows within the oscillator coil inside the head there is no DC flux whatsoever produced in the erase section.

Where an indicator of the DM70 type is used the heater may be serisled with the circuit, as shown below. This offers a further economy of power, and in this case a total of 35mA at 6V, therefore, supplies indicator heater, indicator HT, 30 kc bias supply and erase power.

CLOSE TOLERANCE ON RECORD AND REPLAY HEADS

As the tape recording art has developed, so manufacturers have quite rightly asked for closer tolerances and higher performances in heads. How can you produce an extremely high quality range of record and playback heads offering the maximum in performance, having far closer tolerances in all mechanical and electrical characteristics than hitherto envisaged and at the same time offer these at a reasonable price? That was the development and production problem we set ourselves eighteen months ago.

Some 75 heads from manufacturers throughout the world were examined and tested. Performance features were co-related to design factors applicable and so a design took shape based upon the rejection of all known bad features and the incorporation of good. Our design and production experience of over 34 million heads over fourteen years, including heads for practically every special purpose, enabled us to maintain a realistic approach to the problem. We purchased superb new machinery and produced many special purpose machines ourselves, numerous items of special electronic test gear being developed to provide as comprehensive a system of quality control as could be envisaged, and last but not least, we engaged many highly skilled personnel.

A complete range of record, playback and erase heads ('X' series) is available with these qualities for providing all the requirements of heads for in. tape. Full track, 4 track stereo and 2 track stereo are all available and most of these in various impedances. A special feature of the erase heads is their extremely low power requirement, and that they can be operated at 100 kc without appreciable heating.

'R' AND 'DR' RANGE OF 'X' SERIES HEADS have been redesigned and now give higher output with the maximum in top response and with greatly improved shielding. Over 34 MILLION 'R' and 'DR' heads are in use throughout the world!

Self-oscillatory erase head circuit with Marriott 'X'-type erase and record/play heads.

Details of all the above types of heads are available from:

MARRIOTT MAGNETICS LTD.
BRIDGE WORKS, WATER ROAD, WEMBLEY, MIDDX.

WIRELESS WORLD OCTOBER, 1965
G. A. Stanley Palmer Ltd. are pleased to announce that RESISTA, High Stability Resistors are now available from U.K. manufactured stock. Technical specifications are unimpaired and delivery of the popular RSX3 carbon film type can now be expedited.

Now more than ever it pays to ASK PALMER'S FIRST.

Reference sheets of the extensive RESISTA range, including U.H.F. High Voltage, Carbon, Metal Film and Precision Wire-wound Resistors are available on request. Complete module assemblies to customer specifications are produced. Write or phone for complete Data information.

G.A. STANLEY PALMER LTD.
Island Farm Avenue, West Molesey
Trading Estate, Surrey. Molesey 7254

WW—297 FOR FURTHER DETAILS.
a NEW standard in low cost counters....

The Advance 5Mc/s TC4

- FREQUENCY (0 to at least 5Mc/s, direct reading)
- PERIOD (Single and multiple-period measurements up to 10^1 periods)
- TIME (3μS - 10^5)
- COUNT (1-9999, regular or random pulses)

The new Advance TC4 timer counter offers the best value now obtainable in a four-digit 5Mc/s transistorised and fully portable instrument. The TC4 has many features which places it ahead of similar instruments of its kind; it is outstanding in design, specification flexibility and performance. Frequency measurements to 40Mc/s or 100Mc/s with TCD40 or TCD100 frequency dividers.

Write now for fully descriptive leaflet and specification

Advance Electronics Ltd (Instrument Division)
ROEBUCK ROAD - HAINAULT - ILFORD - ESSEX
Tel: HAINAULT 4444. Telegrams: ATTENUATE, ILFORD

WW-098 FOR FURTHER DETAILS.
THUMBNAIL BRILLIANCE — FROM THORN

Atlas Miniature Neon lamps

Developed in the laboratories of British Lighting Industries Limited, these miniature neon lamps are a brilliant example of big thinking on a small scale. Any electrical appliance or switch with room for an indicator lamp, should have ample room for an Atlas Miniature Neon lamp. Suitable for operation on all mains voltages, A.C. or D.C., their current consumption is negligible and their life expectation from 5,000 to 10,000 hours means that they can be permanently wired in position. They are designed to be interchangeable with similar types of British and American origin. There are both high brightness and low brightness types — with virtually no heat from either. In these miniature neon lamps, Atlas have succeeded brilliantly in scaling down full-sized performance to millimetre dimensions.

THORN SPECIAL PRODUCTS LIMITED
Great Cambridge Road, Enfield, Middlesex.
Telephone: HOWard 2477
A member of the Thorn Electrical Industries Ltd. group of companies.

The latest THORN innovation — WIRED ASSEMBLY SERVICE This service enables a designer to specify an Atlas Miniature Neon lamp complete with series resistor and sleeved leads and terminations in one assembly to suit individual requirements. Orders for several items are thus reduced to an order for one single item. The advantages? — simplification of buying operations, reduction of stockholding to a single item, greater ease of costing, progress chasing, planning and production and reduction of inspection time.

WW—099 FOR FURTHER DETAILS.
Belclere

Miniature Mains Transformers

OCCUPY LESS THAN ONE CUBIC INCH

TYPICAL SPECIFICATION (TYPE ES 2818). PRI: 240v @ 50 c/s
SEC: 12 – 0 – 12v TO GIVE 40 mA D.C. IN CIRCUIT
SHOWN BELOW.

Send for descriptive literature. E.I.D. Approved

THE BELCLERE COMPANY LIMITED
385/387 COWLEY ROAD OXFORD ENGLAND
Tel: OXFORD 77268/7

WW—100 FOR FURTHER DETAILS.

For ALL CLOSED-CIRCUIT T.V. Systems

THE NEW MINIATURE
'IKEGAMI' T.V. CAMERA
T.K. 204 V.
625 LINE VIDEO

ULTRA HIGH DEFINITION

All transistorised, small light-weight camera featuring a stable, high quality picture. Completely control free. Includes automatic 'Cats-Eye' light sensitivity control. Top quality satin silver finish. Can be installed in minutes.

COMPLETE WITH 1 1/13 LENS £145.19

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WE SPECIALISE IN C.C.T.V. SYSTEMS FOR
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- ADVERT. MEDIA

We will quote, supply and install. Increase efficiency within your Organisation with "closed-circuit T.V." You will be amazed at THE LOW COST INVOLVED!

ALL SYSTEMS FULLY GUARANTEED!

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★ SUPPLIERS TO GOVERNMENT DEPARTMENTS, EDUCATIONAL AND CIVIC AUTHORITIES

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(Next to Pan American Airways.) Tel: M1D 0972 OR OEN 6293
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An active probe for
digital counters

RACAL SA.544 ACTIVE PROBE

- All solid state
- Improves counter sensitivity, (typically to 5 mV)
- Wide frequency range – to 100 Mc/s
- Increases input impedance – to 10 MΩ
- **U.K. Price—£55-0-0**

Racal announce the first of a new range of Counter accessories. Digital counters can now be used for measuring much smaller inputs over a really wide frequency range without special external amplifiers and impedance-matching devices. The Racal SA.544 Active Probe is small, easy to use and designed to military standards (N.A.T.O. Code ref. 6625-99-519-1573). Simplify your difficult measurements with Racal equipment.

Racal Instruments Ltd.
Dukes Ride, Crowthorne, Berks. Telephone: Crowthorne 2272/3 & 3763
Telex 84166. Cables: Racal Bracknell

WW—101 FOR FURTHER DETAILS.
Tracemanship

Telequipment type S43 and D43 oscilloscopes can be used with any of five different plug-in amplifiers, including the sensational new G type wide band and differential.

S43 is a single-beam instrument, D43 double. Both have newly developed time-base circuits, ensuring exceptionally good linearity, and both have new 4" aluminised CRTs which give brighter, more accurately read traces than have been offered before in this type of instrument.

The advantages of this Telequipment oscilloscope system are twofold. One basic oscilloscope, together with the appropriate type of amplifier selected from the range, provides a specialised instrument at a very reasonable price. Or, if the range of work to be done requires it, extra amplifiers can be added to adapt the basic instrument to a variety of functions. Additional amplifiers have been developed for specific applications—for example, type D Envelope Monitor for use in the broadcast transmission industry.

**Amplifiers**

- **A** (General purpose)  
  DC-15 Mc/s at 100 mV/cm
- **B** (Differential)  
  DC-75 Kc/s at 1 mV/cm  
  10,000 : 1 rejection
- **C** (Ultra-high gain)  
  DC-15 Mc/s at 100 mV/cm and  
  3 c/s-75 Kc/s at 100 μV/cm  
  (Bandwidths—3 dB approx.)
- **D** (Envelope monitor)  
  2.5 Mc/s-32 Mc/s, sensitivity 1 Vc/m
- **G** (Wide band differential)  
  DC-10 Mc/s at 20 mV/cm  
  Maximum sensitivity 2 mV/cm

*Full details of this oscilloscope system will be sent on request.*

S43 with type A amplifier £98; D43 with type A amplifier £125

Telequipment Limited  
313 Chase Road  
Southgate, London, N.14  
Fox Lane 1166

WW—102 FOR FURTHER DETAILS.
OCTOBER 1965

469 Editorial Comment
470 Domestic Receiver Survey
474 The Season's Sets
483 A Non-resonant Loudspeaker Enclosure Design by A. R. Bailey
487 World of Wireless
489 Personalities
491 News from Industry
493 Letters to the Editor
495 German Radio Show
499 Radio and TV In East Germany
501 Paris Radio Show
503 Slow-motion Television by M. Leeuwin
507 R.E.M.E. School of Electronics
509 INEL 65
511 October Meetings
513 Electronic Laboratory Instrument Practice—10 by T. D. Towers
518 Economical Logic by H. R. Henly
524 Keeping the Radio Peace
526 Books Received
526 New Products
532 Real and Imaginary by "Vector"
534 Commercial Literature
534 H.F. Predictions—October
By foreseeing the needs of the public; by anticipating the practical requirements of setmakers; by helping to solve the problems of service engineers and dealers; by building reliability and performance into every product they make, MULLARD have created a unique business philosophy....in a word INTRINSICALITY.
Bringing signals up-to-date—automatically

Once, the navy was dependent upon flags for signalling. Today more sophisticated methods are available. Naval shore stations are being equipped with STC QT.3-A/4 amplifiers for HF communication with ships at sea. The QT.3-A/4 is a 10kW ISB and general purpose linear amplifier designed for trouble-free point-to-point operation with autotune and remote control facilities.

- Frequency range 2.5-28 Mc/s
- Suitable for telephony and single or multichannel telegraphy
- Automatic tuning and loading correction
- Manual tuning facility incorporated
- Requires front access only for operation and maintenance
- Solid-state logic circuits used for most of the power and tuning control system
- Meets CCIR requirements.

Marconi specialized components are designed and manufactured only when the precision and high performance required is otherwise unobtainable. The Specialized Components catalogue lists the full range.

**Quartz Stability**

**Crystals**
Marconi have more than twenty years' experience in the manufacture of high quality quartz crystals. A wide range of crystals can be supplied from 1 kc/s upwards. Special low aging types are available at 5 Mc/s and 2.5 Mc/s for use in high stability oscillators.

**Crystal Filters**
A selection of crystal filters, both s.s.b and bandpass, are available. New designs are constantly being added to the range and can be produced to meet special requirements.

**Crystal Ovens**
Marconi crystal ovens accommodate various types of crystals. Models are available which can accommodate up to ten crystals. Outstanding in the range is the Marconi 'change of state' oven which needs no thermostat and has a switching differential of ±0.0014°C.

**Marconi Specialized Components**
The Marconi Company Limited, Specialized Components Division, Billericay Works, Radford Crescent, Billericay, Essex, England. Telephone: Billericay 3431 LTD/F54

WW—185 FOR FURTHER DETAILS.
tune . . . set level . . . select AM or FM

for instant direct reading of Modulation Depth or Deviation

Throughout its extensive measuring range, the Airmec Modulation Meter Type 210 has the sensitivity to handle low signal input levels. It will accurately measure AM inputs from 7mV to 700mV, and FM inputs from 7mV to 10V.

Monitor outputs of both LF and IF are available at front panel terminals. The IF output is at 750 k/cs, and allows the modulation envelope of the input signal to be observed on an oscilloscope.

Limiting action is so effective that spurious frequency modulations on AM signals can be measured. Changes of mean carrier level when amplitude modulation is applied can also be measured to an accuracy of better than ±1%.

Airmec Modulation Meter Type 210

Airmec for peak performance consistently

LABORATORY INSTRUMENTS DIVISION—
High Speed Counters, Signal Generators, Oscilloscopes, Wave Analysers, Phase Meters, Ohmmeters, Valve Voltmeters etc.
AIRMEC LIMITED · HIGH WYCOMBE · BUCKS · ENGLAND
TELEPHONE; HIGH WYCOMBE 21201 (10 LINES)

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NEW +125° C

ALUMINIUM FOIL
EXTENDED
TEMPERATURE RANGE
ELECTROLYTIC
CAPACITORS
TO MIL-C-39018 SIZES

-55° C

Please send me a copy of your Bulletin No. 100

NAME
ADDRESS

T.C.C. E.T.R. capacitors are about one third the weight of corresponding tantalum foil capacitors, have a larger capacitance per unit volume and in many cases will match them in performance. Available in seven sizes and from 5-200 volts working at 125°C with a capacitance range of 3.3 μF to 1000 μF. These capacitors are a big step forward in Aluminium Foil Electrolytics and are the product of T.C.C’s continued research and development based on many years of experience in the capacitor field.

Send for the new T.C.C. Bulletin No. 100 by filling in and posting the coupon opposite, this new bulletin gives full details of the range with performance curves and complete specification.

THE TELEGRAPH CONDENSER CO. LTD
Also at CHESSINGTON, SURREY and BATHGATE, SCOTLAND
WW—107 FOR FURTHER DETAILS
**TRANSISTORS**

*British made to the most exacting quality standards—Brimar Transistors are immediately available in all quantities in a wide range of ratings. They are all colour-coded for easy identification—and very competitive in price!*

*For full information write to the address below—or ring GER 9797 now!*

---

**PNP APPLICATIONS**

<table>
<thead>
<tr>
<th>TYPE NO.</th>
<th>VCB (max)</th>
<th>VCE (max)</th>
<th>VEB (max)</th>
<th>PC (max)</th>
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**NPN APPLICATIONS**

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**PNP APPLICATIONS**

- General purpose switching.
- Class B L.F. output, Oscillator or general purpose switching.
- Low Voltage Bias stabilising.
- L.F. Amplifier, Driver, Oscillator, or general purpose switching.

**NPN APPLICATIONS**

- General purpose switching.
- L.F. Amplifier, Driver, or Class B L.F. output, Oscillator or general purpose switching.

---

**THORN-AEI Radio Valves & Tubes Ltd**

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**WW—108 FOR FURTHER DETAILS.**
Species: Associated Aerials arrays

Habitat: Remote rugged
(hot or cold, wet or windy)

Behaviour: Dependable

Associated Aerials make a huge range of communications aerials. Compact, reliable RT aerials to stand up to taxis, fire-brigades and police forces; omnidirectional and directional aerials that work dependably for many years on end in remote and tough territories; marine and ship-to-shore aerials; TV transmitting aerials. VHF, UHF—you name it, Associated Aerials almost certainly already make it. Use still higher frequencies, and Associated Aerials will keep ahead of you. Think of a requirement that nobody's yet heard of, and Associated Aerials will develop an array to meet it. Get in touch with Associated Aerials. Let them make an array for you, and then forget all about it. That's the way with Associated Aerials—the most easily forgotten aerials in the world.

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R.T. Masts Limited

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Sinclair's greatest achievement yet!

THE WORLD'S FIRST POCKET-SIZE COMBINED F.M. TUNER AND RECEIVER

SINCLAIR MICRO FM

7 TRANSISTORS • 2 DIODES • AFC • 2 OUTPUTS

Sinclair's latest design, the SINCLAIR MICRO FM is a high quality FM tuner designed to be used with hi-fi amplifier or tape recorder. It can also be used independently as a self-contained pocket F.M. receiver for personal listening anywhere. This exciting Sinclair triumph, barely half the size of a packet of 20 cigarettes, is a fully fledged 7 transistor-2 diode superhet circuit incorporating many unique and original design features to achieve fantastically good standards of performance. Pulse counting detection ensures better linearity than conventional detection methods, and therefore better audio quality. Powerful A.F.C. which locks on to the station tuned in, together with unusually good sensitivity make tuning easy and the set's own telescopic aerial suffices almost everywhere. Separate output stages are provided for feeding to an amplifier or tape-recorder and to the earpiece, included with the Micro FM. It is this arrangement which allows the unit to be used both as a tuner and as a self-contained receiver. In styling, this is the most elegant, most professional looking design in miniaturised equipment ever made available to constructors, and is one you will be pleased to possess. YET WITH ALL THESE WONDERFUL FEATURES, THE SINCLAIR MICRO FM COSTS POUNDS LESS AND OFFERS ADVANTAGES NOT FOUND IN ANY OTHER F.M. TUNER.

Advance Design Features ensure superb performance

- Pulse counting detector
- A.F.C.
- Unique 7 transistor superhet circuit
- Requires no alignment
- Professionally styled case
- High sensitivity
- Tunes from 88-108 Mc/s
- MEASURES ONLY 2½" x 1½" x ½" plus detachable aerial.

Guarantee

Should you not be completely satisfied with your purchase when you receive it from us, your money will be refunded in full and at once without question.

Total Cost

£5.19.6

USE IT AS A TUNER AND A POCKET F.M. RADIO

☆ TECHNICAL DESCRIPTION

The SINCLAIR MICRO FM is a seven transistor, two diode F.M. superhet designed to be used both as a tuner for feeding to an amplifier or tape recorder and as a self-contained pocket portable receiver. The set is coupled to an R.F. amplifier followed by a self oscillating mixer. Use of a low I.F. dispenses with the need for bulky I.F. transformers and removes the need for alignment. A three stage I.F. amplifier amplifies and limits the signal to produce a square wave of constant voltage which is fed into the pulse counting discriminator. This converts the square wave modulation into uniform pulses, the average output from which is directly proportional to the signal frequency, so that the original modulation is reproduced exactly. After equalisation for pre-emphasis, the signal is fed to the audio output socket for use with an amplifier or recorder and also to the receiver's own amplifying stage which enables the Micro FM to be used as an independent self-contained receiver. The inclusion of A.F.C. makes tuning simple in each station tuned in to automatically lock on to the desired station. The SINCLAIR MICRO FM is completely self-contained within a neat black plastic case faced in polished solid aluminium tuning dials to match. The tuning scale is marked in Mc/s.

- SUPPLY VOLTAGE - 9V from well-contained standard battery.
- CONSUMPTION - 5 mA
- SENSITIVITY - Typically 3 microvolts
- AUDIO OUTPUT - 600mW output from 10K ohms
- HIGH LEVEL AUDIO OUTPUT - 600mW peak to peak, for use with earpiece
- TUNING RANGE - 87.5 to 108 Mc/s
- SIGNAL TO NOISE RATIO - 30dB at 30 microvolts
- AUDIO FREQUENCY RESPONSE - 10 to 20,000 Mc/s ± 1dB

The complete kit of parts for building the SINCLAIR MICRO FM is comprising 7 transistors, case, tuning dials, tuning diodes, front panel light weight enclosure, plugs and sockets and instructions costs only £5.19.6

Send items as detailed on reverse side for full service facilities available at all times to Sinclair customers.

More Sinclair designs on next page.

FULL SERVICE FACILITIES AVAILABLE AT ALL TIMES TO SINCLAIR CUSTOMERS

SINCLAIR RADIONICS LTD.
COMBERTON CAMBRIDGE
Telephone: COMBERTON 582
DESIGNED FOR POWER AND QUALITY

WEIGHS 40 OZ.

COMPLETE SINCAL  X-20 INTEGRATED 20 WATT P.W.M. AMPLIFIER & PRE-AMP

By the use of Pulse Width Modulation in circuitry developed exclusively by Sinclair Radionics, the unique X-20 achieves standards never before reached by any audio amplifier in the world. From the input of the integrated pre-amp through to the power output stage, this amazing amplifier gives quality and power far ahead of anything in its class to make it the most original and interesting design for years. You use your X-20 like any conventional quality amplifier. It has brilliant transient response and a flat frequency response from 20 to 20,000 c/s as well as a reserve of power so you will ever want in real high fidelity reproduction. Yet with all these features this remarkable amplifier, which is complete with integrated pre-amp, occupies far less space, costs less and behaves perfectly. It brings a refreshing new approach to audio that is setting the standard for the whole industry. You can build the X-20 in a single evening!

MEASURES 8½" x 3 ¼" x 1"—DELIVERS 20 WATTS RMS

Only the Sinclair X-20 has all these features!

- 12 Transistors including silicone epitaxial planar in output stage
- Constant square wave amplitude
- 90% conversion efficiency factor at output stage
- Frequency response—from 20 to 20,000 c/s ±3 dB
- Total harmonic distortion—0.1% at 10 watts R.M.S.
- Input sensitivity—1 mV into 5kΩ
- Signal to noise ratio—better than 70 dB

Complete kit of parts including X-20 Manual and instructions

X-20 MANUAL

Details in full about tone and volume control systems to suit the equipment you use with your X-20. Includes stereo, stereo balance and input switching. FREE with all X-20 amplifiers. Available separately 2/- post free.

IN KIT FORM OR READY BUILT

£7.19.6

Guarantee

Should you not be completely satisfied with your purchase when you receive it from us, your money will be refunded in full and at once without question.

WRITE YOUR ORDER HERE, NAME & ADDRESS OTHER SIDE

Guaranteed

May 1965

SINCLAIR MICRO-6

THE SMALLEST SET ON EARTH

SIZE 1½" x 1⅝” x ⅜”

- Self-contained aerial and batteries.
- Weighs less than 1 oz.
- Brings in Luxembourg like a local station.
- Plays anywhere.

No transistor set has ever yet compared with the Micro-6 for size, power, performance and design. No set has ever given such pleasure and satisfaction both in building and using it. Everything except the lightweight earpiece is contained within the tiny, elegant white and black case. Important features include bandspread at the higher frequency end of the tuning for easy reception of Luxembourg, powerful A.G.C. to counteract fading of distant stations, and vernier-type tuning. Quality is outstandingly good. Many thousands of Micro-6 receivers have been built all over the world, and it cannot be too highly recommended as an intriguing design to build and a most practical radio to use. When you have built it, you will want your Micro-6 with you always—and it plays everywhere!

AMAZING CIRCUITRY AND POWER

The technical specification of the Micro-6 is fantastic for its size. It has a highly efficient 6-stage circuit using 3 M.A.T.'s to provide 2 stages of R.F. amplification, double diode detector and high gain 3 stage A.F. amplifier, with A.G.C. and vernier-type tuning. Tuned over medium waveband. Plugging-in earpiece switches set on.

MYLAR HD RPM CARTRIDGE

FULL SERVICE FACILITIES ALWAYS AVAILABLE TO SINCLAIR CUSTOMERS

SINCLAIR RADIONICS LTD., COMBERTON, CAMBRIDGE...
NAVAL RADIO TRANSMITTING SYSTEMS

Complete flexible systems for any class of vessel

Adopted by the Royal Navy and ordered by navies in the Commonwealth and NATO

- Precise frequency setting and positive stability allows full advantage to be taken of SSB which provides the most reliable communications under difficult conditions of propagation or interference
- Continuous frequency coverage from 240 Kc/s to 24 Mc/s
- Covers all types of signalling
- Broadband amplifier and synthesizer system provides simplest operation and almost eliminates tuning
- Aerials can be sited for maximum radiating efficiency.

MARCONI NT 203/204 SYSTEMS

COMPLETE NAVAL RADIO AND RADAR SYSTEMS

THE MARCONI COMPANY LIMITED, CHELMSFORD, ESSEX, ENGLAND

WW-112 FOR FURTHER DETAILS
NEW PUSH-HOME UNITOR

developed from type 102

- Robust, slim, glass filled Diallyl-phthalate moulding
- Contacts simply soldered or crimped, then loaded into rear of moulding
- Contact inserts designed to international crimping standards—need little force to insert and withdraw
- Contact springs of beryllium-copper
- Closed-entry sockets
- 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 Enfield 5393 Ext. 27.

BELLING-LEE

Belling & Lee Ltd - Great Cambridge Rd
Enfield - Middx. Telex: 263265

WW—113 FOR FURTHER DETAILS.
Here is a versatile stereophonic recorder which has no equal in its price group.

IT CAN record monaurally or stereophonically with its own mixed inputs from Gram, Radio or other sources and from high grade low impedance balanced line microphones. With good microphones, etc. the result is a suitable master for disc manufacturers. "Before and After" monitoring is provided together with adjustable metered bias for perfection.

IT CAN also make a recording on one track and then transfer it to the other track while measuring and listening to it and adding one or two more signals also metered.

IT CAN repeat the process and transfer this combined signal to the first track with one or two more signals. Composers use it for this purpose. One track may have music or commentary and the other cueing signals or commentary and either may be altered without the other.

IT CAN playback stereophonically or monaurally with its own amplifiers of 3½ watts each.

<table>
<thead>
<tr>
<th>Speeds</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>3½ i.p.s.</td>
<td>£172 0 0</td>
</tr>
<tr>
<td>7½ i.p.s.</td>
<td>£180 0 0</td>
</tr>
</tbody>
</table>

The Vortexion W.V.B. is a high quality monaural machine with "Before and After" monitoring. The recording inputs are a high sensitivity socket for moving coil or ribbon microphone and a high impedance socket for radio, etc., either of which can be selected by a switch. Superimposing and echo work can be done and the playback has reserve gain for abnormal requirements. This model cannot be converted for stereo playback, but it is a thoroughly reliable machine for the engineer specialising on monaural work.

<table>
<thead>
<tr>
<th>Speeds</th>
<th>Price</th>
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<tbody>
<tr>
<td>3½ i.p.s.</td>
<td>£115 10 0</td>
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<tr>
<td>7½ i.p.s.</td>
<td>£128 0 0</td>
</tr>
</tbody>
</table>

The Vortexion W.V.A. is a monaural machine which has a performance equal in sound quality to the other models. It possesses all the features of the W.V.B. except for "Before and After" monitoring, Dubbing and Echoes. The recording being made can be heard on the internal loudspeaker as in the W.V.B. and C.B.L. The controls are uncomplicated.

<table>
<thead>
<tr>
<th>Speeds</th>
<th>Price</th>
</tr>
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<tbody>
<tr>
<td>3½ i.p.s.</td>
<td>£96 7 0</td>
</tr>
<tr>
<td>7½ i.p.s.</td>
<td>£107 3 0</td>
</tr>
</tbody>
</table>

All tape recorders have adjustable bias controls, low impedance mic. inputs for unlimited lengths of cable, highly accurate position indicators and meters to measure recording level and bias.

**VORTEXION LIMITED**

257-263 The Broadway, Wimbledon, S.W.19

Telephone: LIBerty 2814 and 6242-3-4

Telegrams: "Vortexion London, S.W.19"

WW-114 FOR FURTHER DETAILS.
Wayne Kerr, makers of the world's most comprehensive range of electronic bridges, have also developed many precision signal-generating, attenuating, measuring and analysing instruments for frequencies from DC to 60 Mc/s. These instruments combine maximum versatility with simplicity of operation, and are in widespread use throughout Government Establishments, Broadcasting Authorities, the Armed Services and all types of scientific and industrial laboratories.

**INSTRUMENT-OF-THE-MONTH**

**VTVM measures 30µV-100V from 20 c/s to 300 kc/s**

The Wayne Kerr M121 AF Voltmeter has open, linear scales for the accurate measurement of voltages with negligible loading on the source. The mirror-scale movements are individually calibrated in r.m.s. values and in dB relative to 1mW in 600 ohms. Exceptional linearity and stability have been achieved by including the rectifying elements in a current-feedback loop. The h.t. supply for all stages is fully stabilised, eliminating any undesired effects of mains fluctuations. A cathode-follower output stage is included to permit feed-through amplification of up to 60dB.

**Brief Specification:**
- **Ranges**
  - 1, 3, 10, 30, 100 and 300mV,
  - 1, 3, 10, 30 and 100V r.m.s.
- **(Multiplier for 300V.)**
- **Accuracy**
- Better than 1% f.s.d.

**Input Impedance**
- 1 mV to 10V (direct): ≥ 15 MΩ shunted by 20pF
- 1 mV to 10V (transformer): 600Ω and 100kΩ, balanced or unbalanced
- 30V and 100V (direct): 1 MΩ shunted by 15pF

**AUDIO SIGNAL GENERATOR S121**

Very low harmonic content, 13-ft. tuning scale.
- **Frequency**
  - 10 c/s to 120 kc/s
- **Stability**
  - 100 ppm
- **Accuracy**
  - 1% ± 0.5 c/s
- **Output (600Ω)**
  - -70 dBm to + 10 dBm

**COMPLEX-WAVEFORM ANALYSER A321**

High selectivity plus simple operation.
- **Frequency**
  - 20 c/s to 20 kc/s
- **Stability**
  - 1%
- **Response**
  - ± 1 dB
- **Accuracy**
  - Frequency: 2%
  - Level: 5% or ± 1 dB

**WIDE-BAND ATTENUATOR Q251**

Compact, high accuracy and stability.
- **Frequency**
  - DC to 60 Mc/s
- **Range**
  - 0-61.5 db (0.5-dB steps)
- **Impedance**
  - 50Ω or 75Ω
- **Accuracy**
  - ±0.1 dB

**VIDEO OSCILLATOR O22D**

Output level unaffected by frequency changes.
- **Frequency**
  - 10 kc/s to 10 Mc/s, plus mains - frequency square wave
- **Accuracy**
  - 1%
- **Output**
  - -51.5 to +10 dB on 1 Vp-p across 75Ω (alternatives: 1mW in 75Ω, or 1mW in 50Ω)
- **Stability**
  - ± 0.5 dB

FOR MORE INFORMATION use the coupon below (faster) or the reader enquiry service (easier).

Reader enquiry service code no.
- 'Instrument-of-the-month' AF Voltmeter M121
- Audio Signal Generator S121
- Complex-Waveform Analyser A321
- Wide-band Attenuator Q251
- Video Oscillator O22D
- Electronic Bridges

WAYNE KERR

The Wayne Kerr Laboratories Limited
Sycamore Grove, New Malden, Surrey
Telephone: MALden 2202 Telex 262333
Cables: Waynkerr, New Malden

Please send me further information about the instruments I have indicated (tick appropriate box)
- 'Instrument-of-the-month' AF Voltmeter M121
- Audio Signal Generator S121
- Complex-Waveform Analyser A321
- Wide-band Attenuator Q251
- Video Oscillator O22D
- Electronic Bridges

Name
Position
Firm
Address
... is the Receiver of the 1970's. Its performance and reliability set a standard unlikely to be equalled for the next decade.

Naturally, it's all solid-state. Silicone planar transistors for reliability. Full, no-gap frequency coverage 13 kc/s to 28.0 Mc/s. Single or double conversion depending on range selected. Choose your own bandwidth anywhere in the range 800 c/s to 8.0 kc/s—or the 160 c/s crystal filter for winking out that elusive CW signal. All the sensitivity you can use plus excellent frequency stability and resetting accuracy.

Handling qualities on all modes—SSB, AM or CW—are as smooth as the performance. Unprecedented AGC performance—selectable for variable attack and delay times to combat the worst conditions.

There are AC and DC models available for mains or vehicle supplies.

Full technical information available on request.
British made to the most exacting quality standards—Brimar Silicon Diodes are immediately available in all quantities in the two most popular types. The price is very competitive.

For full information, write to the address below—or ring GERrard 9797 now!

<table>
<thead>
<tr>
<th>TYPE NO.</th>
<th>ABSOLUTE RATINGS (Tamb ≤ 70°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vr (max) V</td>
</tr>
<tr>
<td>BY100</td>
<td>800</td>
</tr>
<tr>
<td>BY114</td>
<td>450</td>
</tr>
<tr>
<td>BY125</td>
<td>200</td>
</tr>
<tr>
<td>BY124</td>
<td>50</td>
</tr>
</tbody>
</table>

* Tamb ≤ 50°C. † Max. duration 10 ms.
when you face a communications problem, consult Ultra!

Ultra can give you so much more than conventional systems provide. Ultra miniature radio-telephone networks can give you instant contact with key personnel on the move, 10 or 100 persons, selectively or altogether, in vehicles or on foot, dispersed over wide areas like docks, airfields, hospitals or large engineering sites. Or keep emergency contact with security and rescue patrols and men in danger. And for every form of public address system, or the reproduction, amplification and distribution of sound in all locations, there is a complete range of Ultra equipment to do the job, which is utterly reliable and simple to operate.

Walkie-Talkies, A.M. and F.M.
Mobile radio-telephones for all applications

Complete base station equipment

Public address systems, large and small

Speakers for indoor and outdoor service

A large range of microphones

So whatever your communications problem, keep in touch with Ultra. Please write or telephone Mr. A. E. Outten for further information or advice.

ULTRA ELECTRONICS

Manufacturers of 'Vigilant' and 'Valiant' Radio Telephones and 'Trix' Audio Equipment.

### High amplitude pulse generators

#### Double pulse generator PP 1122

<table>
<thead>
<tr>
<th></th>
<th>Amplitude</th>
<th>Polarity</th>
<th>Output impedance</th>
<th>Rise time</th>
<th>Pulse width</th>
<th>Delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prepulse</td>
<td>1-10 V</td>
<td>pos. or neg.</td>
<td>75 Ω</td>
<td>20 ns</td>
<td>100 ns</td>
<td>120 or 320 ns with respect to triggerpulse</td>
</tr>
<tr>
<td>Main pulse I</td>
<td>10 mV-10 V</td>
<td>pos. or neg.</td>
<td>75 Ω</td>
<td>&lt; 20 ns</td>
<td>50 ns-50 ms</td>
<td>100 ns-10 ms with respect to prepulse</td>
</tr>
<tr>
<td>Main pulse II</td>
<td>10 V-100 V</td>
<td>pos.</td>
<td>6.3 n/V + 135 Ω</td>
<td>&lt; 25-100 ns</td>
<td>200 ns-50 ms</td>
<td>100 ns-10 ms with respect to prepulse</td>
</tr>
<tr>
<td>Double pulses</td>
<td>Both main pulses can be doubled; minimum spacing 200 ns</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Pulse repetition frequency</td>
<td>Internal 10 c/s-1 Mc/s, external dc-2.5 Mc/s, adjustable trigger level</td>
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</table>

#### Pulse generator PM 5710

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<tr>
<th></th>
<th>Amplitude</th>
<th>Polarity</th>
<th>Output impedance</th>
<th>Rise time</th>
<th>Pulse width</th>
<th>Delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prepulse</td>
<td>&gt; 5 V</td>
<td>pos.</td>
<td>100 Ω</td>
<td>50 ns</td>
<td>150 ns</td>
<td>200 ns with respect to triggerpulse</td>
</tr>
<tr>
<td>Main pulse I</td>
<td>0-5 V</td>
<td>pos. or neg.</td>
<td>135 Ω</td>
<td>&lt; 25 ns</td>
<td>1/2 T or 200 ns-200 ms</td>
<td>200 ns with respect to prepulse (jitterfree by use of delay cable)</td>
</tr>
<tr>
<td>Main pulse II</td>
<td>5 V-100 V</td>
<td>pos. or neg.</td>
<td>120 Ω - 12 kΩ</td>
<td>&lt;100-170 ns</td>
<td>1/2 T or 200 ns-200 ms</td>
<td>200 ns with respect to prepulse (jitterfree by use of delay cable)</td>
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<tr>
<td>Pulse repetition frequency</td>
<td>Internal 10 c/s-1 Mc/s, external dc-3 Mc/s, adjustable trigger level</td>
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<td></td>
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<td></td>
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</tbody>
</table>

**For the U.K.:**
Philips Electronics and Control
The M.E.L. Equipment Company Ltd.,
207 Kings Cross Road,
London WC1 TERMINUS 2877

WW-118 FOR FURTHER DETAILS.
AMPLIVOX FOR COMMUNICATIONS

A range of tropicalised microphones and earphones
Ampligard: A range of noise excluding headsets
New Ear Defender Handset Type 16450
Noise cancelling hand microphone Type 15700
Ampliphone: Pocket size inter-communication system
New Throat Microphone Type 19600/1

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Telephone: WEMBLEY 8991

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50% more display area
... plus added capabilities for the same price

IMPROVED 545B oscilloscope

The Type 545B is an improved version of the Type 545A, which has proved itself of great service to a multitude of laboratories and industries throughout the years and has been considered a standard by which other oscilloscopes can be judged.

plus plug-in unit adaptability
1. accepts one of 17 letter-series plug-ins for differential, multi-trace, sampling, other laboratory applications, or
2. accepts one of many new spectrum analyzer plug-ins (L-10A, L-20, L-30, others) for frequency-based displays, or
3. accepts one of 2 new dual-trace plug-ins (1A1 or 1A2) for 50 mv/cm at dc-to-33 Mc/s — with the Type 1A1 also offering 5 mv/cm at dc-to-23 Mc/s dual-trace, and approximately 500 µV/cm at 2 cps-to-14 Mc/s, single trace.

But to hear the complete story, call your Tektronix Field Engineer. He will know if a Type 545B offers the best solution to your measurement problem. If the Type 545B appears to be the answer, try it. Use it in your own application — with one of your letter-series plug-ins or one of the new spectrum analyzer or dual-trace plug-in units.

Type 545B Oscilloscope (without plug-ins) ........................................ £664
Type L-20 Spectrum Analyzer Plug-In Unit ...................................... £829

Rack Mount Model Type RM545B ........................................ £700
Type 1A2 Dual-Trace Plug-In Unit ........................................ £132
Type 1A1 Dual-Trace Plug-In Unit ........................................ £244

Prices shown are free of duty subject to Treasury direction.

TEKTRONIX U.K. LTD
BEAVERTON HOUSE, STATION APPROACH, HARPENDEN, HERTS.
Telephone: Harpenden 61251 Telex: 25559

For overseas inquiries: TEKTRONIX CANADA LTD., Montreal, Quebec & Toronto (Willowdale), Ontario TEKTRONIX LTD., Albany House, St. Peter Port, Guernsey, C.I. TEKTRONIX INTERNATIONAL A.G., P.O. Box 57, Zup, Switzerland TEKTRONIX AUSTRALIA PTY. LTD., P.O. Box 488, Sydney, New South Wales TEKTRONIX inc., P.O. Box 500, Beaverton, Oregon, U.S.A.

WW-120 FOR FURTHER DETAILS.
A SUCCESSOR TO THE FAMOUS "TROUGHLINE II": FM "TROUGHLINE 3"
Price £31:14:6d.

HI-FI NEWS—"To sum up, the Leak Troughline II belongs to the very limited class of aristocrats in the tuner world."

A MAJOR LOUDSPEAKER INVENTION THE "SANDWICH" Price £39:18:0d.

AUDIO AND RECORD REVIEW—"... This design must be regarded as a breakthrough of fundamental and far-reaching importance."

ANOTHER MILESTONE IN AUDIO ENGINEERING "STEREO 30" TRANSISTORISED AMPLIFIER
Price £49:10:0d.

WIRELESS WORLD Editorial, May 1963—"Last autumn during his presidential address to the British Sound Recording Association, H. J. Leak demonstrated a prototype high-quality transistor amplifier which gave results indistinguishable from those of his valve amplifiers...

"People sometimes ask why there is any necessity to change to transistors. The elimination of the output transformer is, in our view, sufficient reason now that solutions of the problem of linearity in the response of the rest of the transistor circuit have been found. As additional bonuses we get smaller size, cooler running and the prospect of longer life."

If you are interested in Hi-Fi equipment combining faultless presentation with audio engineering to impeccable standards offering studio quality reproduction at reasonable cost...

WRITE NOW FOR FULLY ILLUSTRATED AND DETAILED LITERATURE.

LEAK... the first name in High Fidelity since 1934

H. J. LEAK & CO. LTD., BRUNEL ROAD, WESTWAY FACTORY ESTATE, LONDON, W.3


WW-122 FOR FURTHER DETAILS.
no shadow of doubt...

why Sifam 'CLARITY' instruments are specified, so often

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.

The use of a completely transparent moulded front provides for a greater scale length for a given front area of instrument. Interchangeable masks are available in a choice of contemporary colours to blend with customers' equipment. Designed with special reference to ergonomic considerations, Sifam 'CLARITY' instruments have a clean, modern appearance, combining contemporary styling with consistent accuracy. Sifam 'CLARITY' instruments are normally supplied to meet the requirements of B.S.S.89 (1954) but other accuracies, i.e. the now obsolete B.S.S.89 (1937) can be supplied on request. Scale arcs, mountings and pointers can be supplied in accordance with the new B.S.S.3693 Part 1, 1964, or to customers' requirements.

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

SIFAM INSTRUMENTS
SIFAM ELECTRICAL INSTRUMENT CO. LTD.
Woodland Road, Torquay, Devon
Telephone: Torquay 63822/6

WW—123 FOR FURTHER DETAILS.
This is an under chassis view of our 226 Stereo Tuner Amplifier, showing the modular construction which is common to all our products.

In this model the modules are:
1. AM-FM Tuner
2. Control Unit
3. Blank plate for mounting our Stereo Decoder
4. Preamplifier
5. Power amplifier
6. Power amplifier
7. Power Supply Unit

All the modules are manufactured and wired separately, assembled on a steel frame, and finally interconnected. Other models have different combinations. There are a number of advantages in this approach, both to us as manufacturers and you as customers. For example, the AM-FM Tuner module (1) is included in 6 different models, and the 10 watt amplifiers (5&6) in five. This enables the modules to be produced in large quantities, with all the extra efficiency and economics that this implies. The great saving gained in this way accounts, in part, for the very competitive prices of Armstrong products, and enables us to achieve a greater degree of specialisation in our factory than would normally be possible.

There are separate production lines for modules and finished models, each with its own inspection and test departments. This means that exacting inspection and test procedures are applied to the modules and the final models, providing a double check on performance and reliability. Added to all this, the module concept enables us to offer you a very much wider choice of models, encompassing almost everyone's requirements. The 226 Tuner Amplifier price £61, is the most expensive item in our range, but prices start at £22.10.0

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<table>
<thead>
<tr>
<th>Weight</th>
<th>12 oz.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating time</td>
<td>20 secs.</td>
</tr>
<tr>
<td>&quot;Push-in&quot; Bit Sizes</td>
<td>3/32&quot;, 1/16&quot;, 1/32&quot;</td>
</tr>
<tr>
<td>Voltage</td>
<td>250 to 12 volts</td>
</tr>
<tr>
<td>Price</td>
<td>55/-</td>
</tr>
</tbody>
</table>

Instrument Model 70 watt

<table>
<thead>
<tr>
<th>Weight</th>
<th>44 oz.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating</td>
<td>11 min.</td>
</tr>
<tr>
<td>Bit Size</td>
<td>11/64&quot; dia.</td>
</tr>
<tr>
<td>Voltage</td>
<td>250 to 24 volts</td>
</tr>
<tr>
<td>Price</td>
<td>73/6</td>
</tr>
</tbody>
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1 mf. 350 v. Small tubular metal mesh condenser made by Mahler, 20/- doz.


110 Volt American magnets (wound) 45/- each transformer or receiver. Post 2/6. E.P. Post Free.

Mouse Practice Unit—Comprise valve condenser with controls in wooden box, battery operated. 12/6. Plus 2/6.

Motor from C.W. Electric Motor generators, 24 volt 240 volt output. 110 100 60. 600. 600. 600. 600.

H.E.O. Power Pack. Suitable for 360 or 110 volt mains give 200 H.G. and 0.5 amp. New and unused, built on excellent valve, 60/- or post.

A.D.C. Ammeter 24m. form mounting 9-9 amp. but external coil easily removed for extra 3/-, 6/- each.

ELR. Read 130/6. 6/6 pack. Post 2/6.

Solen Power Inverters. Make excellent microphones or speakers, 6/6 each. 6/- doz.

See in the Dark

INFRA-RED BINOCULARS

These infra red from a high voltage source will enable objects to be seen in the dark, permitting the objects in the rays of an infra-red beam. Each eye contains a complete optical system within a compact case. The optical systems can be used with binoculars, aerial, or photo equipment. To the binoculars, 1 pack, £5.00

---

-MAKING AN F.M. TUNER-

Available at present for very nice end product. Full stepless volume control. Complete with 100 watts output. No tubes or other components. All a simply pressed Perspex front, calibrated to R.M.C. High dc permanent magnet type with either 8 or 15 watts. Suitable will handle up to 50 watts. Similar, by return.

---

SPEARER BARGAIN

Mains Heater Regulator

Suitable to control elements, heaters, soldering irons and building stoves up to 1500 watts. Complete, adjustable, normal price 52/- each, special price 25/- for 5 or 25/6 doz. plus 1/6 postage.

---

THERMOSTATS

This MONTH'S NEW BARGAINS

NOUGHTS & CROSSES MACHINE—Dependable for this you are willing to pay the money, in Practical Electronics. Kit of 10 switches only 45/- doz.

---

Mains Heater Regulator.

New and turned by G.R.C.—suitable for normal refrigerator temperature, 12/6. 8. 15 watts. High dc permanent magnet type with either 8 or 15 watts. Suitable will handle up to 50 watts. Similar, by return.

---

TAPES RECORDER

TAPE RECORDER BARGAIN-

THE " MINY " TAPE RECORDER

Make one of these latest type heaters. Ideal

for 750 watts element, all parts, metal casing as illustrated, 19/6.

---

INFRA RED HEATERS

TYPE "A" is a 15 amp. for controlling room heaters, greenhouses, airship controlle. Has op-er .peltier plate which quickly adjustable from source directly into room. 8/6 plus 1/6 post. Replaceable for wall mounting, 2/6. P. A. F. 1/2.

Type " B " is a 30 amp. This is a type of heater made by the famous Baxster Co. F. Stanley. Adjusts itself from 150-600°. Internal screw alters the setting so this could be adjustable over 50 to 1000 W. Suitable for many purposes, can be to make this start-up or fire alarm, 5/- plus 2/6 post and insurance.

---

THERMOSTATS

Type "C" is a small porcelain thermostat, fitted to electric razors, makes one lead for test meters and enamelled, 8/6. P. & P. 2/9.

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Electronics (Croydon) Limited

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Post orders to: Dept. WW, 43 Silverdale Road, Eastbourne, Sussex
R.S.C.

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Terms: C.W.O. or C.O.D. No C.O.D. under £1. Postage 2/6 extra under £12. 5d. extra under £15. Trade supplied. 3/6 with all inquiries please. Personal orders welcomed at any of the branches below. Open all day Saturday.

BRADFORD 14 North Parade, Tel.: 25349, (Half-day, Wed.).

BIRMINGHAM 1001 Gt Western Arcade. Opp. Smith's Hotel. Sizel and 103 High St. (No half-day). Larger premises now open.

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EDINBURGH 13 Leith Street, Tel.: 377 (No half-day)

GLASGOW 296 Argyle St., Tel.: 1508 (No half-day)

HULL 51, St. John St., (Half-day Thursday). Tel.: 20505.

LEICESTER 34 High St. (Half-day Monday).

LEEDS 5 County (Mecca) Arcade. (No half-day). Tel.: 28252.

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218 Edgware Road, W.2. Tel.: TADDINGTON 1629.

MANCHESTER 40A-40B Oldham St. Tel.: CENtral 2778. (No half-day)

MIDDLESBROUGH 106 Newport St. Tel.: 47096

SHEFFIELD 13 Exchange St. Tel.: SHEFFIELD 19. (Half-day Thursday)

PRINTED CIRCUIT KITS With your own designs. 16/9 Power, Print and Brush finish.

POWER PACK KITS Full moisture proof output 250 – 500 v. 30 WATTS. H.T. and L.T. 6.3 v., 1.5 amp. Operating voltage, module size 10 x 9 x 2.5 in.

R.S.C. STEREO/TEN HIGH QUALITY AMPLIFIER KIT

V.E.L.

Stirling, „cut“ and „boost.“

50 v. 100 m.a. High quality output on each channel. Can be used as stereo 50 watt amplifier. Controls: Stereo/Mono switch, ganged volume controls, bass and treble controls. Parts List: 5000, 1 MΩ, 10,000 Ω, 2 MΩ, 10,000 Ω, 1 MΩ. Full details and parts list 1/9.

R.S.C. A10 30 WATT AMPLIFIER

HIGH FIDELITY ULTRA LINEAR PUSH-PULL OUTPUT

11 GNS. * Or factory built into R.S.C. STEREO/mono output units. 20 GNS. (Total £60 Gns. 1/2)

Features include:

1. Four-position tone and compensating equalizer. 2. Stereo/Mono switch so that mono output is available at 100 m.a. 3. Independent bass and treble controls. 4. Ultra linearity of output stage. 5. Output for 3 and 15 ohms. 6. Full output. 7. Philips full output socket included. 8. Prewired, ready for connection. 9. Fully assembled and tested.

R.S.C. A11 All 12-14 WATT AMPLIFIER

HIGH FIDELITY PUSH-PULL ULTRA LINEAR OUTPUT

51/2 GNS. * Or factory built into R.S.C. STEREO/mono output units. 9 GNS. (Total £65 Gns. 1/2)

Features include:

1. Suitable for the connoisseur and for large halls, clubs, or outdoor functions. 2. Ideal for use with musical instruments, such as string bass, electronic орган, etc., for dance bands, grass band, etc., based on a current Mallard design, and employing valves ECC83, ECC83, EL84, EL84, EZ81. High activity. 3. Bass and treble cut-out. Size approx. 30 in. x 15 in. x 8 in. 4. Connected and ready for use. 5. Front plate lay out.

MICROPHONE TRANSFORMERS

100/1 high quality, small condensers of current manufacture. 2. Type 807 output valves are used with high quality sectionally wound output transformers specially designed for this amplifier. 3. Neutral feedback of 20 D.B. in low bass. 4. Certified performance figures are equal to those of the best designs. 5. For high quality work. 6. Suitable for the connoisseur or for large halls, clubs, or outdoor functions. 7. Type 807 output valves are used with high quality sectionally wound output transformers specially designed for this amplifier. 8. Neutral feedback of 20 D.B. in low bass. 9. Certified performance figures are equal to those of the best designs. 10. For high quality work. 11. Suitable for the connoisseur or for large halls, clubs, or outdoor functions.

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BAKER LOUDSPEAKERS
NEW MULTIVARIETY

12ins., 15 ins. In 80 to 1200 ohms.

Choosing an amplifier for your loudspeaker can be a daunting task. Many options are available, from tube amplifiers to solid-state models, each with its own advantages and disadvantages. A good starting point is to consider the power requirements of your loudspeaker. Most speakers are rated in terms of impedance and power handling, so choose an amplifier that can deliver the necessary power while maintaining good efficiency.

NEW MODEL AREAS FOR ALL GUITARS AND VOCALS

In the world of guitar amplifiers, there are many options available, from small pedalboard models to large rack systems. When choosing an amplifier, consider the needs of your particular instrument and style of playing. Some amplifiers may be better suited for electric guitars, while others may be more appropriate for acoustic or bass.

BOOKS (Please Add Postage)

"W.W." Radio Valve Data
High Fidelity Speaker Enclosures
Mullard Maintenance Manual
Tube Ratings and Fuses
Mullard Audio Amplifier Manual
Radio Valve Guide, Books 1, 2 or 3, or 4, ca. 5
Practical Radio Units
Anon. by wood
International Radio Stations List

NEW MULLARD TRANSISTORS

0071 6/-; 0072 7/6; 0081D 7/6; 00817/6 AF115 10/6; AF117 9/6; 0026 11/6. Circuit included. Amp meter 5.1 amp. 250 v. 20 mA D.C. + wave 6.3 v.

SPEAKERS

15 DIFFERENT TYPES AVAILABLE FOR IMMEDIATE DELIVERY.

PORTABLE

Input 230 v. A.C. Output continuously

VARIABLE VOLTAGE TRANSFORMERS

Price £23/6.

1 AMP.

RADIO COMPONENT SPECIALISTS

NO EXCUSES! NO DELAYS! FROM STOCK!

VARIOUS VOLTAGE TRANSFORMERS

Price £34/10/6.

100 WATT POWER RHEOSTATS (NEW)

Ceramic construction winding embedded in porcelain. Printed circuit, carbon brush assembly designed for continuous duty.

AVAILABLE FROM STOCK IN THE FOLLOWING 9 VALUES

100 ohm, 0.1; 100 ohm, 0.25; 100 ohm, 0.5; 100 ohm, 1; 100 ohm, 2; 100 ohm, 5; 100 ohm, 10; 100 ohm, 20; 100 ohm, 50.

SERVICES TRADING COMPANY
OCTOBER, 1965

20,000 ohm, 2 Heavy duty make.
2,000 ohm, 4 make, 4 break
H%C, 145 ohm +145 ohm, new.
H96G, 50 ohm
H96A, 2.2 ohm i2.2 ohm, new.
SIEMENS SEALED HIGH
plus 1/6 P. & P.

Easy to use source of U.V. for dozens of practical
2,300 ohm coil, 36-48 v. D.C. operation. Any type,
mounting
break every 24 hrs.
SWITCHES.

Telephone jack, Sockets, overall size 11 x 34 x
141,"

200/250 volt A.C.
12 volt 60 watt A.C./D.C. 'SBC 8/6.

MI100 670 ohm, 2 c/o.Ex new equipment.
H96D, 500 ohm
P. & P.

P. & P.

H96B, 1000 ohm
P. & P.

H96C, 2500 ohm
P. & P.

H96F, 5000 ohm
P. & P.

H96E, 10000 ohm
P. & P.

H96G, 25000 ohm
P. & P.

H868, 50000 ohm
P. & P.

H869, 100000 ohm
P. & P.

H86A, 2.2 ohm
P. & P.

H86B, 50 ohm
P. & P.

H86C, 100 ohm
P. & P.

H86D, 200 ohm
P. & P.

H86E, 500 ohm
P. & P.

H86F, 1000 ohm
P. & P.

H86G, 2000 ohm
P. & P.

H86H, 5000 ohm
P. & P.

H86I, 10000 ohm
P. & P.

H86J, 25000 ohm
P. & P.

H86K, 50000 ohm
P. & P.

H86L, 100000 ohm
P. & P.

H96A, 2.2 ohm
P. & P.

H96B, 50 ohm
P. & P.

H96C, 100 ohm
P. & P.

H96D, 200 ohm
P. & P.

H96E, 500 ohm
P. & P.

H96F, 1000 ohm
P. & P.

H96G, 2000 ohm
P. & P.

H96H, 5000 ohm
P. & P.

H96I, 10000 ohm
P. & P.

H96J, 25000 ohm
P. & P.

H96K, 50000 ohm
P. & P.

H96L, 100000 ohm
P. & P.

H96A, 2.2 ohm
P. & P.

H96B, 50 ohm
P. & P.

H96C, 100 ohm
P. & P.

H96D, 200 ohm
P. & P.

H96E, 500 ohm
P. & P.

H96F, 1000 ohm
P. & P.

H96G, 2000 ohm
P. & P.

H96H, 5000 ohm
P. & P.

H96I, 10000 ohm
P. & P.

H96J, 25000 ohm
P. & P.

H96K, 50000 ohm
P. & P.

H96L, 100000 ohm
P. & P.

H96A, 2.2 ohm
P. & P.

H96B, 50 ohm
P. & P.

H96C, 100 ohm
P. & P.

H96D, 200 ohm
P. & P.

H96E, 500 ohm
P. & P.

H96F, 1000 ohm
P. & P.

H96G, 2000 ohm
P. & P.

H96H, 5000 ohm
P. & P.

H96I, 10000 ohm
P. & P.

H96J, 25000 ohm
P. & P.

H96K, 50000 ohm
P. & P.

H96L, 100000 ohm
P. & P.

H96A, 2.2 ohm
P. & P.

H96B, 50 ohm
P. & P.

H96C, 100 ohm
P. & P.

H96D, 200 ohm
P. & P.

H96E, 500 ohm
P. & P.

H96F, 1000 ohm
P. & P.

H96G, 2000 ohm
P. & P.

H96H, 5000 ohm
P. & P.

H96I, 10000 ohm
P. & P.

H96J, 25000 ohm
P. & P.

H96K, 50000 ohm
P. & P.

H96L, 100000 ohm
P. & P.
CLEAR PLASTIC METERS

<table>
<thead>
<tr>
<th>Type</th>
<th>Model</th>
<th>Current (mA)</th>
<th>Accuracy</th>
<th>Type</th>
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</thead>
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<td>Type MR.50</td>
<td>0</td>
<td>0.01 - 10.00</td>
<td>0.1%</td>
<td>0.1%</td>
</tr>
<tr>
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<td>0.01 - 10.00</td>
<td>0.1%</td>
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<tr>
<td>Type MR.52</td>
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<td>0.01 - 10.00</td>
<td>0.1%</td>
<td>0.1%</td>
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BAKELITE PANEL METERS

<table>
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<th>Model</th>
<th>Current (mA)</th>
<th>Accuracy</th>
<th>Type</th>
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<tr>
<td>Type MR.11</td>
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<td>0.01 - 10.00</td>
<td>0.1%</td>
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</tr>
<tr>
<td>Type MR.12</td>
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<td>0.01 - 10.00</td>
<td>0.1%</td>
<td>0.1%</td>
</tr>
</tbody>
</table>

R.F. METERS

- 2 Round plug-in type 50mA or 1 Amp. 3/8-6sat. P. & P. 3/8.

MAGNAVOX 363 TAPE DECK


PROFESSIONAL 4-TRACK STEREO RECORD AND PLAYBACK TAPE DECK


MODEL 170.E MULTIMETER

- 300,000 V.D.C. 30,000 V.A.C. 30,000 V.A.C. 1000 V.A.C. 1000 V.A.C. £15/10. P. & P. 1/3.

MODEL 200.E MULTIVOLT

- 300,000 V.D.C. 30,000 V.A.C. 30,000 V.A.C. 1000 V.A.C. 1000 V.A.C. £15/10. P. & P. 1/3.

MODEL 200.F MULTIVOLT

- 300,000 V.D.C. 30,000 V.A.C. 30,000 V.A.C. 1000 V.A.C. 1000 V.A.C. £15/10. P. & P. 1/3.

MINE DETECTOR No. 4A


MINE DETECTOR No. 4A


WIRELESS WORLD October, 1965
XIS Kit, IN STOCK. I X20 Kit, calibration chart attenuator, 8.9-15.5 Mc/s. and 20-300 Mc/s. 1 volt.

In as new condition, fully tested, complete with all tubes. 105-125 v. A.C. supplied brand new and guaranteed.

R-278/GR RADIO RECEIVER
E.H.F. receiver designed by Collins Radio. Provides reception of A.M. and C.W. signals on any one of 17 channels in the frequency range of 225 to 310.9 Mc/s. and simultaneously on one fixed tuner channel in the frequency range of 238-248 Mc/s. Power requirements 110/240 v. A.C.

LEADER LSU-10 AMPLIFIER GENERATOR

MAIN LONDON AGENTS FOR CODAR EQUIPMENT
For further details, send 1/- P.O. for full catalogue and lists. Open 9 a.m. to 5 p.m. every Monday to Saturday. Trade supplied.

SEND 1/- P.O. FOR FULL CATALOGUE AND LISTS. OPEN 9 A.M. TO 5 P.M. EVERY MONDAY TO SATURDAY. TRADE SUPPLIED.

NEW MODEL!
LAFAYETTE HA-350 AMATEUR RECEIVER

LAFAYETTE HA-230 AMATEUR COMMUNICATIONS RECEIVER

NEW MODEL!
LAFAYETTE HAJ5 AIRCRAFT RECEIVER

MARCONI TF44G/4 STANDARD SIGNAL GENERATOR
50 kHz-50 Mc/s. Output variable from 1µV to 1 volt. Internal noise level modulation 400 µV, up to 25% effective depth. Operation 200/250 v. A.C. Supplied in excellent condition, like new, fully tested and guaranteed. £25 0/0. Carr. 20/6.

CT71 SIGNAL GENERATOR

G.E.C. BRT.402 RECEIVERS
New crystal controlled triple conversion design for 10-15 metres band receiver. Extremely high sensitivity, selectivity and stability. Special features include 3 L.F. stages, crystal controlled oscillators, 6-section 125µµF. variable, 0-200 Kc/s. output, R.F.O., A.M.E., 8" meter, etc. Supplied brand new and guaranteed. £9 19/6. R.A.E. for full details.

LAFAYETTE HA-63 COMMUNICATION RECEIVER

TE22 SINE SQUARE WAVE AUDIO GENERATORS
8 Mc/s-20 Mc/s. square wave, 20 Mc/s. to 30 kHz. Output impedance 450,000Ω. Crystal controlled operation. Supplied Brand New and Guaranteed. As fitted to Conan, Mk. IV and Studio Decks. £4 15/0. Carr. 20/-. £8.

LEADER LSG-12 R.F. SIGNAL GENERATOR
120 kHz-350 Mc/s, on 6 ranges. Variable R.F. and A.F. outputs. Large clear meter, carry-through scale. £3 10/- x 1 Mc/s. A.C. operation. Brand New. £22 15/6.

AMERICAN RECORDING TAPES

NEW NUMBER!
LAFAYETTE STAR SR.40 COMMUNICATION RECEIVER

DIP METER
Compact two band operation. Frequency range 1.7-140 Mc/s. 250 v. A.C. operation. Supplied complete with all cords and instructions. £12/10/-.

OS/18 /U OSCILLOSCOPES
High quality Portable Oscilloscope. Sn. etc 764. 7 in x 8 in, 50-1,000 Kc/s. Output impedance 50,000Ω. A.C. or D.C. operation. 105-125 v. A.C. Supplied brand new and guaranteed. £25 0/0. Carr. 10/6. £55 0/0. S.A.E. for full details.

REUTER H-TRACK TAPE HEADS
As fitted to Conan, Mk. IV and Studio Decks. Double head 1 track, 1 in, 10 Mc/s. £40.00. Microphone jack, low imp. connect, high imp. record/play back. £25.00. Brand new. £135.00. All fitted with R.F.O., A.M.E., crystal controlled. £25 0/0. Carr. 10/6. £55 0/0. S.A.E. for full details.

T.S-312 F/U AUDIO OSCILLOSCOPES
High quality modern American instrument. Frequency coverage on 6 bands. 2-320 Kc/s. Output impedance 1,000Ω. Output monitoring meter. 7 range output selector from 12 micro-volts to 12 volts. Operation 115 v. 60-1,100 CPR. Supplied as new. £45 0/0. Carr. 20/6.
114 WIRELESS WORLD

(1) MULLARD "10 Plus 10" STEREO AMPLIFIER
A High Fidelity design providing up to 10 watts per channel.
KIT OF PARTS £20.0.0.
BUILT AND TESTED £25.0.0 (C. & I. 7/6).
We can also supply the MAIN AMPLIFIER, for operation with our DUAL CHANNEL PRE-AMPLIFIERS.
KIT OF PARTS £4.0.0.
BUILT AND TESTED £5.0.0 (C. & I. 1.5/6).

(2) MULLARD DUAL "CHANNEL PRE-AMPLIFIER"
A four-valve design for both STEREO-PHONIC and MONOPHONIC operation.
KIT OF PARTS £8.10.0.
BUILT AND TESTED £13.10.0 (C. & I. 8/6).

(3) THE "TWIN THREE" STEREO AMPLIFIER
Based on a recent design by MULLARD LTD. It is suitable for use in PORTABLE TAPES or RECORD PLAYERS.
KIT OF PARTS £10.0.0.
BUILT AND TESTED £14.10.0 (C. & I. 8/6).

(4) VERITONE 30 AMPLIFIER
A general purpose Amplifier of outstanding quality, ideally suitable for Home Radio Cabs, Clubs, Hotels, Factories, Indoor and Outdoor Public Address requiring a powerful, volume control Amplifier which will provide high quality reproduction, distortion free. The Amplifier has two standard 4-pin Socket inputs, with individual volume controls and a master volume control, designed to avoid feedback. The Amplifier is housed in a really robust steel case finished in smooth grey hammer finish with chrome handles and silver grey front panel with recessed buttons and knobs.
PRICE 18 GNS.

(5) TUDOR AM/FM TUNER
Pre-assembled & tested. Supplied complete together:
KIT OF PARTS £7.0.0.
BUILT AND TESTED £12.0.0 (C. & I. 7/6).

(6) MULLARD 3-VALVE PRE-AMPLIFIER
Designed mainly for the STERN/MULLARD range of Monophonic Power Amplifiers.
KIT OF PARTS £10.
BUILT AND TESTED £13.10.0 (C. & I. 8/6).

(7) MULLARD 3-VALVE PRE-AMPLIFIER TONE CONTROL
Suitable for use with MULLARD MAIN AMPLIFIERS but also perfectly satisfactory for other makes. Now in new design front panel.
KIT OF PARTS £6.0.0.
BUILT AND TESTED £9.10.0 (C. & I. 6/6).

(8) STEREO TAPE PRE-AMPLIFIER Model STP-I
For use with current TREVOR, BREWELL or COLLARO "STUDIO" 1 and 4-track Stereo Decks. Now with new design front panel.
KIT OF PARTS £9.22.
BUILT AND TESTED £10.10.0 (C. & I. 7/6).

(9) MULLARD "S-10C" AMPLIFIER
The popular "S-10C" complete incorporating Cresta Control, now offering up to 10 watts high quality reproduction with an input of 500 mV. Passive Control Unit providing up to 10 watts output.
KIT OF PARTS £10.
BUILT AND TESTED £11.10.0 (C. & I. 8/6).

(10) MULLARD "2-30C" AMPLIFIER
A HIGH QUALITY AMPLIFIER DESIGNED FOR THE REMAINING POPULAR 3-WATT MULLARD "3-30" DESIGN.
KIT OF PARTS £5.0.0.
BUILT AND TESTED £5.0.0 (C. & I. 8/6).

(11) THE "MONO-GRAM"
A small Amplifier of genuine high quality performance providing up to 3 watts undistorted output.
KIT OF PARTS £1.10.0.
BUILT AND TESTED £2.0.0 (C. & I. 8/6).

(12) MULLARD TAPE AMPLIFIER Model HF/TR3
Based on Mullard's type "A" design and suitable for most 4-track Mono Tape Decks. Now with new design front panel.
KIT OF PARTS £13.10.0.
BUILT AND TESTED £18.10.0 (C. & I. 8/6).

(13) J10 POWER AMPLIFIER
Incorporates the latest reliable 4-stage 2J10 valves in push-pull, PARTIRDGE ultra linear output transformer, and smoothing choke. 30 watts output.
BUILT AND TESTED £12.12.0 (C. & I. 7/6).

(14) MULLARD TAPE AMPLIFIER Model HF/TR3
Based on Mullard's type "A" design and suitable for most 4-track Mono Tape Decks. Now with new design front panel.
KIT OF PARTS £13.10.0.
BUILT AND TESTED £18.10.0 (C. & I. 8/6).
VERN-CLYNE Appointed stockists for the New veritone range of hi-fi equipment

TWO ENTIRELY NEW DESIGNS FOR THE MODERN-MINDED HI-FI ENTHUSIAST

VERITONE SATURN
(Teak Case optional extra.)

VERITONE VEGA
TRANSISTORISED STEREO AMPLIFIER. Specification. Power response, with channels used simultaneously 13 watts R.M.S. per channel at 50 c/s and 10 Kc/s the above figures are reduced by approximately 2 watts. Loudspeaker Impedance, 15 ohms. Frequency response on unequallised input, flat +1db from 40 c/s to 20 Kc/s, –3 db at 20 c/s. Total harmonic distortion at 10 watts, approximately 0.5%. Cross Talk, –50 db at 1 Kc/s, ±5 db. Hum and noise –55 db on Radio, Aux., Tape and Magnetic P.U.—50 db on Ceramic P.U. –3 db. Filter, 3 db/s down at 6 Kc/s, thereafter attenuation at 6 db/s per octave. Bass Control. Treble Control. Inputs for Radio, Aux., Magnetic P.U., Ceramic P.U., Tape output and Tape Monitor. Mains input, 200-220-240 volts. Transistors, per Channel, 5 x OC245, 2 x OC35 or OC29, 2 x ACY17, 1 x OC666, 6 x Diodes per amp. Dimensions, 11 x 4½ x 6in. Front panel, Silver grey with contrasting black markings and knobs. Operation, 200/250 v. A.C. 50 c/s. PRICE 39 Gns. Carriage and insurance, 10/-.
(Teak case optional extra.)

NOW ON DEMONSTRATION AT ALL BRANCHES

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SEE FOLLOWING PAGE FOR ADDRESSES
**Stern-Clyne**

**Electronic Centres Throughout Great Britain**

**Record Player Bargains**

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- LAB 80 less cartridge: £25/10/-
- B.S.R. IIA.15 Super Slim 3B, 4-speed Auto - cartridge: £35/-

**Record Player Bargains**

- **HIGHWAYMAN DE LUXE CAR RADIO KIT**
  - Look at these features:
    - Push-pull output.
    - Three latest Mullard transistors plus valve types EBF83 and ECH83.
    - No buzz, high output and sensitivity.
    - Printed circuit (latest type).
    - 7 x 4 in. high flux p.m. speaker and baffle.
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    - Extremely low battery consumption (less than 1 amp). Easy to fit any make car (positive earth only).
    - Push button for finger-tip control includes wavechange, pre-set tone control and provision for switching in an Extension Speaker.
    - Attractive new styling, tuning scale and chrome escutcheon.

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  - 5in. 600ft Std. Acetate: £8/6
  - 5in. 900ft L.P. Acetate: £10/-
  - 5in. 1,200ft L.P. Acetate: £12/6
  - 3in. 600ft D.P. Polyester: £11/6
  - 7in. 1,200ft Std. Polyester: £12/6
  - 5in. 1,200ft D.P. Polyester: £15/-
  - 7in. 1,800ft L.P. Polyester: £20/-
  - 5in. 1,800ft D.P. Polyester: £22/6
  - 7in. 2,400ft D.P. Polyester: £25/-

- **P. & P. 1/- per Reel extra, 4 or more Reels POST FREE.**
  - Fully Automatic Tape Splicer: £14/6.
  - P. & P. 1/6.

**Other Garrard Models**

- **RECORD PLAYER BARGAINS**
  - Supplied complete with Microphone, Reel of Tape and Spare Spool. PRICE £18 gns. C. & I. 15/- extra. Total credit price E20/10/-.


**CERTIFICATE OF QUALITY**

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5 GNS. CARR. 5/-

GARRARD A.T.A.
Stereo/Mono EV26 cartridge. TEMPLISED
9 GNS. CARR. 5/-

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12 TRANSISTORS 1 DIODE
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SUPER WALKIE TALKIES

25 gns PAIR

MODEL HE-150.

MODEL HE-28C.
Crystal control on both Transistor and Receiver. Push to talk operation. Earphone for personal listening. Complete with carrying case, batteries and telescopic aerial. Size 5½ in. x 2½ in. x 1½ in.

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Crystal control on both Transistor and Receiver. On-off Volume control and push to talk switch. Earphone for personal listening. Complete with carrying case, batteries and telescopic aerial. Size 6½ in. x 2½ in. x 1½ in.

MODEL HA-70A.
Crystal controlled transmit, Super sensitive regenerative circuit. Size 5½ in. x 2 in. x 1½ in. Complete with carrying case, batteries and telescopic aerial. S.A.E. for descriptive leaflet.

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MODEL TF, RE-ENTRANT HORN. 8 ohm, 10 watt. Brand new. Fully guar. 5.00 gns.

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S.A.E. for Tape List.
HEAVY DUTY L.T. TRANSFORMERS
ALWAYS IN STOCK
ALL PRIMARIES 220-240 V.A.C. TERMINAL BLOCK CONNECTIONS

*Denotes Shrouded Types

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Primary</th>
<th>Secondary</th>
<th>Price</th>
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MULTI TAPPED L.T. TRANSFORMERS

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AUTO TRANSFORMERS

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<tr>
<td>No. 3</td>
<td>450W</td>
<td>£45 6/6</td>
</tr>
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</table>

SOLARTRON TRANSISTOR POWER SUPPLY UNITS TYPE A 576-5

A.C. input 110-110 and 220-230 V, 50/60 c/s output 0-130 V, 5 A.

BRAND NEW 30 AMP VENNER TIME SWITCH TYPE FBP

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P. & P. 1/-.

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Ice cube size encapsulated circuits
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Machined parts of 0.018 x 0.005 x 0.002. Output 100 mW per pair. All packing and

ADJUSTABLE POT CORE, Multifit Vickers L440 28 mm. adjustable core, suitable for frequency range 100 kHz-3 MHz. Effective primedness 25. Turns for 1 mH 150. Complete and tested new. 1/6. 3/8.

RUBBER RECTIFIERS, X1012 60 P. 100 mA 3.5. X1013 1,000 P. 100 mA 7/6.

Silicon bridge 24 x D. O. 100 p. Full wave 22.

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Silicon bridge 24 x D. O. 100 p. Full wave 22.

ADJUSTABLE POT CORE, Multifit Vickers L440 28 mm. adjustable core, suitable for frequency range 100 kHz-3 MHz. Effective primedness 25. Turns for 1 mH 150. Complete and tested new. 1/6. 3/8.
BRAND NEW 3 OHM LOUDSPEAKERS

13@2: "8" HORN, "8" 15 ohm imp.
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Wattage: 70 watts.
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3 or 12 ohms. Current projection by acknowledged British maker.
Offered below list price at 3/6. P. & P. 5/-.

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OCTOBER, 1965

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Frequency range 10-1,000,000 cycles in 2 bands. The United States Naval Radio School test of the LM730 Frequency Meter, which has many additional features which increase its usefulness. Specifically designed for radio amateurs, control engineers extreme accuracy and in addition is fitted with an Internal Modulation Switch to allow use as a Signal Generator. Shipping only 5/- m.w. in 5/- only 5/-.

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FLAME GAUGE 11-100-04 GENERATOR - 110-250-04

and 110-250-04, 80 mA. 5 amps. type £15/15/-. 10 amp. type £16/7/-.

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110-308-05, 200 ohms to 1000000; 50000 m.w. 20000 m.w. and visual indicator. With battery £6/10/-. WITH ELECTRIC BALLAST.

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VARIABLE TRANSFORMER VOLTAGE SUPPLIES

Fully adjusted input 200-500 volts. Output 0-200-500 volts. 25 amp. type £15/15/-. 50 amp. type £15/15/-.

STANDARD TRANSFORMERS

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TOTAL COST TO BUILD
£8.19.6 P.P. 2/6
7 x 4 inch Hi-Flux speaker with car fixing kit and baffle 30/- extra.
6-transistor push-pull superhet design.
Uses factory assembled panels.
Permeability geared tuning.
Double tuned I.F.'s.
Size 7 x 4 x 3in. Fits any car.
Attractive chromed front plate.
Prebuilt units available separately.
Full MW/LW tuning, push-button wavechange.
Highly sensitive selective reception.
HIGH PERFORMANCE SUPERHET

THREE WAVEBAND TRANSISTOR PORTABLE TO BUILD
TOTAL COST TO BUILD
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(All parts sold separately.)
Short waves (17-50 metres).
Medium and longwaves.
The ONLY fully tunable 3-waveband portable available to the home constructor.
Push-button coil pack.
Printed circuit geared tuning.
Car aerial and record sockets.
Full 3-waveband tuning.
Size 11 x 7 x 3 in.
Black fabric—chrome fittings.

VHF FM ALL TRANSISTOR TUNER TO BUILD
TOTAL COST TO BUILD
£6.19.6 P.P. 2/6
(Gold sprayed metal cabinet assembly 20/- extra.)
Printed circuit design.
5-transistor 4-diode superhet design.
Geared tuning 87 to 105 Mc/s, FM.
R.F. stage and double tuned I.F.'s.
Peak audio output up to 1 volt.
30mV output for 10V input, 5/N 50 dB.
Output for 30 to 100 k/ohm impedance.
9 volt 9 mA supply.
Size in cabinet, 4 x 3 x 2 in.
HIGH FIDELITY SUPERHET TUNER

SIZING SUPERHET DESIGN

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CRYSTALS
MICROPHONES
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New design 5 watt unit
6-transistor push-pull printed circuit design.
For 3 to 5 ohm speakers.
Size only 2 x 1 x 2 in.
5 watt 12/18 volts, 1 watt 12/18 volts.
7V/m, into 1 k/ohm sensitivity.
PRICES 1 watt 65/- 5 watt 79/6 P.P. 1/6 BUILT.

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1000 kcs (1 Mc/s) HC6U Miniature, 25/-
1000 kcs RCA; 3-pin type, 15/-
100 kcs; 1 Mc/s, 3 pin, 10X type, 22/6

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Over 450 types from stock. LISTS 1/-.
SILICON RECTIFIERS 250 v. A.C. 230/250 factory rating, silent operation. Can be used as a rectifier.

Aluminium A.C. 50 v. D.C. Input. 2 bi-pin holders, starter and starter holder.

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FLUORESCENT LIGHT FITTING Twin 40 watt 200-250v. transformer, less tubes.

RINGO BURGLAR ALARM A.C. Mains 200/240 volts. Fire alarm slightly strained. List price 7 gns. Our price complete with double gong bell, five micro switches and full instructions. 49/6 P. & P. 5/-.


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6 VALVE IS WATT PUSH-PULL AMPLIFIER 15 x 7 x 3½ in. A.C. mains 200-250 volts. 4 inputs with controls for same and bass treble tone controls. Tapable for 3 and 15 ohm speakers. Extra H.T. and L.T. for F.M. tuner supplies, etc., built-in and tested, 7 gns. plus 3/- P. & P.

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COMBINED PORTABLE & CAR RADIO. The Radio with the STAR features 4½ in. SPEAKER.

POWER SUPPLY KIT to purchasers of Elegant Seven parts, incorporating mains-transformer, etc. A.C. mains 200-250v. Output 9v. 100mA. 1½/- P. & P.

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- * 8 stages - 6 transistors and 2 diodes
- Front panel: Ferrite Rod Aerial and new type 30mm speaker
- Size: 9 x 7 x 3.5 in.
- Carrying strap: £2
- Total cost of all parts now only £3.95.

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- * 6 stages - 2 transistors and 2 diodes
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- 7 WAVEBAND PORTABLE OR CAR RADIO AMAZING PERFORMANCE AND SPECIFICATION
- NOW WITH PHILIP MICRO-ALLOY R.F. TRANSISTORS
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- * 7 stages - 5 transistors and 2 diodes
- Covers M. and L. Waves and Short Waves.
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Tannoy portable loud speaking amplifiers with power microphone. Four 6LG5's in output, with sufficient power for 10 speakers. Price £18

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Automatic carbon pile voltage regulators by Newton Bros. (Derby) Ltd. 115v AC, type 2L (for alternators). Price £12

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Circular rubber covered twin leads, suitable for battery chargers, etc., 30ft. long 8/- coaxial cable, .45 diameter, 2/- per yard.

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TCC tubular, 5pf, 5,000 DC 1/9

Rubber tube, 1 mf., 350 v. DC 1/9

TCC .1 mfds., 11000 v. DC £2

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Large laboratory type variable, suitable for transmitter use £2

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Transmitter inductances used by Redifon with mains supply. 35. diameter, and sliding clip. Very suitable for laboratory use £3

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Moving iron projecting type meters, A/C, D.C., approx. 4m. dia. 0-150 v. £1

Some other types of meters available.

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Miniature potentiometers, 1 meg. 2/-

Reliance 400 ohm wire wound potentiometers, 1.5m. diameter, with knob 4/3

Clovey, wire wound potentiometers, 20,000 ohms, pre-set type 3/-

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Westinghouse 12 v., 3 amp. metal rectifiers 12/6

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Type 8A, Input 20, Output 115 v, 3 phase, 400 cycles, 1.8 amps. Price £5

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Marconi type TP317F1, covering 18-58 mcs, and 150-300 mcs. These are offered by us brand new, and as received from Government sources, at £15 each, with instruction book. Carr. and packing 35/- extra. Signal generator, service type, SHF, No. 6, with equipment 60.

TRANSFORMERS

Heavy duty unit in sealed container. Nominal input voltages, 117/234 v.

Outputs 330-0-330 v., 200 ma., 5 v., 2 amps. 6.4 v., 4 amps. Price 35/-

Heavy duty unit, inputs 230 v. Outputs 4.5 v. C.T. at 6 amps, 4.5 v. C.T. at 6 amps, 4.5 v. at 20 amps. Price £3/10/-

Telephone transformers, type 34 or 35 5/-

Transformers, fitted with terminals. Input 230 v., outputs 365-0-365 v. at 180 ma. 0-7.5/0.75 v. at 12 amps. 0-7.5/0.75 v. at 12 amps. Price £3/10/-. Other types available.

Westinghouse transformers, input 115 v., 400 cycles, and various LT outputs. Prices on request.

Postage or carriage extra. Prompt despatch.

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OCTOBER, SYNCHRONOUS MOTOR. 200/250 1,400 r.p.m., SIEMENS OVER 120 TYPES IN STOCK. SEND FOR LIST.

E.M.I. RELAYS. Sub-miniature.
WEYMOUTH RELAYS.

Wainsons MIDGET SILICON RECTIFIERS.
Pole on/off. Commutating switch section and post 3/-.

10/- 1965
7,000 11
24 volt D.C. 4 Make, 4 Break, 10 amp.

C.O. 180 11
2600
1800
1800
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75/-, quantity.

Low Capacitance Capacitor 230 v. A.C. 1/40th h.p.

SPEAKERS ELAC Sin. ROUND
2C2K
2CO2K
600 P.I.V. 750 milliA. S.T.C.

STABILITY CARBON POST 4/-.


SELEGMENT SILICON ZICG ACCUMULATOR. 1.5 volt, 1.5 amperes. Size 2.5in. x 1.13in. x 0.65in. Weight 1 oz. Ideal for model work, 12 to 1300,- post, 30/-.

AMPEREMETERS, WIREWOUND AND CARBON includes hybrid rectifier types.

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TRANSISTOR TESTER
Model AT-1

WORLD FAMOUS “SLIDE-TRANS” AVAILABLE ONLY FROM I.M.O.

* RATED CURRENT CONSISTENT AT ALL POINTS ALONG THE WINDING

Shrouded fully variable transformers for bench or panel mounting.

1 Amp. £4.10.0
2.5 Amp. £5.17.6
5 Amp. £9. 0.0
10 Amp. £18. 5.0
20 Amp. £32.10.0

Carr. & Pkg. extra

VARIABLE VOLTAGE TRANSFORMERS

IMMEDIATE DESPATCH
FULL SPARES AND SERVICE AVAILABLE

AC/DC VALVE VOLTMETER

Price ONLY £35.0.0

C/W probes and leads—no extras.

Latest circuitry provides perfect stability and sensitivity. Professionally acknowledged. JUST LOOK AT THIS SPECIFICATION!

* 11 megohms per volt.
* 3mv-1,500 V. A.C.
* 100 mV-1,500 V. D.C.
* 0.1 ohm—1,000 Megohms.
* PLUS

* 1 kc Oscillator Test Source.
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This superbly finished instrument is invaluable in Production Deps. and Labs. and is presented in an attractive light grey crackle steel case with satin alloy front. mains operated.

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LATEST Miniature

Produced to existing specifications by leading manufacturers E. K. Cole & Co. This Transmitter/Receiver weighs only 5lb. (approx.) and measures 3½ x 5 x 9½in. A crystal controlled 4 frequency set operates from standard dry battery—H.T./L.T. (i.e. Vidor LS557), 14 current series B7G valves used.

As supplied by us to Overseas Govt. Deps. SUPPLIED COMPLETE WITH VALVES & CRYSTALS

Details & Prices of all Accessories supplied on request.

IMMEDIATE DESPATCH
FULL SPARES AND SERVICE AVAILABLE

PORTABLE VARIABLE A.C. POWER SUPPLY UNIT

INSET shows latest type brush gear providing 1 volt variation.

30 Amp. L.T. SUPPLY UNIT

0 to 18 V.D.C. WITH SMOOTH STEPLESS VARIATION.

Designed for CONTINUOUS use at max. loading.

* Fitted voltmeter and ammeter.

Input and output fully fused.
Input: 230 v. A.C. 50/60~. Unit fitted with fuse, voltmeter, safety indicator, on-off switch and lead.
Size: 8 x 5 x 6½in. high.

PRICE £8.10.0 Carr. & Pkg. 10/-

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Check these vital points:

* Made from 6 x 1½in. dia. Sherardized steel sections, for durability and strength.

Extra strong locating base.

* Top cap with fitted pulley and halyard.

* 2 sets (8) Rotproof Guys.

Rustproofed Steel Picketing Stakes.

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**CARRIER FREQUENCY SHIFT ADAPTOR.** This modern equipment of recent manufacture is in excellent condition and suitable for operation with most Service Receivers. IF frequency adjustable internally 445-475 kcps. The adaptor will operate two independent Teleprinters. Power supplies A.C. mains 230 v or 24 v. D.C. Price £5 each, carriage 10/-.

**RELAY UNIT.** G.P.O. 600 type 5 relays 150 ohm 1 set C/O, and 5 relays 400 ohm 2 M, 1 set C/O, in metal box 8 x 6 x 5in., £2, post 5/-. BC-221 or LM 13. Freq. meter complete with original charts in good working order. Range 125 kcps-20 Mc/s, £10/0/- or £15/0/-.

**TS 36AP POWER METEER** with accessories, used for checking radar outputs, £5 each, 10/- carriage.

**DE-ICER, Controller Mk. 3.** Contains 10 relays D.P. changeover heavy duty contacts, 1 relay 4P C/O, (20,000 ohm coil). Stud switch 30-way D.C. operated, one five-way dito, D.C. timing motor with Chronometric governor 20-30 volts 12 R.P.M.; geared to two 30-way stud switches and two Ledcor solenoids, 1 delay relay, etc., sealed in steel case, size 4 x 5 x 7in., £3 each, post 5/-. BC-40 MODULATOR UNIT. 2 x 811's, mod. transformer and fil., trans. complete mod. unit fits 19in. rack 50 watts, £5/10/-.

**GEARED MOTORS (Twin).** 230/115v. 4500 R.P.M. 15 amps., plus relays and switches, etc., £2/6/- each, £22/10/-.

**CONTROL UNIT.** 230 v. A.C., output 24 v. 2 amp., 230 v. A.C. supply in solid state, £35/0/- each, carriage £5/0/-.

**TX DRIVER UNIT.** 100-156 Mc/s.

**INVERTERS.** Type AN3499, 28 v. D.C., 9.2 amps. input, 115 v. 400 cycles, £31/- each, 10/- post.

**TRANSFORMER 20 w. Pri., 1,500 ohm. Sec., 125,000 ohm.** £2 each, £20/- carriage.

**CARRIER SHIFT RELAY UNIT.** .2 x 6C5G, plus 10Amp. relay, £3. Voltmeter TF428-0/1.

**MODULATOR UNIT APQ.43 mounted in a fine oak case with circuit.** Weight 110 lbs. As new, £6/12/6, carriage 30/-.

**RELAY UNIT.** 100-250 v. A.C. input 24 v., D.C. at 3 amps. or 12 v. twice at 3 amps., continuous rating, switched fused, etc. In metal case 19 x 7 x 7in. Weighting two large chokes and 0.1 ma., meter scaled 0-50 volts. £7/10/- (pr.), 1/5/- each.

**RESISTORS.** Variable 3 ohm. 10 amps., 25/-, post 4/-. FOR 1,200 Mc/s.). Price £10 each, carriage £1.

**ROTARY TRANSFORMERS.** 24 v. input, 175 v. at 40 ma. output, 25/-, plus 2/- post. EICOR type, 12 v. input, 400 at 180 ma. output, 30/-, plus 4/- post. 12 v. input, 225 v. at 100 ma. output, 25/-, plus 3/-. (All the above are D.C. only).

**MICROPHONES Type T50.** Fits the palm of hand with on/off switch and lead (Elecro Dynamic) 3/- each, 2/6 post. Type T17 with lead and PL55 plug 45/-, 3/-. post.

**CIRCUIT BREAKER.** 150 amps. 600 v. A.C, £3 each, carriage £7.6.

**PLUGS.** Standard two-way incl. plug PL55 with 6ft. lead and transformer, low to high impedance, 7/6 each, plus 1/6 post. F168 plug and switch lead assembly, 1/- each, plus 1/6 post.

**DIPOLE AERIAL.** Complete set suitable for 60-100 Mc/s, 27/6, carriage £4/-.

**COMPRESSOR UNIT.** Aircraft cabin pressurisation unit, 28 v. D.C. with automatic switches, etc., £3/10/-, post 6/-.

**ARR8 SPARES.** Set of 14 valves and headphones and 3 pilot lamps, original carton, £3/10/- each, post 2/6. Set of 14 valves only, £2/10/-, post 2/-; Vibrato 6 v. at 40 ma. £5, post 1/6; £150 r.p.m., post 12/-, /2.-. Speaker unit, R.C.A., £3/10/-, plus 5/- post. Block condenser unit, 3 x 4 mfd. at 600 v., £15.20/-, plus 2/- post. 230 v. 400 v. D.C., 4 for 126/12. Capacitor air trimmer, 2-20 pf. box of 3, 10/-.

**154 TRANSFORMER UNIT** less power supplies (used), £4 each, plus 15/-.

**TRANSFORMERS.** 230 to 115 v., isolation 300 va., £3 each, plus 5/-; 230 v. pri., 1,850-0-1,850 at 500 ma. £10 each, plus 15/-; 230/115 v. auto 300 watts, £2, post 6/-; 230 v. pri., 24 v. at 2 amp, 22/-, post 5/-; 230/115 v. pri., 275/225 v. at 120 ma. 6 v. at 4 amp., £6.3 v. at 1 amp, 25/-, post 5/-. THELEMETRY AERIAL fixed, mobile or both in one. D.C. or A.C. connection, £61/0/- each.

**AUTOMATIC PILOT UNIT Mk. 2.** This complex unit of diodes and relays, relays, magnetic switches, motors and plus-in amplifiers, with many other items, price £7/10/-. £1 carriage.

**POWER SUPPLY 110/230 v. A.C or 12 v. D.C input, £2/5/- each, carriage 12/6.**

**U.S.A. DESK MICROPHONE CRV/51018/A.** Complete with 7 yards of screened cable and universal jack (adjustable), 15/- each, plus 15/- carriage.

**WHEATSTONE BRIDGE in a beautiful oak case, centre zero galvanometer 2.5 ma, 4 stud switch, 0-10 ohms, 0-inf., size 16 x 7 x 6in., 45/-, each, 5/- post.**

**CONVERTERS.** Type S8, 24 v. D.C., 115 v. A.C. at 1.8 amps 500 cycles, 15/-, 72/6 each, post 8/-.

**SCANNER UNIT.** AS. 596/APQ.43. This modern piece of equipment made by a well-known American firm, normally for aircraft use, has a 30in. diameter parasol reflector adjustable 160 deg. vertical and horizontal and is complete with switchgear and rotary joints. Three powerful D.C. motors by Dalmotor Company, i.e. Types SG-5, SR-2 and PM.4. Three units 500-675 f.p.m. and 0-150 r.p.m., also Kollmann Magispot motor type 9711-0406. Two solenoid contacts, small compressor unit with pressure gauge 0-30 and dehydrator unit. All the above is mounted in an aluminium casing complete. Appox. weight 120 lbs. Two relays d.p. c/o. £5/10/-, plus 10/- post. 4 Relays 4 p.c, £24/25 v. 350 ma, Mechanical Counter 0-9999, 20 K ohm ± 0.15 % Linear Potentiometer, 1,400 ohm. ± 3% Suppressors, Switches, Plugs, Sockets and assorted gear. Price £17/10/-. £2 carriage and £5 deposit for returnable container.

**MODULATOR UNIT APQ.43 mounted in a pressurised container with pulse transformer network units, 7 various relays, high voltage condensers 0-001 mfd. 10,000 v. D.C, 0.75, 5,000 v. working. Valves: KU25, 2E2W, 705A3, (blower motor 27 v. 17 b.p., 7,000 r.p.m. 4.6 amps 90 c.f.m. Omits switch 150 v. 10 ma, 8 p.c. Approx. weight 80 lbs. Price £100, £5.00 casks.

**ARN.21 or TR.9171 (Tachan Equipment), complete with valves, £25 each, carriage £1.**

**TRANS/REC WIRELESS SET No. 31, complete sets with aerials, headphones and microphones in working order. Freq. 30-40 Mc/s. 4 channel stl-controlled, £8/10/- each. WIRELESS SET No. 88. 4 channel stl-stabilised, complete with all valves and aerials and attachments. £40 each.**

**HIGH SPEED RELAYS H6M0, 500 + 500 ohms, 12/6 each, post 2/-.**

**AERIAL CHANGEOVER RELAY, London 24 v. 176/6 each, post 2/-.**

**POWER UNIT P94A. 24 v. D.C. input, 13 amps, 300 v. D.C. £300 ma. 150 v. D.C. @ 100 ma, 12 v. at 5amps., complete with relay, voltage regulator and radio suppressor, £3 each, carriage 12/6d., or 12 v. input £3/10/- each.**

Complete installations can be quoted for. Please write further details.

Listed available S. A. E. for all enquiries.

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Phone: Tottenham 9213 & 9330
LEDEX SOLENOID DRIVEN WAFER SWITCHES

9-Bank 9-pole 8-way plus 3-Bank 4-way switching, located to carry up to 10 kw on last two banks, operating voltage of solenoid 10-04 v. d.c. All wires are standard size, removed from brand new equipment 52/6 ea. P.P. 0/6.

RELAYS TYPE 3000
8 G.O. double wound coil 14-16 ohms, special latchine type, a reverse polarity current to either coil releases armature, operating voltage 6 or 12 v. d.c., brand new stock by famous manufacturer.

MINIATURE RELAY BANKS
Six miniature relays 0-3 v., 1 make per relay, contained in a small aluminum case 4 x 4 x 1 in., with six ball bush spaced crystal holders, designed to switch any desired voltage by remote control. Relays and crystal holders can be easily removed for other uses if required. terrific value, only 15/-.

RELAYS, MINIATURE
B.T.C. 4946G. 21, 700 ohms, 2 G.O.
B.T.C. 4946H. 57, 750 ohms 2 C.O.
B.T.C. 4946F, 1, 720 ohms, 2 C.O.

COMMUNICATIONS RECEIVERS

1.5-3 mc. 1000 watts, 500 ults. £105. P.P. 9/6.
2.5-6 mc. 500 watts, 500 ults. £115. P.P. 9/6.
3.5-5 mc. 300 watts, 300 ults. £125. P.P. 10/-.
4.5-7 mc. 200 watts, 200 ults. £135. P.P. 10/-.
5-8 mc. 150 watts, 150 ults. £150. P.P. 10/-.
6-10 mc. 100 watts, 100 ults. £175. P.P. 10/-.
8-10 mc. 50 watts, 50 ults. £200. P.P. 10/-.
9-12 mc. 25 watts, 25 ults. £250. P.P. 10/-.

RELAYS TYPE 600

4 C.O. 1000 ohms, new stock. 7/6 ea.
4 C.O. 2000 ohms, new stock. 7/6 ea.
4 C.O. 5000 ohms, new stock. 7/6 ea.

RELAYS, MINIATURE
B.T.C. 4946G. 21, 700 ohms, 2 G.O.
B.T.C. 4946H. 57, 750 ohms 2 C.O.
B.T.C. 4946F, 1, 720 ohms, 2 C.O.

S.T.C. 4186EA. 1 v. 2 ohms, 2 C.O.
S.T.C. 41840D. 24 v. 700 ohms, 2 C.O.

RELAY TYPES
4 C.O. 600 ohms slugged type.
4 C.O. 500 ohms, new stock.

RELAY TERMINALS

10/- extra for each terminal.

MICROPHONE MINIATURE RELAYS

10/- extra for each relay, contained in a small aluminum case 4 x 4 x 1 in., with six ball bush spaced crystal holders, designed to switch any desired voltage by remote control. Relays and crystal holders can be easily removed for other uses if required. terrific value, only 15/-.

WIRELESS ELECTRONICS

THE "SKYROVER" RANGE

ELIZABETHAN LZ 27
PORTABLE TAPE RECORDER

Special Bargain Offer of this very popular cassette model—new, fully tested and fully guaranteed. Ideal home or mobile use.
Woe stock.
Input: headphones, 1.2 m. Output: magnetic tape, 45 c/s to 20 kc/s; volume, bass, treble and balance controls provided.

Radio Receivers BC-312 and BC-342 are 1.5-18 mc.
6-band highly sensitive and selective Superheterodyne general purpose 9 valve Communications Receivers. All sets are exactly the same except for their Power Inputs. These Receivers are ruggedly built and are ideal for fixed or mobile installation. These sets have the added feature of a slow Tuning Knob, B.P.O Control, A.V.O and M.V.C. Control. The latter two controls are for Ambient for sensitivity and three bands. For 1.7 Mr.

MINIATURE PRINTING BANKS
10/- extra for each relay, contained in a small aluminum case 4 x 4 x 1 in., with six ball bush spaced crystal holders, designed to switch any desired voltage by remote control. Relays and crystal holders can be easily removed for other uses if required. terrific value, only 15/-.

RELAY TERMINALS

10/- extra for each terminal.

WIRECOMP’S BARGAIN STORE

THE "REALISTIC" 7

This tunes a 7-transistor home service receiver, or any other. All modern and long wavelength bands can be tuned in. Dimensions: 9 x 5 x 6 in. Price £5. 19/-

PORTABLE 81 SPEAKER UNIT
Cabinet type forward facing system. Fitted with 15 ohm 8 x 8 ft. elongated double cone speaker, will handle 7 watts. Wood cabinet size 10 x 12 x 16 in., finished in medium walnut. New, and guaranteed.

WIRECOMP’S PRICE £19.6

GARCUTER 340 FM/VHF TUNING HEART
Pamphlet, with H.P. terms: 33/- deposit & 11 months £3. Post 4/-.

WIRELESS WORLD

October, 1965

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All branches open all day Saturday. Early Closing Thursday.
Mail Orders to the above address for prompt service.

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7 VALVE AM/FM RAFIOGRAPH CHASSIS

Valve line-up: ECC85, ECH81, E945, E946, EL84, EM81, EZ60


Aligned and tested ready for use

3 ohm I.F. Speaker only required. Recommended Quality Speakers Dim. 21/2". 121/2". R.A. with Twickenham, 45/50. R.M.I. 5/11 x 31/2. Ctr. 9/-

GO-AX 80 ohm CABLE


New only 6yd. strand.

BARGAIN PRICES—SPECIAL LENGTHS

20 yds. 17/6. P.P. 2/-

20 yds. 9/-. BARGAIN

3 ohm I.F. Speaker only required. Recommended Quality Speakers Dim. 21/2". 121/2". R.A. with Twickenham, 45/50. R.M.I. 5/11 x 31/2. Ctr. 9/-

NEW VALVES

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EAR.

PHILIPS Red Type (cost. air space)—49/- 1 pair, 79/- 3 pair.

METAL RECTIFIERS-STY. Type-MU 99/-


dia.

R Ново. 800 £12/-/£14/-

R NEW 17/6/-

MURRAY 171/6.- Muriay By100 15/-

TUBES: 59/6-

ZACK 59/6-

ZACK SPECK—gray type 2/6-

BENDON 59/6-

ZACK BAKKETS—Molded Ipecac type, open knobs, dia. 1-1 4/5". 4 p. type open knobs, dia. 2 1/2". 3 knobs, Closed. 9/-

X Broadcast. Twin knobs.

PHONO Plugs 9d. Stereo Plugs (open), 1/-

OCCASIONAL CONTINUOUS 3 p. or 5 p. plug.

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Incorporating 4 Sp. Garrard Auto-Sim unit and Mullard latest 3-east printed circuit amplifier (ECL84 and EZ20), valve and treble controls, with 8 x 5 in. 10,000 line speaker. Contemporary styled two-tone cabinet, charcoal grey and off-white with matching built-in blue relief. Size 171/2 x 16/4 x 8in. A stylish unit capable of quality reproduction. Circuit and construction details. 2/6 (ies. LUXURY SELECTION AVAILABLE)

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TERMS: C.W.O. or C.D.O. post and packing 1/-, 1b. 1/-, 3b. 3/9, 5b. 4/6, etc.

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AR-88D RECEIVERS

We have a number of "D" and "FF" receivers in stock for personal shoppers only. Prices are from £30 and vary according to condition, whether fitted with "5" meter, etc. All are in sound working order.

WIRELESS SET No. 76

A compact CW only crystal controlled transmitter. Consists of a Pierce oscillator (807) and a Power Amplifier (807). Both are cathode keyed by means of a relay. Six switched crystal channels are available in the frequency range of 2 to 12 Mc/s. (Cathodes not included.) Aerial current is indicated on a panel meter and two spare valves are supplied. Operates from 12 volt battery via internal rotary transformer. RF output 9 watts. Contained in steel case 12 x 12 x 8 in. Weight 30 lbs. Ideal for 80 or 40 metres or cheap enough for breakdown. Good condition and working order. Circuit included. £31.10. Carr. 10/-.

TELEVISION SWEEP GENERATOR

MARCONI TF 1104/1.

V.H.F. alignment oscilloscope for TV, V.H.F., UHF and VHF receiver. Crystal controlled or variable oscillator markers. Sweep width up to 10 Mc/s. Can be used as normal oscilloscope. With handbook. Details on request. ABSOLUTELY BRAND NEW. £75.

V.H.F. SIGNAL GENERATOR

MARCONI TF 891/A. Covers 85 Kc/s to 30 Mc/s in 8 switched ranges. Effective length of film scale is 50 ft. Output level variable in 1 stop steps from 1 V to 100 mV (T5C). Also IV Outputs down to 0.1 mV from an output of 7.5 Mc/s. Int. mod. at 450 Kc/s, 1.6 Mc/s and 3 Kc/s. FM at frequencies above 390 Kc/s. Variable mod. depth and deviation. Crystal calibrator 200 Kc/s and 2 Mc/s. Monitor speaker for best detection. Fully metered. Black painted, Painted case. A.C. mains 100 to 150 and 200 to 250 volts, 45 to 100 volts. 17 x 10 x 7 in. Weight 11.7 lbs. Fully tested and guaranteed. Under 10% of original price. £85. Carr. 50/-.

WIRELESS WORLD

October, 1965

LOW CAPACITANCE BRIDGE

MARCONI TF 1342. Range 0.002 pF to 1000 nF. Accurate to 0.5 nF. Three terminal transformer ratio arm bridge allows "in situ" measurements. Internal oscillator frequency 1,000 c/s. 12 x 17 x 8 in. Weight 52 lbs. A.C. mains 200 to 250 and 100 to 150 v. 40-100 c/s. With leads and handbook. ABSOLUTELY BRAND NEW. £45.

PHASE MONITOR ME-55/U (AN/URM-47)

Designed to measure directly the phase angle between two applied audio frequency signals of from 20 to 20,000 c.p.s. ±1°. Direct indication on a panel meter. Input can be sinusoidal or non-sinusoidal from 2 to 30 volts peak. Of recent manufacture (1957) by General Electronics, Inc. and ex-U.S.A. Air Force, in first class condition with handbook. A complex instrument with 19 valves. £60. Carr. 30/-.

MOVING COIL PHONES. Finest quality Canadian with chassis ear-muffs and leather-covered headband. With lead and jack plug. Noise excluding and supremely comfortable. 2/- each. Post 3/6. As above but complete with moving coil microphones. 25/- Post 2/6. D.L.R-5. Low impedance headphones with stretched chromed microphones. £10/- Post 1/6. All these items BRAND NEW.

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8 ml. 800 v. D.C. wkg. at 71°C. CP 122. Size 3 1/8 x 1 1/8 x 1/2. BRAND NEW (boxed) 8/6 each. DUBILIER NITROGOL. 8 ml. 350 v. D.C. wkg. at 71°C. Size 1 1/4 x 1 1/4 x 1/8. With fixing clips. BRAND NEW (boxed) 5/- each. T.C.C. or DUBILIER. 10 ml. 600 v. D.C. CP 1800 or similar. 1 1/4 x 1 1/4 x 1/8. BRAND NEW (boxed) 14/- each. Post all paid.

ASSORTED CAPACITORS. Mixed packet of 100 all brand new, marked value, quality types, mica, ceramic and lead from through from 1 pF to 3,000 pf. 10/-.

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Vacuum impregnated, not oil filled, paper, screen, universal mounting. Size 4 x 3 x 4 x 241. ALL BRAND NEW. 21/- each. Post 2/- each.

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THE LINEAR ‘SUPER 30’ HIGH FIDELITY PUBLIC ADDRESS AMPLIFIER

TECHNICAL DETAILS:
Sensitivity for 30 Watts
-50 millivolts.
Mic. 1. 5 millivolts.
Mic. 2. 150 Microvolts.
Frequency response
±2 db 30 c.p.s. — 20,000 c.p.s.
Bottom control
+15 db to 15 db at 50 c.p.s.
Trebble control
+12 db to -12 db at 10 Kcs.
Hum and noise
-60 db
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0.5% for 30 watts.
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Mullard ECC83, ECC83, ECC83, EL34, EL34, GZ34.
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A HIGHLY EFFICIENT 30 WATT GENERAL PURPOSE PUBLIC ADDRESS UNIT

With input mixing facilities and outputs for 3 - 7.5 - 15 and 330 ohms (100 volt line).

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Three high sensitivity standard Jack inputs with provision for high and low impedance microphones.

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Complete with pick-up and 4-speed mains model

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THE FINEST RANGE OF MONO/Stereo MAINS AND TRANSISTORISED PORTABLES

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ELIZABETHAN LZ 27 PORTABLE TAPE RECORDER

Special bargain offer—brand new, unseen and fully guaranteed. Briefcase: 9 speeds—7½ and 7 ¾ in. 4 track; 3½ in. 2 track; 3 in. 2 track; 4 speaker; amplifier and additional amp. or monitor; built-in 7 in 4 speaker; tape position and record level indicator; forward and reverse. Volume and tone controls also super-sensitive facilities. Takes 7½ in. reels. 210/10/-; 1 track £13/19½.; 2 tracks £14/19½. Insured at Post 2/6 extra.

LASKY’S PRICE 18 GNS. Carriage and Insurance 10/-.

COLLARO STUDIO TAPE DECKS

3 speed model—12, 16 and 25 in. p.s., available with various model, 3 track head. Fitted with 3 motors; 7 in. range position indicator. Fast forward and reverse. Par岂 12, 16 in. 1½ v. 9, 10½ v. 15 v. For special applications only to be ordered direct from Collaro main. State whether 30 or 60 c.p.s. model required when ordering. Mains is normally 30 c.p.s.). Brand new and unseen.

LASKY’S PRICE £16.19.6. Carriage and Insurance 3/-

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Price £5.19.6.

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MODEL C


LASKY’S PRICE £13.19.6. Size 10 x 12 x 4½ in. Insured at Post 2/6 extra.

TAPE DECK MOTORS

Motors for the Collaro Studio Deck—new and unused. 200-250 v. A.C. Take-up and rewind. Lasky’s are now able to offer the complete kit of parts as specified by the designers.

LASKY’S PRICE £3.19.8. Post and Packing 6/-.

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Motors for the Collaro Studio Deck—new and unused. 200-250 v. A.C. Take-up and rewind. Lasky’s are now able to offer the complete kit of parts as specified by the designers.

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HI-FI TAPE RECORDER HEADS

High quality tape decks carry the standard Hi-Fi tape heads, 200-250 v. A.C. Take-up and rewind. Lasky’s are now able to offer the complete kit of parts as specified by the designers.

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BUILD A HIGH QUALITY TAPE RECORDER

Using the famous Collaro "STUDIO" deck and Martín pre-assembled amplifiers, 2-4 track models.

COLLARO STUDIO DECK.

Lasky’s 21/- 3 speed, 5 motors. Take-up, red, fitted with half-track heads. Now and unused. LASKY’S PRICE £6.10.0. Carriage & Packing 7/6.

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MARTIN TAPE RECORDER HEADS.


LASKY’S PRICE £5.19.6. Carriage and Insurance 10/-.

FROM PRE-AMP TO 20 WATT HI-FI STEREO ASSEMBLY

BY BUILDING WITH MARTIN AUDIKITS

One of the only developed circuits for tape head for recording and printed circuits—these kits are all fully checked and tested before leaving the factory.

KIT 1: Voltage Matching Input Selector Unit

LASKY’S PRICE £2.10.0.

KIT 2: Pre-amplifier with volume control

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KIT 3: Channel Meters, with preamp adapters for individually matching each circuit.

LASKY’S PRICE £2.10.0.

KIT 4: Pre-amplifier with tone/volume control stages

LASKY’S PRICE £2.10.0.

KIT 5: 10 in. x 15 in. Main Amplifier

LASKY’S PRICE £6.19.6.

KIT 6: Power Supply Controller Unit

LASKY’S PRICE £6.19.6.

KIT 7: 16 span amplifier for KIT 6

LASKY’S PRICE £2.19.6.

TAPE DECK MOTORS

Motors for the Collaro Studio Deck—new and unused. 200-250 v. A.C. Take-up and rewind. Lasky’s are now able to offer the complete kit of parts as specified by the designers.

LASKY’S PRICE £14.11.11. Post 2/6.

HIGH QUALITY TAPE DECKS

High quality tape deck motors made by E.M.I. Holland. Bi-directional. 200-250 v. A.C. Take-up and rewind. Lasky’s are now able to offer the complete kit of parts as specified by the designers.

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HI-FI TAPE RECORDER HEADS

HI-FI TAPE RECORDER HEADS

BY BUILDING WITH MARTIN AUDIKITS

Upper or lower track. Static track required. 3-18 speed head. Lasky’s are now able to offer the complete kit of parts as specified by the designers.

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BODEN 3-track heads

LASKY’S PRICE £8.19.6.

BODEN 4-track heads

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TRANSFILTERS

BY REDUCER_CRYSTAL, Co, Available from stock

TRANSFILTERS

BY REDUCER_CRYSTAL, Co, Available from stock

GOLLER UNIT 340 FM/VHF TUNING HEAR

GOLLER UNIT 340 FM/VHF TUNING HEAR

Permanently tuned—operating 97 to 108 M.C.S.,. Designed for use with one ECC 83 valve.


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THE HARROW POWER PACK
Battery eliminator for portable radios, etc. Converts your battery radios to A.C. units. Replaces 3, 4, 6 or 9 volt, with 6 only. 5V. x 2Am, x 2Jw. LASKY'S PRICE 29/6.

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TEST EQUIPMENT

TEST METER ADAPTOR
Type PB 250—this is a fully transistorised device which enables any 50 millivolt D.C. Multimeter to be used in place of a valve voltmeter. The input impedance is 1 megohm which increases on the 1,000 v. range to 150 megohms. 7 ranges: 1 to 1,000 v. Designed for instantaneous connection to Audio and similar line meters but quite suitable for use with any other 50 millivolt meter. Size 6 x 6 x 4 in. New and boxed. List Price £7.6s.

LASKY'S PRICE 39/6

READY BUILT TEST METERS

JASON TEST EQUIPMENT
AG 10 Audio Generator
Can be built complete for:
1. £15 0. P. & P. 4/- extra.
2. £17 10. P. & P. 4/- extra.

NOMBREX TEST EQUIPMENT
MODEL 27 TRANSISTORISED SIGNAL GENERATOR
With switchable 400 kHz, 100 MHz Accuracy better than 0.1%. Built-in 50 kHz oscillator. Weight and strongly made. Complete with test leads and bux.

LASKY'S PRICE £91.13

OTHER NOMBREX MODELS AVAILABLE:
MODEL 63. Wide range AUDIO GENERATOR
10,000 KHz. £152/6s.

MODEL 66. Wide range MULTI-TONE BRIDGE
20,000 KHz. £12/10/-

INTERNATIONAL TAPE
Famous American Brand—Fully Guaranteed at record low prices. In sealed cartons.

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This post, which is hoped to be filled by 1st October, 1965, will be for a period of three years. The duties will include the selection, modification, construction and maintenance of input keyboards for computer type-setting.

APPLICANTS should have experience of small electronic/mechanical devices such as tape typewriters and a good background knowledge and interest in wired or printed electronic logic circuits, digital processing techniques and systems, and of cathode ray circuitry will be an advantage. A graduate membership of the I.E.E. or of the I.M.E. will be required for appointment as Experimental Assistant, although candidates with a H.N.C. or equivalent experience in industry or the armed services may be considered. The appointment will be commencing salary for appointment as Experimental Assistant will be at a suitable level on a scale £925 to £1,400 per annum.

APPLICATIONS, giving full details of age, qualifications, experience and references should be sent as soon as possible to the Department of Physics, The University, Newcastle upon Tyne 1, from whom further details on the research programme and the organisation of the project can be obtained.
**Systems test engineers**

English Electric Leo Marconi need test engineers to work in close liaison with systems designers on industrial data processing and handling systems. These systems cover a wide range of applications from power station monitoring, through industrial control to data logging for ships' engine-rooms. Since each system is different, the work is varied and interesting.

The vacancies are at Kidsgrove—well placed on the Staffs/Cheshire border. House hunting in the area is a pleasure, with plenty of rural country at hand.

Qualifications: H.N.C. standard with at least eighteen months relevant experience. If your qualifications fall slightly short of these, a few openings exist for technicians.

Please write, giving details of age, qualifications and experience to:

G. M. BOLTON, Dept. WW, P.30,
English Electric-Leo-Marconi Computers Ltd.
Kidsgrove, Stoke-on-Trent.

**Engineers: could you know your way round a computer?**

An IBM Data Processing Customer Engineer does. It's his job to keep data processing installations working smoothly. He works with his own customers in their offices, yet within daily reach of his home. His job is stimulating and rewarding; it is never dull. As well as maintaining a wide range of electronic and associated electro-mechanical machines, he applies his engineering knowledge and skill and develops a real understanding of his customers' needs. As customer management moves towards a more effective use of highly complex equipment, new problems may arise. The IBM Customer Engineer has the ability to produce new ideas and has confidence in his own judgement. He is a responsible man on whom all customer staff rely.

We provide a thorough training for a worthwhile career. You should be between 21 and 29 and have a basic knowledge of Electronics. An acceptable standard would be a Radar/Radio/Control Equipment Fitters Course, Telecommunications experience or O.N.C./H.N.C. Electrical or Electronic.

Starting salaries are at least £1,000 a year, with more for men with special aptitude or specific experience. Increases are on individual merit. As a Customer Engineer you could be earning between £1,250 and £1,700 in three years. Promotion is also on merit and from within the company.

If you're not quite old enough to have reached the standards we've indicated we'd still like to hear from you. If you've just left school with 'A' level Maths and English or are studying for O.N.C. Electrical Engineering, there could be a place for you.

Please telephone or write briefly, summarising details of age, experience, training and background to: Mr. D. J. Dennis, IBM United Kingdom Limited, 101 Wigmore Street, London, W.1. Telephone WELbeck 6600, quoting reference CE/WW/922.
HAWKER SIDDELEY DYNAMICS LTD.
Gladstone Road, Farnworth,
have vacancies for:—

A SPECIFICATION WRITER—
to be responsible for preparing and issuing Specifications, applicants to have had 2-3 years experience in this type of work.

CIRCUIT DESIGN ENGINEERS—
for design and development of a wide range of Test Equipment. Applicants are required to have Higher National Certificate or equivalent qualifications together with 5 years experience including digital techniques or precision measurements.

Applications should be made to the Personnel Officer at the above address, giving brief details of career to date.

HAWKER SIDDELEY

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with at least two years' experience in British Industry are invited to avail themselves of our Confidential and Free Service.

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E.A.L. is in contact with all firms in B.B. England and undertakes a complete and thorough survey of any area for suitable vacancies for every engineer registered with us.

For further information please phone or write to:
Electronics Appointments Ltd.,
26 Bromsgrove Way,
Cambridge Circus,
London, W.C.2
Phone: TEMple Bar 6557/8

BATTERSEA COLLEGE OF TECHNOLOGY
Proposed University of Surrey

Applications are invited for the post of SENIOR LABORATORY TECHNICIAN in the Electronics Workshop of the Physics Department. Experience in the servicing and development of electronic apparatus is essential.

Salary scale £840 per annum to £1,040 per annum with additions for Qualifications and L.A.

Initial placing on the scale will depend on qualifications and experience. Forms of application from the Staff Officer, Battersea College of Technology, Battersea Park Road, London, S.W.11.

The College will soon achieve full University status and expects to move into new buildings at Guildford within the next few years.
The Civil Service offers an interesting and full career for professional engineers in government departments ranging from Cadetships which provide professional training for young graduates to Chief Engineer appointments with salaries of over £5,000. A booklet giving further details can be obtained from the Civil Service Commission at the address given below.

Current vacancies include the following:

**RADIO AND ELECTRONIC ENGINEERS**

**MINISTRY OF AVIATION**

Qualified engineers required as Assistant Signals Officers in the field of Civil Aviation for the provision and installation of advanced electronic equipment—including the latest type of radar, telecommunications, navigational aids, etc. QUALIFICATIONS: A.M.I.E.E., A.F.R.Ae.S., A.M.I.E.R.E. (September 1962 syllabus), 1st or 2nd class Honours Degree or Dip. Tech. in Electrical Engineering or Physics, or pass in (or exemption from) Institution Examinations, with some experience. AGE: 23 and normally under 35 on 31/12/65 (extension for Forces and Overseas Civil Service). SALARY: On the scale £930 to £1,772 depending on age and qualifications. Good prospects of promotion (Reference: S/85/ASO).

**ASSISTANT PROFESSIONAL ENGINEERS**

**RADIO AND ELECTRONIC ENGINEERS**

Vacancies exist for Electronic, Mechanical and Aeronautical Engineers. The posts are open to young men and women (preferably under 26) who are qualified but lack post-graduate experience. The posts provide an excellent opportunity for obtaining such experience through doing professional work in accordance with a two-three year programme which is planned to meet individual needs.

QUALIFICATIONS: Applicants must have served an apprenticeship or had equivalent practical training, and must have passed or be planning to meet individual needs. Good prospects of promotion (Reference: S/85/ASO).

**FINANCIAL STAFF**

MINISTRY OF PUBLIC BUILDING AND WORKS

Mechanical and Electrical Engineering vacancies in London, provinces and abroad. QUALIFICATIONS: O.N.C. in Electrical or Mechanical Engineering or equivalent, together with an engineering apprenticeship followed by 3 years' practical experience and a responsible position. DUTIES: Supervising the installation, maintenance and operation of electrical and mechanical plant and equipment. Experience of the installation and maintenance of equipment for the application of high power microwaves to concrete breaking and to dry rot and woodworm eradication. QUALIFICATIONS: Degree, Dip. Tech., H.N.C., or equivalent in appropriate subject. Under 22, minimum qualification is 2 G.C.E. 'A' levels in Science and/or Mathematics subjects. Experience in design and measurement of waveguide components preferred. SALARY: A.E.O. £1,094 (at 18)-£1,276; E.O. (minimum age 26) £1,394-£1,675. Prospects of permanent pensionable posts.

**ENGINEER TECHNICIANS**

**DIPLOMATIC WIRELESS SERVICE**

The Diplomatic Wireless Service have vacancies for about 20 posts in (a) Grade II, (b) Grade III.

A.E.O. (minimum age 26) £1,201; E.O. (minimum age 26) £1,319-£1,675.

**EXECUTIVE ENGINEERS**

**POST OFFICE**

Seven posts in London and Provinces for mechanical, electrical and electronic engineers to develop and design communications systems and postal service equipment.

QUALIFICATIONS: Degree or Dip. Tech. in engineering or physics or, exceptionally, very high professional attainment. Final year students may apply. SALARY (Inner London): £685-£1,748. Promotion prospects. AGE: At least 21 and normally under 35 on 31/12/65. Some extensions for service in H.M. Forces or Overseas Civil Service (Reference: S/325).

**MECHANICAL AND ELECTRICAL ENGINEERS**

**MINISTRY OF AVIATION**


**ASSISTANT EXPERIMENTAL OFFICER/EXPERIMENTAL STATION**

ATLOW. SALARY: £1,068-£1,201; £1,109-£1,282; £1,201-£1,319. Job description: Experience of aircraft servicing is desirable either in the field of radio or instrument/electrical.

**ROYAL AIRCRAFT ESTABLISHMENT, BEDFORD**

This Department operates a worldwide network of Radio Communication Stations which is in the process of being modernised and expanded. The duties of Engineers in this field involve the installation, modification, maintenance and operation of radio transmitters and receivers of the most modern types, remotely tuned aerial systems, teleprinter and voice frequency telegraph equipment. In addition several high powered broadcasting stations relaying programmes in both the H.F. and the L.F. bands. The Transmitters involved include some of the highest powers yet produced for this purpose. The duties in this field are divided into three main sections: Installation, modification and operation of these very high power transmitters, the modern receiving equipment, tape recorders, diesel generating plants, etc. The Department's policy is to encourage versatility and to carry out as much installation and modification work as possible with its own staff. The initial appointments will be either to Crowborough, Sussex, or Hanslope, Bucks. Liability for service overseas.

QUALIFICATIONS: O.N.C. in Electrical or Mechanical Engineering or a City and Guilds Telecommunications, Electrical, or Mechanical Engineering Technicians Certificate (Nos. 49, 57 or 293). Good experience in design and installation of equipment for the provision and installation of advanced electronic equipment is essential. Good prospects of promotion. SALARY (national intermin): (a) £1,129-£1,288; (b) £796 (at age 21)-£1,009 (at 20 or over)-£1,129. Promotion prospects. Closing date extended to 18th October, 1966. Candidates who have already applied need not do so again (Reference: S/6116/05).

Except where otherwise stated all the above posts are pensionable, and APPLICATION FORMS may be obtained from:

Marconi test activities

HIGH POWER TRANSMITTER TEST

TEST METHODS

AUTOMATIC TEST PROGRAMMING

ENVIRONMENTAL TEST

There are vacancies in these and other test activities at Marconi's Chelmsford Works, for men with previous experience.

Marconi

Please write, with brief details, to The Marconi Company Limited, Assistant Manager (Works), Group Personnel Services, English Electric House, Strand, London WC2, quoting reference WW/2504E.

The Marconi Company Limited, Chelmsford, Essex
PROFESSIONAL TELEVISION

Cintel Telecine Units

We are expanding our activities in the Cintel Telecine Design Department. There are heavy commitments in the field of high quality flying-spot monochrome and colour television picture generating equipment which is widely used by British and Overseas broadcasters. Additional design staff are required at all levels, and details of some of our current vacancies are shown below. All posts offer attractive conditions and salaries within an absorbing technical environment.

ELECTRONIC ENGINEERS

for work on:—Transistorised flying-spot film and slide scanning equipment. Transistorised wideband amplifiers for use in the signal processing chain of television broadcast equipment.

MECHANICAL DESIGNER

to design film transport mechanisms and associated hardware with the minimum amount of supervision. Previous experience designing precision mechanisms is necessary, and H.N.C. or equivalent qualifications in mechanical engineering would be preferred.

JUNIOR DRAUGHTSMAN

Aged 22 and over, to prepare layouts and piece parts for telecine equipment. Some previous experience is necessary, and a knowledge of printed Circuit layout techniques would be preferred.

Please write with brief details to:

RANK-BUSH MURPHY LIMITED,

The Personnel Officer—Technical Staff,

Welwyn Garden City, Hertfordshire.

THE RANK ORGANISATION LIMITED

INSTRUMENT MECHANICS

Chapelcross Works requires experienced men with knowledge of electronic equipment and/or industrial instrumentation for fault diagnosis, repair and calibration of a wide range of instruments used in nuclear reactors and radiation laboratories. This work involves maintenance of instruments using pulse techniques, wide band noise amplifiers, pulse amplifier analysers, counting circuits, television and industrial instruments used for measurement of pressure, temperature and flow.

Men with H.M. Services, industrial or commercial background of radar, radio, television or industrial or aircraft instruments are invited to write for further information.

HOUSING is immediately available.

For further details, write to—

Labour Manager,

Chapelcross Works,

ANNAN, Dumfriesshire.

THE UNIVERSITY OF SUSSEX

SENIOR TECHNICIAN

IN THE BIOLOGICAL LABORATORY

An ELECTRONICS TECHNICIAN is required for the Biology Laboratory to be responsible for maintenance and construction of electronic instruments used in research and teaching. Opportunities will be available for the design and operation of instruments.

Possession of a National Certificate in Electrical Engineering or equivalent would be an advantage.

Appointment on scale £640–£1,040 per annum according to age and experience, plus a supplementary award of £30 or £50 for certain specific qualifications.

Applications (three copies) giving full details, including age, qualifications and experience, with the names and addresses of two referees should be sent to the Assistant Registrar (Establishment), University of Sussex, Stanmer House, Stanmer, Brighton as soon as possible.
**H.M. GOVERNMENT COMMUNICATIONS CENTRE**

Hanslope Park, near Wolverton, Bucks.

This Establishment is engaged in Research and Development covering an extensive range of communications projects. Graduate Scientists keen to work in this field are required. Areas of interest include:

- **Acoustics**
- **Magnetics**
- **Radio (VLF to microwave)**
- **Infra Red Optics**
- **Signal Analysis**
- **Computer Programming**

Qualifications: A university degree or Diploma in Technology with first or second class Honours. Exceptionally, evidence of high professional attainment would be accepted. All applicants and their parents must have been British subjects at all times since birth.

Salary Scales: Within the range £995 to £2,082 per annum according to age and experience. These posts can lead to permanent and pensionable positions and carry good prospects of promotion to more senior posts.

The Establishment is situated in pleasant rural surroundings within easy reach of several residential areas.

Applications, stating age, qualifications and experience, should be addressed to:

The Personnel Officer, H.M.G.C.C.

Hanslope Park, Hanslope, Near Wolverton, Bucks.

---

**ABC TELEVISION**

**A Career in Television**

A young man with minimum qualification of H.N.C. is required by ABC Television Limited.

The successful applicant will have a good basic knowledge of the theory and circuitry of television transmission equipment and domestic television receivers.

There is an opportunity for the right man to gain experience, and progress within the Company, provided he is prepared to enlarge his knowledge to keep in step with advancing techniques in the industry.

Apply Personnel Manager, ABC Television Ltd., Broom Road, Teddington, Middlesex.

---

**Testers**

required for interesting work on L.F. and H.F. Transmitters. Previous fault-finding experience essential.

The positions available would be of special interest to persons employed in the fault-finding and repair of television who are keen to establish themselves in a position that offers:

- Satisfactory employment
- Five-day week
- Good prospects of advancement
- Staff status
- Sick pay
- Generous salary

Apply: Personnel Manager

Multitone Electric Co. Ltd.

12-20 Underwood St., London, N.1

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**Vacancies in the Composite Signals Organisation**

A limited number of vacancies, offering good career prospects, exist for

**Radio Operators (Male)**

Interviews will be held in NOVEMBER.

Candidates should have a minimum of two years' practical Radio Operator experience.

Write, giving details of Education and Qualifications to:

Recruitment Officer (CSO/3), Government Communications Headquarters, A 'Block, Priors Road, CHELTENHAM, Glos.

---

**ELECTRONICS TECHNICIAN**

**ONC STANDARD**

Required by expanding company producing miniature electro-magnetic units. This is an interesting and progressive position where personal resourcefulness and ability is encouraged.

For further details and an interview please call, telephone or write to:

KNOWLES ELECTRONICS LIMITED

Victoria Road, Burgess Hill. (Telephone 5432—4 lines)
PHYSICIST for Noise Control
to work in Harlow

There is a vacancy in this expanding Division concerned with noise reduction.

The division undertakes:

* Noise measurement and analysis.
* Development of new materials and techniques for vibration damping insulation and absorption.
* Consultancy on industrial noise reduction problems.

* Qualifications: Preferably an honours degree but H.N.C. would be considered.

Some relevant experience is essential.

Salary by negotiation but would be appropriate to qualifications and experience. Generous bonus scheme and other fringe benefits.

Write giving details to Laboratory Manager

Revertex Limited Temple Fields Harlow Essex

SURPLUS HANDBOOKS

<table>
<thead>
<tr>
<th>HANDBOOK</th>
<th>PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>19 Set Instruction Handbook</td>
<td>3/6</td>
</tr>
<tr>
<td>135 Instruction Handbook</td>
<td>3/6</td>
</tr>
<tr>
<td>R.R.O. Instruction Handbook</td>
<td>3/6</td>
</tr>
<tr>
<td>RF Unit 26 Circuit Diagram and Details</td>
<td>1/6</td>
</tr>
<tr>
<td>RF Unit 25 Circuit Diagram and Details</td>
<td>1/6</td>
</tr>
<tr>
<td>RF Unit 24 Circuit Diagram and Details</td>
<td>1/6</td>
</tr>
<tr>
<td>R1355 Circuit Diagram and Details</td>
<td>1/6</td>
</tr>
<tr>
<td>R1224,A Circuit Diagram and Details</td>
<td>3/6</td>
</tr>
<tr>
<td>R1116/A Circuit Diagram and Details</td>
<td>3/6</td>
</tr>
<tr>
<td>18 Set Circuit Details and Notes</td>
<td>1/6</td>
</tr>
<tr>
<td>Wavemeter Class D Instruction Handbook</td>
<td>1/9</td>
</tr>
<tr>
<td>Frequency Meter BC221 Instruction Handbook</td>
<td>1/10</td>
</tr>
<tr>
<td>38 Set Instruction Handbook</td>
<td>1/10</td>
</tr>
<tr>
<td>88 Set Walkie-Talkie Instruction Handbook</td>
<td>1/10</td>
</tr>
<tr>
<td>46 Set Walkie-Talkie Circuit and Notes</td>
<td>1/10</td>
</tr>
<tr>
<td>H.R.O. Instruction Handbook</td>
<td>1/10</td>
</tr>
<tr>
<td>1155 Instruction Handbook</td>
<td>1/10</td>
</tr>
<tr>
<td>W19 Set Instruction Handbook</td>
<td>1/10</td>
</tr>
</tbody>
</table>

INDEPENDENT TELEVISION MIDLAND STUDIOS

Two vacancies have arisen for trainees to work in the Engineering Department at the above studios. Candidates must have a good working knowledge of radio and television fundamentals and a keen interest in the maintenance of complex electronic equipment. The preferred age range is 20-25 years and one of the following types of experience may be suitable:

- Ex-Service Wireless or Radar fitter or mechanic.
- Radio and Television servicing (C. & C. Finalist).
- Keen Radio and Television Amateur.

The salary for this grade is £628 p.a. at the present time and on completion of training salaries in excess of £1,100 p.a. will be paid. Applications must be made in writing and be addressed to—

The Engineer-In-Charge,
Alpha Television Studios,
Aston, Birmingham 6.

SCOTTISH TELEVISION LIMITED

has a vacancy for an

ENGINEER

with experience in Sound Film Recording. Applicants must be fully conversant with 16 mm. magnetic re-recording and transfer techniques. A wide experience in the maintenance of valve and transistorized motion picture recording and reproducing equipment is essential. We offer good salary and working conditions.

Apply in writing to the Personnel and Labour Relations Officer, Scottish Television Limited, Theatre Royal, Hope Street, Glasgow.

INSTRUMENT TECHNICIAN

Required to work in a group engaged on research and advanced development of high vacuum instruments and allied devices. The position is suitable for a person who has completed an apprenticeship in the Scientific Instrument Industry and/or is taking a recognised Technician's course.

Age 21-25. Salary according to qualifications.

Apply: Head of Central Research Laboratory,
Edwards High Vacuum International Ltd.,
Manor Royal, Crawley, Sussex.

ELECTRONIC ENGINEERS

Service Engineers required for London Area and Provincial Offices of well-known Company manufacturing Electronic Desk Calculating Machines. Applicants should possess a sound knowledge of basic electronics with experience in electronics, Radar, Radio and T.V., or similar field. Position is permanent and pensionable. Comprehensive training on full pay will be given to successful applicants. Please send full details of experience to: Service Manager, Sumlock Comptometer Ltd., 102/108 Clerkenwell Road, London, E.C.1.

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Apply in writing to the Personnel and Labour Relations Officer, Scottish Television Limited, Theatre Royal, Hope Street, Glasgow.
ABC TELEVISION

Senior Engineer

Applications are invited for the position of Senior Engineer at Teddington Studios.

Applicants must have considerable experience of studio operation including
the maintenance of all types of television transmission equipment, with
particular reference to video tape recording and associated techniques.

Starting salary will be £1,924 per annum.

Applications, in writing, stating age, qualifications and previous experience,
should be addressed to:

The Personnel Manager,

ABC Television Limited,

Broom Road, Teddington, Middlesex

TEST ENGINEERS

These vacancies are suitable for Engineers who wish to be engaged in testing a
wide range of valve and semi-conductor industrial control equipment, including digital
systems. A working knowledge of electrical/electronic circuitry is essential.

These are interesting permanent staff situations, and the salary paid will be commensurate with ability and experience.

Applications for the above positions, stating age, qualifications and previous relevant
experience, should be addressed to:

Personnel Manager,

LANCASHIRE DYNAMO ELECTRONIC PRODUCTS LTD.,

RUGELEY, Staffs.

TELEVISION DEVELOPMENT ENGINEER

Applications are invited from electronics Engineers for development of television re-
cievers and associated electronic equipment from conception, following through all phases
to production. Applicants should preferably
have experience in a similar capacity, i.e., radio
or television design/development. Engineers
who have a wide experience of servicing will be
given consideration, depending on standard attained.

Applicants should be in age group
25/35 years and must be capable of working on
own initiative. Housing assistance may be given.

Applicants giving details of age, experience, qualifications, if any, present salary, etc.,
Personnel Manager, Ultra Radio and
Television Ltd., Fareham Road, Gosport,
Hants.

MARSHALL 100 channel pulse height analyser re-
mained in any condition: price and details to—

Physics Department, University of Durham, South Rd., Durham City. Tel. Durham 3541 ext. 292

ASTATIC voltage relays 50/60c, YB.02565; Trans-
formers YB.02550; Chokes YB.02551; Condensers
1.6mF, 2.2mF, 4.7mF YB.02552/3/4; Mercury
switches YB.01456; Voltimeters 50/B —Box WW 150, Wireless
World

SAVE on cost of hi-fi. See Audio Supply notice (advert.
No. 111).

A UNIQUE Buy! Recording tape, top brand, Tin.
2,400ft. D.P., 25/-; Tin.
1,200ft, 19/6: P. & P.
1/6 per spool; bargains
in all sizes: s.a.e.
for list; we repair, buy and sell
recorders.—E. C. Kingsley &

EDITORIAL ASSISTANT

required for

ELECTRICAL AND ELECTRONIC TRADER

Must be capable of writing up product
and general news with accuracy and speed.

Some knowledge of the radio, TV and
electrical appliance industries a consider-
able advantage.

Age between 20 and 30.

Apply to The Editor,

ELECTRICAL AND ELECTRONIC TRADER,

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