JULY/AUGUST 1959 · TWO SHILLINGS

Show Preview

Wireless World

ELECTRONICS
Radio · Television

PAGES 348–356 TRANSISTOR CONVENTION.

GE EXPERIMENTAL SILICON TRANSISTOR BY TEXAS
350 INSTRUMENTS.

FORTY-NINTH YEAR OF PUBLICATION

Wireless World

ELECTRONICS, RADIO, TELEVISION

JULY/AUGUST 1959

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JULY/AUGUST 1959
Vol. 65 No. 7/8

Wireless World

We Were About to Say

THE hiatus in the publication of this journal caused by the slow-down and eventual stoppage in the printing industry is very much regretted. Although the June issue was eventually dispatched it was very late, and there was no possibility of producing anything in July. However, the present enlarged issue will help to bridge the gap and bring readers up to date with information of some of the interesting things to be seen at the Radio Show at Earls Court.

Throughout the "rest period," as some of our facetious friends have called it, the editorial staff have continued their normal duties, which include the assessment of events at home and abroad, and the present issue contains first-hand reports of the International Transistor Convention and Exhibition at Earls Court, the Brit.I.R.E. Television Convention in Cambridge, the "Automath" Computer Exhibition and Information Processing Conference in Paris and the French Air Show. Another International Congress on Medical Electronics was also held in Paris, but the full report on this will be held over until our next issue as we feel that any attempt at further condensation would do less than justice to its importance.

Our next issue, due for publication in mid-September will contain a full stand-to-stand report of the National Radio Show (for the benefit primarily of those who are unable to see for themselves, but useful also as a record for future reference), while the October issue will carry a technical review of the Show in retrospect which will look more closely at any new developments and assess the general trend of progress. In these issues we hope to give also some first-hand impressions of developments on the Continent as exemplified by the German Radio Show in Frankfurt, the Dutch Firato in Amsterdam and the International Electro-Acoustics Congress in Stuttgart.

The present spate of conventions and exhibitions, interesting as it is, will not be allowed to take more than its fair share of our space, and we shall continue to provide balanced issues with articles catering for a wide variety of interests and at different levels of technical understanding. While maintaining the standard of articles addressed to the professional we hope to extend our service to the student and the amateur experimenter by more articles of an expository and constructional nature. And there will be occasions when we shall take time off to look at ourselves and perhaps discover that there is a less serious side to what must often appear the grim business of radio and electronics.

Finally, a word of reassurance to our subscribers. To compensate for the loss of an issue in July, subscription periods will be extended by one month.

Eurovision—Five Years

ON June 6th the European Broadcasting Union celebrated the fifth anniversary of Eurovision, for it was on that day in 1954 that eight countries collaborated to bring to their viewers the first of a memorable series of live programme exchanges which have set the pattern for subsequent expansion and improvement. True, there had been earlier pioneer work by the B.B.C. and the French R.T.F. but the "Lille Experiment" of June 1954 marked the establishment of a flexible network which superseded what was until then merely a chain.

The history of the technical development of the system is admirably recorded by E. L. E. Pawley (Chairman, E.B.U. Technical Committee) and M. J. L. Pulling (Chairman, E.B.U. Working Party L) in No. 55a of the *E.B.U. Review* (June 1959). At the present time sixteen television services in twelve countries are able to share programmes, and in 1958 no fewer than 233 exchanges were handled by the co-ordination centre in Brussels.

The sole justification of the Eurovision network is immediacy and this has brought many production problems, particularly in arranging multilingual commentaries. Furthermore, the picture itself is not necessarily an international language. As Jean d'Arcy (Vice-chairman, E.B.U. Programme Committee) writing in No. 56b of the *E.B.U. Review* points out, people of different races "simply don't see the same thing when looking at the same picture. . . . A brilliant theme for a broadcast that seems lively and attractive to the Latin is quite unbearable to the English person; a programme that is thought highly of in one place is forbidden in another. Eurovision became a school for us where we learned tolerance and understanding of others."

Looking to the future, world-wide television is already feasible. Using an airborne relay station the French have already linked Europe with Africa. Transatlantic television by such a method or by satellites would be prohibitively expensive, but by exploiting the principle of redundancy and transmitting only new information in each frame it might be possible to reduce bandwidth and so come within the capacity of the transatlantic telephone cable.

National Radio Show

THIS year's National Radio Show opens to the public at Earls Court on August 26th. Last year's innovation of a section devoted exclusively to audio equipment was such a marked success that the area allocated to this section is this year enlarged. There are nearly 150 exhibitors at the show and of this number 38 are in the audio hall; some are in both sections. Seventy-five per cent of the exhibitors are manufacturers of domestic receiving equipment, the remainder being either users (such as the Services, B.B.C. and I.T.A.), publishers and those providing services for the radio and electronics industry. The manufacturing and retailing sides of the industry have joined forces to provide a comprehensive display and information centre (Stand 401) devoted to careers in the radio and electronics industry.

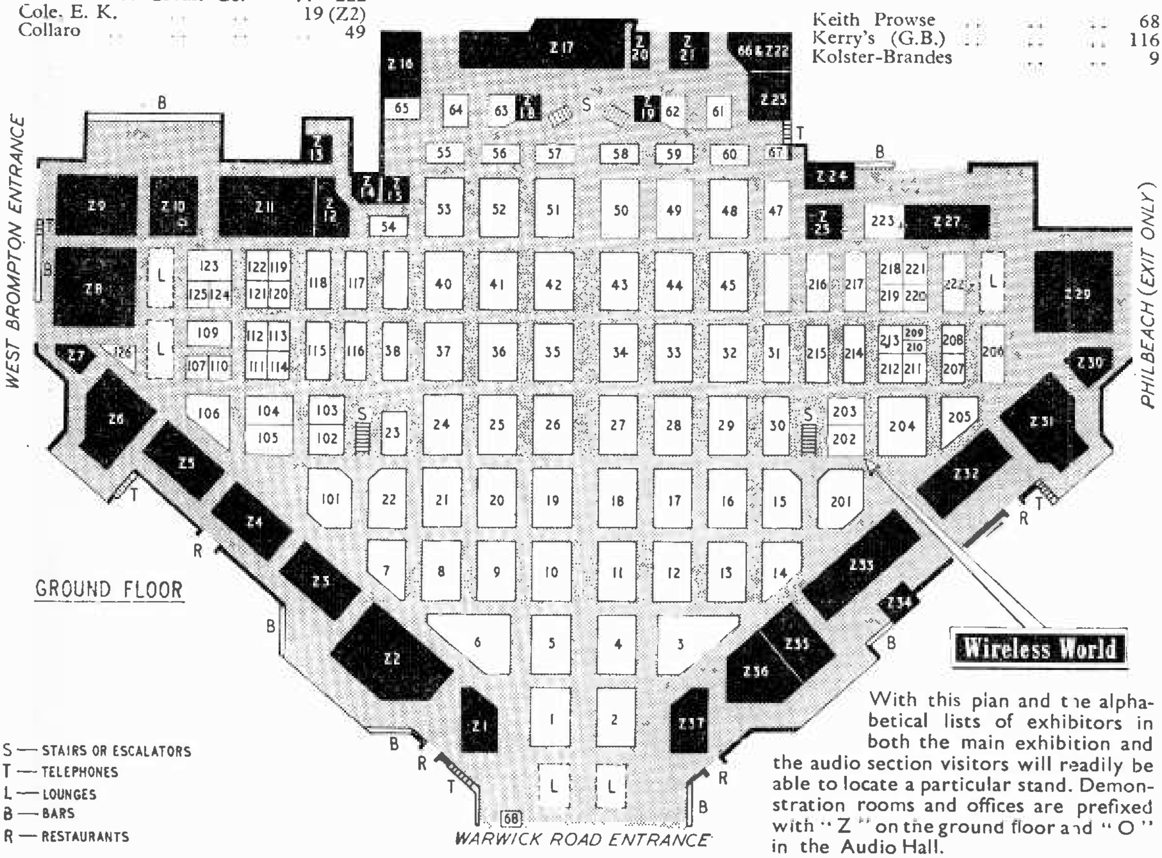
In the following few pages will be found a selection of highlights from the information made available by exhibitors at the time of going to press.

ALPHABETICAL LIST OF EXHIBITORS

Name	Stand
Admiralty	408
Aerialite	22
Air Ministry	409
Airmec	61
Alan-Markovits	109
Alba (Radio & Television)	27
Antiference	15
Barclays Bank	1
Belling & Lee	53 (Z13)
Bernards	126
Bowmaker	208
B.B.C.	410, 411 & 412
British Radio Corporation	214
British Railways	104
Broomhall Joinery	218
Bulgin	59
Bush Radio	6 & 8
"C" Aerials	210
Careers	401
Charterhouse Credit Co.	222
Cole, E. K.	19 (Z2)
Collaro	49

Name	Stand
Co-operative Wholesale Soc.	2
Cossor, A.C.	216
Cossor Radio & Television	50 (Z14)
Daystrom	122
Decca Record Co.	42 (Z6 & Z7)
Design Furniture	103
Domain Products	220
Dubilier Condenser Co.	60
Dynatron Radio	14
E.A.P. (Tape Recorders)	215
E.M.I. Records	55
E.M.I. Sales & Service	52 (Z11 & Z12)
Econasign Co.	209
Electrical & Radio Trading	120
Electronic & Radio Engineer	202
Electrovac Manufacuring Co.	213
Emerson Electronics	32
Ever Ready Co.	28 (Z24)

Name	Stand
Ferguson Radio Corporation	34 (Z5)
Ferranti Radio & Television	36 (Z4)
Fidelity Radio	117
Field & Co.	112
Garrard Engineering	40
General Electric Co.	12 (Z31)
General Post Office	405
Goodmans Industries	23
Greater London Fund for the Blind	404
Grunther Instruments	113
H.M.V. Radio & Television	37 (Z9)
Hobday Bros.	123 (Z10)
Hunt (Capacitors)	54
Independent TV Authority	403
Invicta Radio	48 (Z15)
J-Beam Aerials	7
Johnson Bros.	124
Keith Prowse	68
Kerry's (G.B.)	116
Kolster-Brandes	9



With this plan and the alphabetical lists of exhibitors in both the main exhibition and the audio section visitors will readily be able to locate a particular stand. Demonstration rooms and offices are prefixed with "Z" on the ground floor and "O" in the Audio Hall.

Name	Stand
Labgear	30
Le Grest & Co.	107
Lee Products	118
Linguaphone Institute	219
Lloyds Bank	217
Lugton & Co.	223 (Z27)
McMichael Radio	24
Marconiphone Radio & TV	21
Margolin	45
Martins Bank	106
Mercantile Credit Co.	203
Midland Bank	5
Mullard	43 (Z29, Z30 & Z35)
Multicore Solders	62 (Z19)
Murphy Radio	16 (Z32)
National Inst. for the Deaf	402
National Provincial Bank	204
Pam (Radio & Television)	3 (Z34)
Perdio	47
Perth Radios	207
Peto Scott Electrical Insts.	17
Philco	35
Philips Electrical	18 (Z17 & Z20)
Pilot Radio	20
Pitrie	119
Plessey	66 (Z22)
Portogram Radio	57
Practical Wireless	105
Pye	41 (Z8)
Radio & Allied Industries	26 (Z3)
Radio Gramophone Development Co.	25 (Z36)
Radio Retailing	110
Radio Society of Gt. Britain	407
Radio & TV Retailers' Assoc.	205
Regentone Radio & Television	29
Roberts' Radio Co.	56
Rola Celestion	212
Rose Projects	125
Saga Films	4 (Z37)
Selcol Products	121

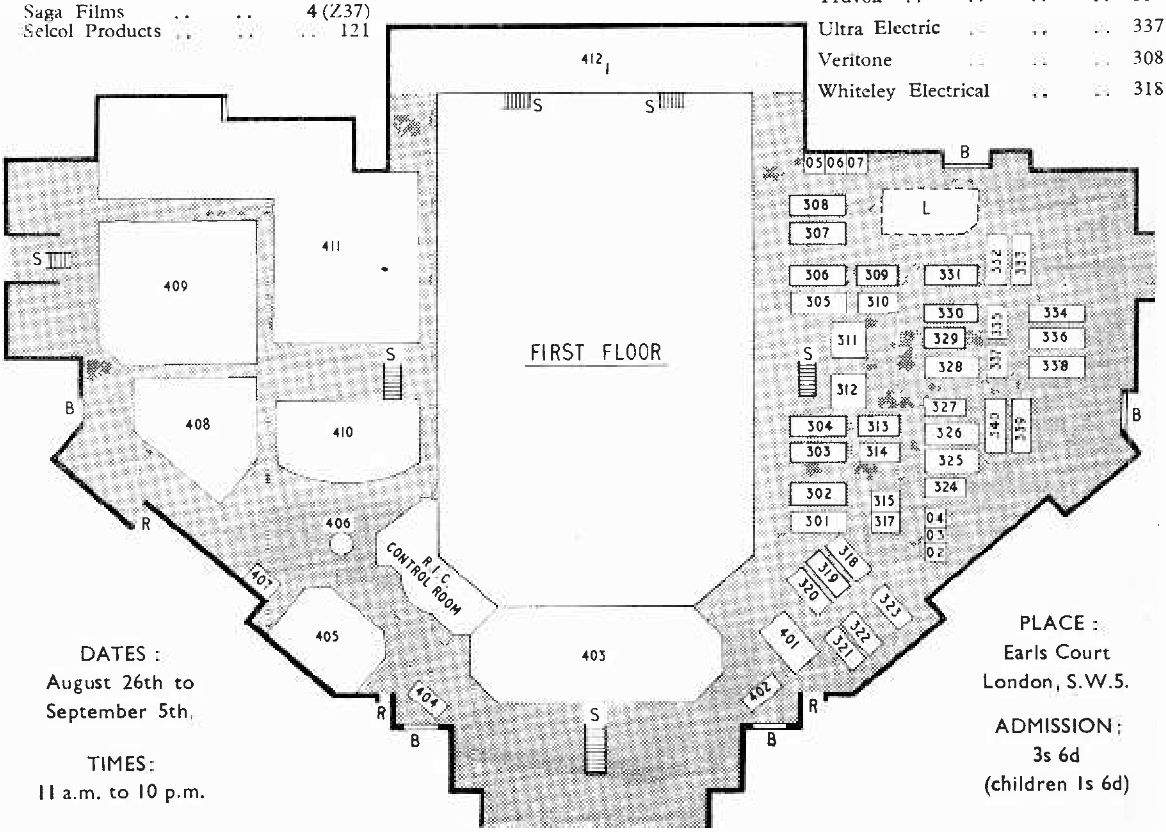
Name	Stand
Siemens Edison Swan	11 (Z33)
Slingsby	115
Spencer-West	114
Standard Telephones & Cables	44 (Z25)
Stella Radio & Television	51
Southgate Tubular Products	111
Tape Recorders (Electronics)	101
Telegraph Condenser Co.	58 (Z23)
Telerection	33
Telesurance	13
The Star	406
Trix Electrical Co.	38

Name	Stand
Ultra Electric	10 (Z1)
Valradio	64
Vulcan Finance Facilities	221
Walter Instruments	206
Waveforms	65
Westinghouse Brake & Signal	102
Westminster Bank	201
Whiteley Electrical	63 (Z18)
Wireless & Electrical Trader	211
Wireless for the Bedridden	67
Wireless World	202
Wolsey Electronics	31

AUDIO HALL (First Floor)

Name	Stand
Alba (Radio & Television)	327
Amplion	338
Associated Electronic Engrs.	309
Ava Sound Enterprises	335
BTH Sound Equipment	307 (05)
Beam-Echo	306 (06)
Brenell Engineering	333
Celestion	305
Cole, E. K.	328
Collaro	330
Cosmocord	304
Decca Record Co.	339 (03)
Dynatron Radio	325
E.A.P. (Tape Recorders)	319
E.M.I Records	323
E.M.I. Sales & Service	303 & 322
Electric Audio Reproducers	320 (02)
Electronic Reproducers	340
Expert Gramophones	329 (07)

Name	Stand
Ferranti Radio & Television	301
Garrard Engineering	336
General Electric Co.	302
Goodmans Industries	334
Hi-Fi News	317
Kolster-Brandes	321
Lustraphone	312
Metro-Sound Mfg. Co.	314
Philips Electrical	331
Portogram Radio	313
Reps (Tape Recorders)	310
Scientific & Technical Dev.	324 (04)
Simon Sound Service	326
Tape Recording	315
Tripletone Mfg. Co.	311
Truvox	332
Ultra Electric	337
Veritone	308
Whiteley Electrical	318



DATES:
August 26th to
September 5th.

TIMES:
11 a.m. to 10 p.m.

PLACE:
Earls Court
London, S.W.5.

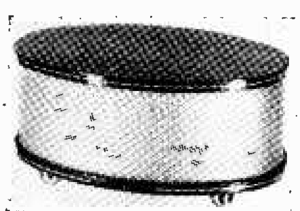
ADMISSION:
3s 6d
(children 1s 6d)

NATIONAL RADIO EXHIBITION

Highlights of the Show

THE innovation of an Audio Hall, combined with the surge of activity in stereophony, made sound, rather than vision, the predominating interest at last year's Radio Show. This year the pattern seems to be repeated, although the following selection of items will show that there has been no lack of development in other branches of the industry.

"**Stereo in one Box**" is more common than last year. Usually, if desired, one or more extension speakers can be connected so as to extend the overall sound field beyond the cabinet. In the E.A.R. Model 500 single-cabinet reproducer the speaker compartments can be spaced up to 5 feet apart or, if greater separation is required, detached altogether from the main cabinet.



Unusual styling is a feature of the K.B. "Stereovox" extension loudspeaker.

Tape Magazine is provided for the new Garrard "Bichette" deck to make the tape easier to handle. The magazine contains two 4-in diameter spools of double-play tape giving about 35 minutes playing time for each track at the tape speed used ($3\frac{3}{4}$in/sec). The spools are so arranged in the magazine that, when the magazine is slotted into its correct position on the tape deck, the tape is already in the correct position for recording or playback.

Low-tracking Weight crystal pickup heads shown by Cosmocord include a stereo model which will track at about 2gm and, tracking at 0.3gm, an improved version of the single-channel pickup described by J. Walton in our April issue. These pickup heads are fitted to the low-friction vibration-stabilized X286 arm which was described in our June issue. An inexpensive low side-thrust arm designed expressly for use with stereo pickup heads is also on show.

Stereo Balance with dissimilar response loudspeakers is simplified in the Tripletone Stereo 5-5 and 12-12 amplifiers and pre-amplifiers by provision of concentric twin middle-frequency as well as bass and treble controls. Conversion to stereo of the Tripletone "Convertible" single-channel amplifier and pre-amplifier is made easier by extending the control spindles on both sides of the potentiometers so that, if two "Convertibles" are bolted together front-to-back, corresponding controls can be ganged together.

Better Television Sound reproduction is becoming more common. Forward facing speakers appear in many sets—the elliptical type being used to save space—and several models have two speakers, one on each side of the screen. This last trend gives a symmetrical arrangement which is often combined with a bow-fronted cabinet.

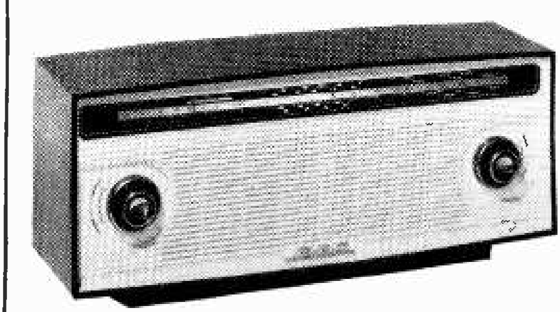
Television and Radio Distribution equipment is shown by Aerialite, Belling & Lee and Wolsey Electronics. The Wolsey Electronics systems can distribute Band-III signals on their own frequencies, or the Band-III programmes can be "translated" to a Band-I channel for distribution over large areas. V.H.F./f.m. can also be distributed on the original frequencies by the system. Another valuable feature is that other programmes, such as Radio Luxembourg, can be translated to a v.h.f./f.m. signal, allowing the use of a combined v.h.f./TV receiver, or a v.h.f.-only receiver instead of an a.m./f.m. set.

"**Sounds Fantastic**"—a demonstration of sound recording given at frequent intervals by the B.B.C.—includes recorded comparisons of v.h.f. and medium-wave reception and recordings from the B.B.C. archives.

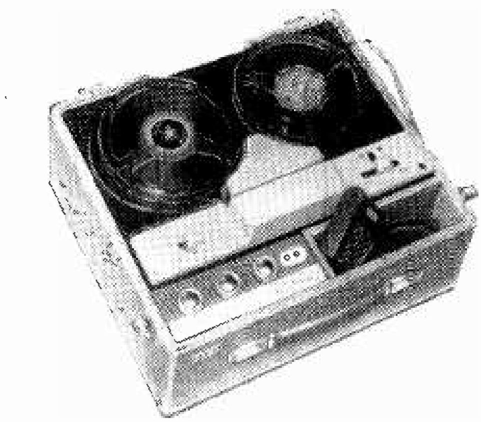
Local Oscillator Stability in f.m. receivers can be assured in two ways—by an a.f.c. system, or by crystal control of the oscillator. As a desirable means of tuning is push-buttons or a switch, crystal control is particularly suitable. S.T.C. are showing among their range of quartz-crystal units a three-crystal assembly on a single B7G valve base.

Video-tape recording is being demonstrated by Tyne-Tees Television, the north-eastern programme contractors, on the I.T.A. stand. The equipment used is a mobile version of the standard Ampex video-tape recorder.

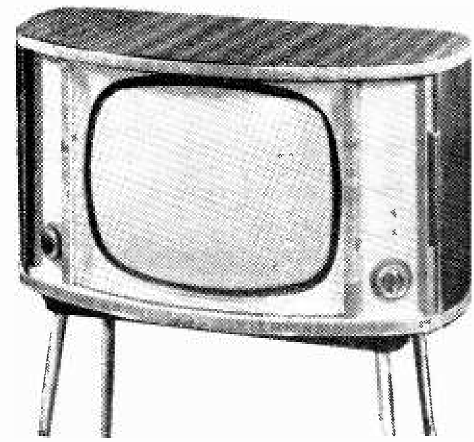
Easier Servicing is a major consideration in the design of many television sets. One recent trend is the use of detachable circuit panels. Decca have a hinged chassis on three models which swings out at the back of the set to give easy access. McMichael have a chassis which unclips and can be withdrawn. Alba's



A "long-low" style is being adopted by several manufacturers this year. One example is the Ferguson "Futurist" a.m./f.m. receiver; another is the G.E.C. BC402 a.m./f.m. receiver, shown here.



Tape level indicators using two neon lamps are not very often seen. The neons are arranged to light at different levels so that, by making the loudest sounds light one neon but not the other, the peak recording level can be restricted between two values. Two examples of this type of indicator may be seen in the Alba R59 (shown here) and R.G.D.MK103 recorders.



Slim television receivers, based on the short-necked 110° tube, are displayed by almost all set manufacturers this year. 17-inch and 21-inch screens are the most popular sizes. Advantage is taken of the shape of the 110° tube to produce bow-fronted cabinets which avoid to some extent the "boxy" look of conventional designs. The 17-inch G.E.C. BT304, shown here, has a curved protection glass following the line of the cabinet. Other designs are wedge-shaped, diminishing towards the back.

"packaged service" system, introduced last year, in which 90% of the components are mounted on two replaceable plug-in printed-circuit panels, has been extended to three new models.

Car Aerial Sockets for transistor receivers have already been featured by Perdio and are now provided by many manufacturers. The use of an external aerial in a car avoids changes in the signal input level from the directional internal ferrite-cored aerial as the car moves about. Another new type of socket which is being increasingly provided on all types of receiver is one for feeding the input of a tape recorder.

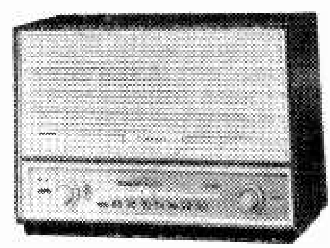
Definition Control by push-buttons in television receivers introduced at a previous Show, is not widely used, but has been continued in two Stella sets, the 21-inch ST. 1001U and the 17-inch ST. 1007U. One button is for "soft" pictures and the other for "crisp" pictures.

Selectivity varying automatically to give the optimum signal-to-noise ratio at various signal input levels (a stronger signal produces a wider bandwidth) is one of the unusual features of the new Perdio "Continental" transistor receiver. Other unusual features of this receiver include an 87-197 metres short-wave band, a loudspeaker as large as 8in by 5in, and fixed bass boost to partially compensate for acoustic losses due to the small cabinet.

In-the-room Aerials are continuing to gain in popularity, due in part to the increasing number of transmitters and improved receiver performances. At last year's show there was a large number of set-top small "V"s. This year Belling-Lee introduce a new V aerial designed for use in areas where the small Vs do not provide enough signal. Called the "Metropolitan," this aerial features elements which extend to about 40in and a tunable matching network in the base pedestal. This network can be adjusted by a "front-panel" control.

Tape Tracking in Both Directions is possible with the new Truvox R7 recorder. Thus both tracks on the tape can be recorded or replayed without having to turn the reels over. Other unusual features of this recorder are a "slide" volume control, and the provision of two alternative fast forward and rewind speeds to permit more accurate selection of a particular position on the tape while fast winding. Two other new tape recorders are also introduced by Truvox.

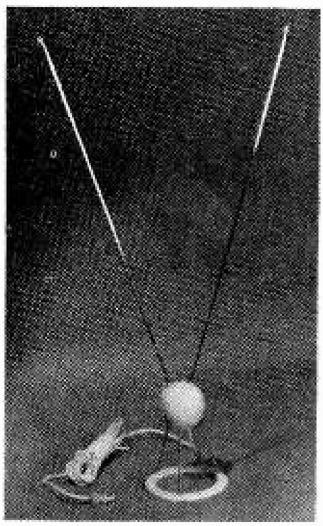
Simplified H.T. Supplies for television sets become possible by the use of silicon junction diode rectifiers. S.T.C. are showing one inexpensive type rated at 400 volts p.i.v. and 500mA up to 50°C ambient temperature. R.G.D. are using them in their latest 17-inch and 21-inch television sets with 110° tubes—the models 610, 611L and 710.



F.M.-only receivers are not very often seen, although their numbers are somewhat increased this year by new models being shown by Ferranti (see photograph), H.M.V. and Ferguson.

Diplexers are usually thought of in connection with television as devices for combining Band-I and Band-III aerial leads, or separating signals in these bands which have been carried on a common lead. Where two Band-III programmes are available, it has hitherto been necessary to change aerial leads when separate directional aerials have been used. Labgear introduce now a diplexer for the combining of Channels 9 and 11 onto one cable. It is claimed to have a negligible insertion loss.

X-Aerial Range of Choice is extended this year. The Wolsey Type X75 is for Band-I stations only, while Labgear have a complete range of combined Band-I/III types. These new aerials feature improved feeder-to-aerial matching. The Labgear series provides not only for independent orientation of the Band-I and Band-III sections, but also for adjustment of the two sections for different linear polarizations of the Band-I and Band-III transmissions.



"Sputnik"-shaped, Labgear's new set-top aerial receives Band-I, -II, and -III stations in areas of good signal strength.

Bass Tone Controls are being increasingly provided in addition to the more usual treble controls even, for example, in relatively inexpensive radio-grams.

Full D.C. Component of the video signal is said to be retained in the Alba 17-inch television receiver, T656. This is an unusual feature not found in the majority of sets nowadays.

Slim Television Trolleys have been introduced for the new slim-cabinet receivers with 110° tubes. As an example one model by Whiteley has a table top measuring 19in × 13in.

Components shown by Dubilier include ganged volume controls for stereo and subminiature electrolytic capacitors for printed circuit and transistor applications. Featured on T.C.C.'s stand is a working model of a rocket-telemetry apparatus illustrating the use of this company's printed-circuit switch panels.

Clock-switched Receiver shown by Ekco, the Radio-Time, incorporates an alarm clock. It can be arranged that, at a predetermined time, the receiver and also a 5-amp mains supply are automatically switched on, and that after any predetermined period up to an hour the receiver is switched off.

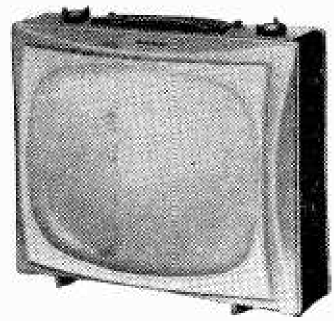
Ipswich is in an area which will receive a reasonably good Band-III signal; but the Band-I transmitter is some distance away. Both Belling-Lee and Antiference introduce new aerials designed for this type of location. The Antiference aerial—Type HL303—has Band-I and Band-III sections of three elements each. The Belling-Lee Type 24A has two Band-I and four Band-III elements, and fits in with the firm's "Unit Plan" system for choosing from a variety of masts and lashing-kits.

Polaroid Television Filters are a new feature to be seen in this year's range of television receivers by Pam. The filters are said to eliminate reflected light completely so that receivers can be viewed with all room lights on or in daylight without darkening the room. In addition the tonal quality of the pictures is said to be improved.

Sound Volume Expansion is an unusual feature of a tape recorder shown by Amplion. From 6 to 8dB can be provided using lamps in a balanced bridge circuit.

Stereo Recording facilities are not very often provided even where stereo playback is possible. Exceptions to this rule are, in the field of tape recorders, the Reflectograph Model 570 and a new Veritone "Venus" model, and, in the field of microphones, the Lustraphone double ribbon model and a new twin crystal microphone shown by Cosmocord.

Revivals of old technical ideas include "variable selectivity" in the Ekco export a.m. receiver Model A733, and "bandspreading" for the short-wave bands in two new Philco receivers. New versions of old ideas in styling include a thermometer-like station indicator on the G.E.C. a.m. receiver Model BC401 and, on Ekco and Ferranti receivers, a pair of tuning scales, each of which is printed upside-down relative to the other to allow easy reading of the station names with the receiver at any angle. Another increasingly common styling feature is the employment of edge-on control knobs outside their usual field of television receivers.



Shorter 110° tube, the 17-inch CME1705, developed by Siemens Edison Swan, is used in this Ekco TP347 receiver to give what is claimed to be the slimmest-ever portable television set. The tube has a new type of electrostatic focusing system, based on a cylinder lens, in which focusing action takes place over a shorter distance than normal. As a result the tube length (11 inches) is about 1¼in shorter than the equivalent 110° 17-inch tube of orthodox gun design.

Band-III Aerials of high gain, good back-to-front ratio and negligible side-lobe response are often required for "de-ghosting," especially in fringe areas. New eleven-element aerials by Antiference and Labgear feature these characteristics, and aerials by C Aerials, Ltd., have a specially shaped folded dipole to achieve these ends. It is claimed that, with the shaped dipole, side lobes virtually disappear, and a reflector is not necessary. Band-I elements can be fitted to the Band-III arrays and a transparent junction-box cover enables inspection of the connections to be made without unsealing the box.

9x2mm, sub-miniature wire-ended fuses in a range of values between 60 mA and 1A are shown by Bulgin.

New Horizons in Computing

PARIS INFORMATION PROCESSING CONFERENCE AND "AUTOMATH" EXHIBITION

"THE day is rapidly drawing near when digital computers will no longer be made by assembling thousands of individually manufactured parts into plug-in assemblies and then completing their interconnection with back-panel wiring. Instead, an entire computer or a large part of a computer probably will be made in a single process. Vacuum deposition of electrodes on blocks of pure silicon or germanium and the subsequent diffusion of the electrode material into the block to form junctions is a most promising method. The successful development of this method would allow large numbers of transistors and all of their interconnecting wiring to be made in one operation. Vacuum deposition of magnetic materials and conductors to form coincident-current magnetic core memory planes is a second promising method that will allow an entire memory to be made in one operation. The vacuum deposition of superconductive switching and memory circuits is a third method that will make possible the printing of an entire computer."

Advanced Engineering

The above quotation is from a paper by K. R. Shoulders and the late D. A. Buck (inventor of the cryotron) which was read by A. Baker at the International Conference on Information Processing held recently in UNESCO House in Paris. While the Conference was not by any means restricted to the engineering design of computers, but included sessions and symposia on such things as mathematical methods, linear programming and machine translation of languages, it did contain a group of papers of rather special appeal to electronics people. Summed up by the paragraph above, they dealt with the advanced engineering methods of the future which may well become known as "third generation" computing techniques.

At the moment we have the "first generation" of electronic computers, which are thermionic-valve machines. These are already on the market, and we are now rapidly passing into the "second generation" of transistor and magnetic-core machines, which have emerged from the laboratories and are on the point of becoming commercial. Although the conventional transistor seems an ideal component for computers it does not prevent the researchers from developing this "third generation" idea which sees the manufacture of computers more in terms of chemical processing than electronic assembly.

But what is the real need for this new approach? What advantages does it offer? There is, of course, the ever-present drive towards simpler and cheaper methods of fabrication. But the main purpose of the new line of development is the achievement of higher speeds of operation. At present the speed of information transfer in electronic digital computers is in the region of 10^{6} binary digits per second. Advanced transistor techniques are likely to increase this by a factor of 10 quite soon. But many applications are envisaged for which speeds in the region of 10^{9} bits/second are required. This is particularly true of the future class of computers which will have the property of "learning" by trial-and-error methods and will form part of self-adaptive control systems*. An essential feature of their operation is the execution of a great many random trial calculations before the optimum control condition is obtained, and here extremely high speed is required if the computer has to work in the natural time scale of the control system.

With digit pulses of millimicrosecond length the problem arises of time delays in the transfer of information through the computer due to the finite speed of the conduction of electricity. For electrical signals in free space the upper limit is the speed of light. In solid conductors, a signal travelling a mere matter of 6 to 8 inches takes 1 millimicrosecond. One can see, then, that machines with dimensions and wiring lengths of the order of several feet would create difficulties in the precise timing arrangements which are so important to the correct operation of digital computers (because time intervals represent numerical values).

This means, in general, that no computer for this 10^{9} bits/second order of speed can be much more than 2 feet cubed in size. It also means that such a small size places a limit on the allowable power and heat dissipation of the circuitry. Many conventional electronic components are therefore ruled out, not only on the score of size but also because their power consumption is too high.

Superconductive Components

The three main groups of components which are at present being investigated for possible use in these small-size high-speed computers are mentioned in the opening paragraph—semiconductor "solid circuits," magnetic film devices and superconductive components. All lend themselves to the fabrication of circuitry by "printing" methods, and, in fact, the term used by Buck and Shoulders in their paper is "microminiature printed systems."

Actually this paper is concerned more with superconductive (or "cryogenic" as they are sometimes called) components than the others. It describes experimental work which has the ultimate aim of printing cryotrons small enough to fit into 1-micron squares. Conductors will have to be only 0.1 micron in width. The basis of the method is the selective etching away of a deposited metal film, but some very unusual processes are involved. The original metal film (e.g. lead or tantalum) is deposited on an insulating base by vapour plating. A "resist" or protective pattern is then formed on this by electron bombardment in the presence of hydrocarbon or siloxane vapours. The bombardment causes polymerization of the vapour and so produces a deposit

* See "Learning Machines," *Wireless World*, January, 1959, issue.
† "Superconductivity," *Wireless World*, July, 1957.

on the metal film where the electron beam is directed. Finally, the unprotected metal, not covered by the "resist," is etched away by a vapour process, using a suitable gas for the metal concerned (e.g., chlorine for molybdenum films).

The magnetic devices so far investigated for printed computers are based on very thin magnetic films of a few hundred to about a thousand angstrom units. Very little has been done on logical switching elements but considerable experimentation has been devoted to magnetic storage systems. These consist of regular arrays of small circular spots of magnetic material, a few millimetres in diameter, deposited by evaporation on to glass bases. Each spot acts in much the same way as a ferrite toroidal core in the familiar matrix type of magnetic store. The material has a rectangular hysteresis loop and it can be switched from one direction of magnetization to the other by currents passing through adjacent conductors, which can be printed on both sides of the glass base.

Actually the magnetic spots are given a preferred direction of magnetization, or uni-diametrical anisotropy, by evaporating the material (e.g., Permalloy) on to the glass base in the presence of a steady magnetic field. In operation the spots change from one direction of magnetization to the other by a simple rotation of the magnetization. Coincident-current methods can be used for the driving system, as in the present ferrite toroidal-core type of matrix stores.

A paper by J. I. Raffel and D. O. Smith described an experimental magnetic film store for 32 ten-bit words which used 1.6-mm spots centred 2.5mm apart, but it is thought that spot densities of the order of 1,000 per square centimetre should be obtainable. Apart from this possibility of large storage density, the main advantage of the magnetic film is its low switching coefficient—defined as the product of switching time (microseconds) and applied field (oersteds). This is at least ten times smaller than the value for ferrite toroids, so in general one can obtain much faster switching times and use much smaller driving currents. Experiments have indicated, in fact, that switching times in the range 1-10 millimicroseconds are possible.

Parametric Oscillator Devices

The problem of time delays in high-speed computers can, however, be tackled in another way besides that of straightforward size reduction. The technique is to use lengths of conductors which are precisely related to the phases of the signals—in other words, transmission lines. This, in fact, is being done in experiments on a new class of parametric-oscillator‡ computing circuits working at microwave frequencies. A paper by J. Wesley Leas described a parametric oscillator system which can be used to gate, amplify and store binary information expressed in terms of two possible phases of the oscillation (see Fig. 1). The oscillation frequency was 2,000Mc/s and the pump frequency 4,000Mc/s.

It is probably true to say that this work actually stems from the original discovery in 1954 by Eiichi Goto, a Japanese scientist of Tokyo University, that parametric oscillators can be used for binary computing circuits**. The computing elements so formed were named "parametrons" and were ex-

‡ For explanation see "Mavars," *Wireless World*, May, 1959.
** See, for example, British Patent 778,883 (1954).

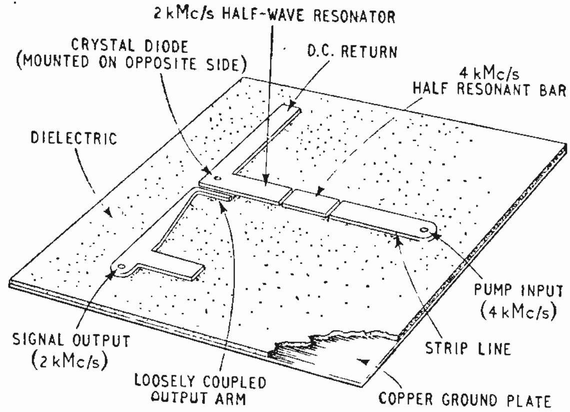


Fig. 1. Construction of microwave parametric-oscillator computing element.

tensively developed in Japan for building digital computers, and now about fifty per cent of the machines in that country make use of them for logical circuitry. It was noticeable in the "Automath" exhibition at the Grand Palais in Paris that, of the 27 exhibitors, four were Japanese firms and all showed parametron computers. (Incidentally, there was only one British stand—Standard Telephones and Cables—and that was present as part of its own international group and displayed a computer designed by a Dutchman.)

As already mentioned, the parametron is basically a parametric oscillator. It has a pump frequency which is twice the oscillating frequency, and the pump signal maintains the parametric oscillation in a resonant circuit by periodically varying the reactance of one tuning element of the circuit. In most of the Japanese machines the variable reactance is a ferrite-cored inductor (see Fig. 2). Because the pump signal is twice the oscillation frequency, it is possible for the oscillation to have either of two phases, 180° apart. These represent the two states, "0" and "1," of the binary circuit. Which state (i.e., phase) the circuit is in at any moment is determined by the forcing or locking effect of the input signal to the parametron. This is a small signal at the oscillation frequency coming from previous parts of the computing system, and it has a phase, representing "0" or "1," which has been determined by previous logical operations.

The linking of parametrons into complete arithmetic circuits is done on the principle of "ballot box" or "majority decision" logic. The outputs of an odd number of parametrons (usually three) converge as primary windings on a transformer whose secondary provides the state-determining signal for the succeeding parametron. If two of the outputs have the "1" phase of signal and the third output has the opposite "0" phase, then by simple cancellation the signal produced at the transformer secondary will have the "1" phase and will trigger the succeeding parametron into the "1" condition.

For "AND" and "OR" gating operations, one of the three inputs to a parametron is arranged to carry a permanent signal, "0" or "1." If a "1" is used for this, a "1" signal applied to either or both of the other two inputs will produce a "1" output at the secondary—that is, an "OR" gate. If a "0" phase is used for the permanent signal input, then a "1" output will be obtained only if a "1" signal is applied to *both* of the other two inputs simultaneously—in other words, an "AND" gate. From such arrangements complete arithmetic circuits can be built up on well-established principles.

Since it is necessary for the parametron to be continually changing its state the oscillation has to be periodically quenched, so that after each quenching it can be started again in a new phase. This is done by a square-wave pulsing system which, in fact, provides the clock pulse or synchronizing signal of the whole computer. Each pulse must, of course, allow several cycles of oscillation to occur in order to establish a binary digit, "0" or "1," on the phase principle, so the clock frequency necessarily has to be somewhat lower than the parametric oscillation frequency. Most of the Japanese machines are restricted by their variable reactors to oscillation frequencies of about 1Mc/s and consequently the clock p.r.f. is limited to the 100kc/s region. This, in fact, is one of the main disadvantages of the existing computers because of the limitation it sets on the speed of the arithmetic circuits.

The obvious way of overcoming this limitation is to use very much higher frequencies of parametric oscillation. This, in fact, is what has been done in the system described by J. Wesley Leas. His 2,000Mc/s oscillator takes the form of a half-wave resonator, constructed on the strip line principle by photographic engraving of a copper-clad insulating board. The variable reactance element in the resonator is a semiconductor diode, and the capacitance of this is varied by the 4,000-Mc/s pump signal delivered through another resonant system. Regarding the device as an amplifier of the small input triggering signals, the gain is about 5 times. With the 4,000-Mc/s pump signal the digit pulse rate can be up to 4×10^{8} pulses per second. Advanced experiments with oscillators using wave-guide components and pump frequencies of 10,000Mc/s suggest that digit rates as high as 2×10^{9} pulses per second (2,000Mc/s) might be possible.

A good many sessions at the Conference were devoted to the logical design of computing systems. This subject is nowadays considered more the province of the mathematician or programmer than the electronic engineer, but even so the engineer has to be brought into it eventually. One recent trend in logical design is the speeding up of computation by what amounts to "time and motion study" in the organization of the machine's facilities. Another trend is towards more complete utilization of the computer by systems in which several programmes of calculation can be run at the same time. This idea was exemplified at the "Automath" exhibition by two Continental computers—the French Gamma 60 (Compagnie des Machines Bull) and the German ER56 (Standard Elektrik Lorenz)—both of which were transistor machines.

The basis of the idea is to divide up the computer into a number of autonomous units (for example a storage system can be divided into several sections) which can be used independently instead of acting as a complete interlocking assembly. These units already exist to some extent in conventional computers (e.g., arithmetic unit, store, input equipment, output equipment) but in normal operation are dependent on each other. The calculation proceeds from unit X to unit Y, and while Y is working X is left idle. But in the newer machines, while Y is working X is used for part of another calculation. This system, of course, calls for a central programme control unit for distributing the work (the sections of different calculation programmes) to the units when they become available. It also has to ensure that the several programmes do not become mixed up! In the Gamma 60 machine this programme control unit is called the "central controller"; in the ER56 it is called the "traffic pilot."

"Intelligent Machines"

Other sessions at the Conference dealt with new character recognition schemes based on the morphological rather than the geometrical approach (in which the recognition depends on the positions of "picture elements" relative to the frame of reference). In so far as these morphological methods are able to cope with characters in unfamiliar positions (upside down, say) they might be regarded as more "intelligent" than previous schemes. But perhaps the most advanced sortie into the field of "machine intelligence," as it is called, was a paper delivered by R. Grimsdale of Manchester University which demonstrated the ability of a computer to do crea-

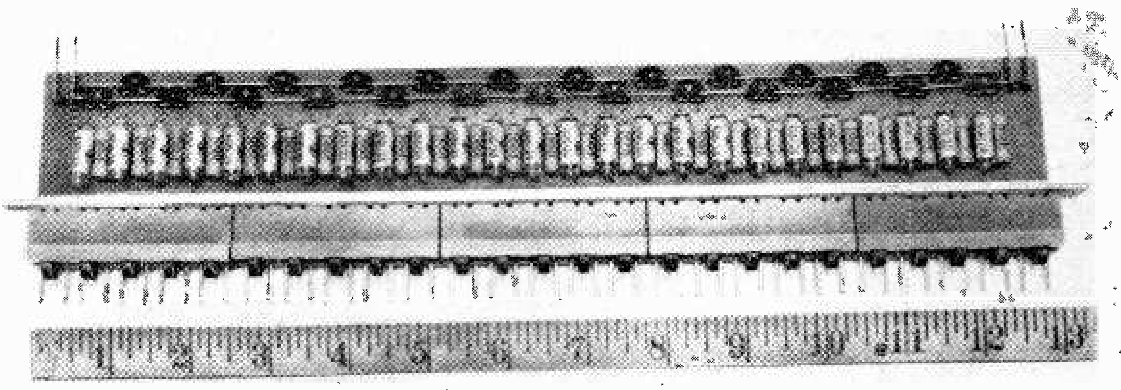


Fig. 2. A unit from a Japanese parametron computer (25 parametrons). The small black semi-circles at the top are the ferrite cores of the variable reactors. Along the bottom are the ferrite cores of the input transformers.

tive thinking. This thinking takes the form of constructing programmes which satisfy certain criteria. The criteria are supplied by human beings, but the human beings have no idea of what form the invented programmes will take. In fact the experimenters admit to being agreeably surprised at the resourcefulness of the machine in producing hitherto unthought-of programmes!

Some degree of randomness is an essential part of creative activity, and in fact the machine operates by generating random sequences of instructions and modifying these by the trial-and-error "learning" process* until the programme conforms to the criteria. For this purpose the programme is performed and tested on a "sub-computer" which is actually the same machine used in a different way. Eventually Dr. Grimsdale and his colleagues hope to devise a thinking machine which will invent its own criteria, based on certain logical concepts. After this, to end with another quotation, "Purposeful thinking to human advantage can only follow if the machine is given contact with the outside world. . . ."

* See "Learning Machines," *Wireless World*, January, 1959, issue.

BOOKS RECEIVED

B.B.C. Engineering Monographs

No. 21 "Two New B.B.C. Transparencies for Testing Television Camera Channels," by G. Hersee, A.M. Brit. I.R.E., and J. R. T. Royle. Pp. 19; Figs. 10.

No. 22 "The Engineering Facilities of the B.B.C. Monitoring Service," by C. J. W. Hill, A.M.I.E.E., A.C.G.I., and H. S. Bishop, Assoc.I.E.E. Pp. 16; Figs. 11. Describes equipment used at the Caversham receiving station.

No. 23 "The Crystal Palace Band I Television Transmitting Aerial," by W. Wharton, A.M.I.E.E., and G. C. Platts, B.Sc. Pp. 15; Figs. 9.

No. 24 "The Measurement of Random Noise in the Presence of a Television Signal," by L. E. Weaver, B.Sc., A.M.I.E.E. Methods based on the sampling of random noise in minimum energy regions of the video spectrum. Pp. 16; Figs. 5.

The price of the above, which are obtainable from B.B.C. Publications, 35 Marylebone High Street, London, W.1, is 5s each.

Metal Industry Handbook and Directory 1959. General properties of non-ferrous metals and alloys, tables of data and lists of suppliers. Pp. 564+XVI. Price 21s. Iliffe & Sons Ltd., Dorset House, Stamford Street, London, S.E.1.

Radio Engineer's Pocket Book, by F. J. Camm. Twelfth edition of a compendium of useful formulæ and figures. Pp. 178. Price 6s. George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2.

British Standard Specifications

3040: 1958. "Radio-frequency Cables for use with Domestic Television and V.H.F. Receiving Aerials." Pp. 15. Price 4s 6d.

3041: 1958. "Television and V.H.F. Broadcast Receiving Aerial Feeder Connectors." Pp. 10; Figs. 3. Price 4s.

3045: 1958. "The Relation Between the Sone Scale of Loudness and the Phon Scale of Loudness Level. Pp. 7. Price 3s.

3081: 1959. "Basic Dimensions for Printed Wiring." Recommendations for rectangular grid dimensions, fixing holes, strip width and minimum spacing, etc. Pp. 6. Price 3s.

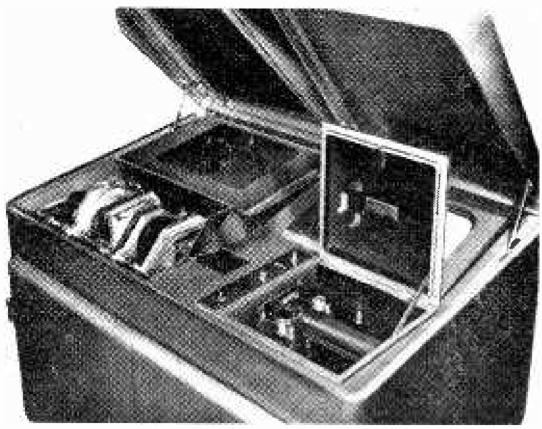
2134: Part I: 1959. "Fixed Electrolytic Capacitors." General requirements and tests. Pp. 15. Price 7s 6d.

The above are obtainable from British Standards Institution, 2 Park Street, London, W.1.

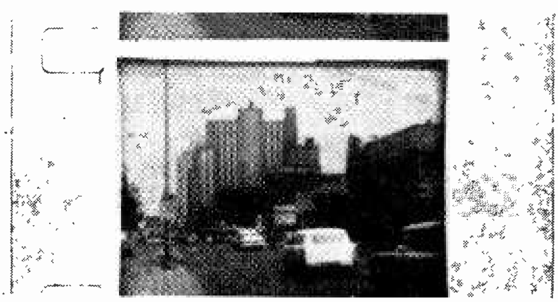
Electronic Apparatus for Biological Research, edited by P. E. K. Donaldson. Contains a great deal of standard electronics theory and practice, but with some chapters on transducers, electrodes and complete circuits peculiar to biological work. Pp. 730; Figs. 949; Plates 47. Price £6. Butterworths Scientific Publications, 4 and 5 Bell Yard, London, W.C.2.

Noise in Industry. Edited by A. E. Stevens, B.A. (Oxon), B.Sc., F.Inst.P. A review of the effects of noise on hearing and possible methods of amelioration. Pp. 6. Issued for the information of managements by Amplivox, Ltd., 2 Bentinck Street, London, W.1.

High-speed Facsimile



Film scanning unit developed by the B.B.C. for the rapid transmission of motion pictures over the transatlantic cable for subsequent TV broadcasting. A specimen frame of 16 mm film, as received, is shown (below). Some details of the system are given on page 362 of this issue



WORLD OF WIRELESS

International Regulations

AT irregular intervals an international conference is called by the International Telecommunication Union to revise the regulations on which the operation of all radio services is based, and to deal with technical and administrative matters coming within the terms of the International Telecommunication Convention.

The revision of the regulations now in use, which were drawn up at Atlantic City in 1947, is the main task of the conference which opened in Geneva on August 17th. It is at this conference that the block allocation of frequencies to the various radio services (broadcasting, marine, aeronautical, telecommunications, mobile radio, amateurs, etc.) is decided.

A delegation of 45, led by Capt. C. F. Booth of the General Post Office, is representing the U.K. at this conference. The delegation includes representatives of various Government Departments, the Armed Forces, B.B.C. and I.T.A., as well as advisers from operating agencies and other organizations.

The conference is expected to last four months.

"Live" v "Mono" v "Stereo"

AS a result of the interest shown in his Royal Festival Hall demonstrations of mono and stereo sound reproduction, G. A. Briggs has decided to carry the experiment a stage further at a lecture-demonstration to be held at the Colston Hall, Bristol on October 9th. For this purpose he is having special recordings made of solo and concerted items in which all available resources will be employed to obtain the best possible recordings by both mono and stereo techniques. We believe this will be the first occasion on which a comparison between live performances and both monodic and stereophonic reproductions of the same items has been attempted in public.

College of Technologists

LAST November the National Council for Technological Awards announced its proposal to create an award higher than the Diploma in Technology, to be known as the M.C.T. (Membership of the College of Technologists). This college, which is an administrative and not a teaching body, will operate within the framework of the National Council for Technological Awards.

A Board of Scientific and Industrial Studies is to be responsible for the academic and industrial aspects of the administration of the new award and among its fifteen members are:—Dr. R. C. G. Williams (Philips' chief engineer), Dr. G. B. B. M. Sutherland (director, N.P.L.) and Dr. J. S. Tait (principal, Northampton College of Advanced Technology).

The Council's intention is that this award should be a "mark of outstanding distinction granted to a student who has proved his ability by completing a substantial programme of work demanding the application of his knowledge to the solution of a problem of value to industry".

Medical Electronics

AT the second International Conference on Medical Electronics held in Paris at the end of June* a new international organization was formed under the presidency of Dr. V. K. Zworykin. It is to be known as the International Federation for Medical Electronics and its object will be to encourage the dissemination of information on medical electronics.

One of its functions will be to sponsor international congresses at regular intervals and the next will be held in this country in July, 1960. This conference is being organized by the Electronics and Communications Section of the Institution of Electrical Engineers. It is also planned to hold an international scientific exhibition on medical electronics in conjunction with this conference.

British members of the committee of the International Federation for Medical Electronics are Dr. C. N. Smyth, of University College Hospital, who is a vice-president; B. Shackel (E.M.I. Electronics), treasurer; W. J. Perkins, of the National Institute for Medical Research; and Dr. R. C. G. Williams, of Philips Electrical.

*A report on the Conference will be published in our next issue.—ED

B.B.C. Satellites

BY the end of this year the B.B.C. will have 23 television stations in operation and these will serve about 98.7 per cent of the population. There will also be a v.h.f. sound service for about 96.4 per cent of the population from 21 stations. The problem of bringing TV and the v.h.f. sound service to the remaining areas—many of them sparsely populated—is being solved by building a number of low-power satellites. Most of the stations will be unattended "translators" which will pick up signals from an existing B.B.C. station and re-transmit them on a different frequency. Initially there will be 14 TV stations, all in Band I, and eight of them will also be equipped with v.h.f. sound transmitters. V.H.F. sound is also being added to two existing television stations—Londonderry and the Channel Islands.

The new stations will be at Berwick-on-Tweed, Fort William, Galashiels area, Llandrindod Wells area, Loch Leven, Oban, Oxford/Berkshire, West Cornwall, Barrow/Lancaster area, Enniskillen area, Ipswich area, Pembroke/Milford Haven area, Sheffield, and Skegness. The first eight of these stations will be equipped for both TV and v.h.f. sound.

The Radio Industries Club, which now has a membership of nearly 1,000, has elected Dennis Curry, a joint managing director of Currys Ltd., as president in succession to Sir Robert Fraser, Director General of the I.T.A. He is the first "retailer" president. The new chairman in succession to L. A. Sawtell (Mullard) is A. E. Bowyer-Lowe, and the new vice-chairman H. C. Roberts (Cossor). W. E. Miller (Trader Publishing Co.) has relinquished the honorary secretaryship of the club which he had held for 19 years. Harold Curtis, until recently with the Radio and Televsion Retailers' Association, has been appointed secretary.

I.E.E. Council.—The new president of the I.E.E. for 1959-60 is Sir Willis Jackson (Metrovick). The two newly elected vice-presidents are G. S. C. Lucas (B.T.H.), and O. W. Humphreys (G.E.C. Research Laboratories). Among the new ordinary members of the council are Professor H. E. M. Barlow, of University College, London; C. O. Boyse (A.T. & E.); L. Drucquer (B.T.H.); H. G. Nelson (English Electric); and G. A. V. Sowter (Telcon).

I.E.E. Electronics and Communications Section.—The following have been elected to fill the vacancies which will occur on the Committee of the Electronics and Communications Section of the I.E.E. in September:—M. J. L. Pulling (B.B.C.), chairman; J. A. Ratcliffe (Cavendish Laboratory), vice-chairman; P. A. T. Bevan (I.T.A.); Dr. J. Brown (University College, London); L. J. I. Nickels (Standard Telecommunications Laboratories); N. C. Rolfe (Newmarket Transistors and Cathodeon Crystals); and C. Williams (R.A.E.).

Audio Fairs Ltd., the non-profit making organization set up a few years ago by a group of audio equipment manufacturers to sponsor the London and provincial Audio Fairs has moved to 22 Orchard Street, London, W.1. (Tel.: Welbeck 9111.) V. G. P. Weake, director of Pamphonic Reproducers Ltd., and Bryan Savage Ltd., has been elected chairman of the council. M. L. Berry (Trix) is vice-chairman and L. H. Brooks continues as secretary. Other members of the council are:—D. A. Lyons (Trix), J. Maunder (Vitavox), Hector V. Slade (Garrard), G. E. Spark (Garrard) and T. R. B. Threlfall (Pye Records).

The Television Society announces that a new centre is being formed in the Cardiff area and that the Leicester centre is being revived. Readers in these areas can obtain information regarding these sections from the Society's headquarters, 166 Shaftesbury Avenue, London, W.C.2.

A full-time course (October to May) for students wishing to sit for Part III of the I.E.E. examinations is again being organized by the South East London Technical College. Information regarding the course, for which the fee is £17, is obtainable from the Department of Electrical Engineering and Applied Physics, Lewisham Way, London, S.E.4.

Information Engineering.—An advanced 12-month course in information engineering is again being held at the University of Birmingham from October. On the satisfactory completion of the course graduates can qualify for the degree of M.Sc. Subjects available cover communications, radar, computers and control systems with some degree of choice to suit individual requirements. (Fee £81.)

Dip. Tech. Course.—Dr. G. N. Patchett, head of the Department of Electrical Engineering at the Bradford Institute of Technology, has sent us a brochure giving details of the four-year electrical engineering sandwich course for the Diploma in Technology provided at the College. Specialization in electronics with additional physics is provided for in the final years.

A.F.C.E.A.—The new president of the London Chapter of the Armed Forces Communications and Electronics Association is Col. J. A. Plihal of the U.S. Air Force. Being an American organization the officers of the Chapter are Americans but there are also British associate officers. The recently elected associate vice-presidents are:—Sir Harold Bishop (B.B.C.), Henry Chisholm (Cossor), Maj. Gen. E. S. Cole (War Office), Henry G. A. Kay (Benjamin), and Sir Reginald Payne-Gallwey. The associate treasurer is P. D. Canning (Plessey) and the associate secreary L. T. Hinton (S.T.C.).

Society of Relay Engineers.—The offices of the Society have been transferred from Kettering to Obelisk House, Finedon, Northants (Tel.: Finedon 204). The secretary is T. H. Hall.

Computer Development.—The National Research Development Corporation is to give its support to Ferranti and E.M.I. Electronics in further development work on advanced high-speed computers. E.M.I. have been collaborating with the N.R.D.C. for the past four years in the development of large business computing systems which has resulted in the production of the EMIDEC 2400. The new programme will be devoted to the development of the EMIDEC 3400 suitable for large-scale high-speed scientific work. The experience gained from the operation of Ferranti computers has shown the need for the new very powerful high-speed computer now proposed—the ATLAS—for both scientific research and development and for data processing.

Reliability.—The sixth American National Symposium on Reliability and Quality Control in Electronics will be held in Washington, D.C., from January 11th to 13th, next year. Information regarding the submission of papers and attendance at the Symposium may be obtained from R. Brewer, of the Research Laboratories, The General Electric Co., Wembley, Middlesex.

Automatic Control.—The first International Congress for Automatic Control is to be held in Moscow from June 25th to July 5th next year. It is being held under the auspices of the International Federation of Automatic Control, of which the British Conference on Automation and Computation is the U.K. national member. The secretary of the I.F.A.C. is Dr.-Ing. G. Ruppel, Prinz-Georg-Str. 79, Dusseldorf, Germany.

"**Photo-Emission**" is the title of the latest film in the advanced science series for sixth forms and technical colleges which is issued by the Mullard Educational Service. It runs for 18 minutes on 16-mm black and white sound film. It can be hired together with comprehensive teaching notes from the Educational Foundation for Visual Aids, Film Library, Brooklands House, Weybridge, Surrey.

Two new I.T.A. stations are scheduled to come into service in October; the East Anglian station on the 27th and the Northern Ireland transmitter on the 31st. The Mendlesham, Suffolk, station will radiate in channel 11, with an e.r.p. of 200pW, and the Black Mountain, Belfast, station in Channel 9 with an e.r.p. of 100kW. Both stations employ directional aerials with horizontal polarization.

Isle of Man V.H.F.—The B.B.C.'s transmitting station at Douglas, Isle of Man, which has been radiating one v.h.f. sound programme since December, 1957, now broadcasts all three sound programmes. The frequencies are 88.4Mc/s (Light); 90.6Mc/s (Third) and 92.8Mc/s (Home). The mean e.r.p. is 3.3kW.

Brighton.—The B.B.C. has recently brought into service a permanent television transmitter at Whitehawk Hill, near Brighton, to replace the temporary transmitter at Truleigh Hill which has been in use since early 1953. It operates in the same channel (2).

Receiving licences in the U.K. at the end of June totalled 14,847,483. The number of combined television/sound licences increased by over 82,000 to 9,495,188. Sound-only licences were 5,352,295—a decrease of nearly 27,000.

Reunion Dinner of **R.A.F.** radio ex-apprentices is being organized for September 19th at the Grand Atlantic Hotel, Weston-Super-Mare. Particulars from Flt. Lt. E. C. Hargest, No. 1 Radio School, R.A.F., Locking, Somerset.

Correction.—We have been asked to point out that in the advertisement on p. 104 of the June issue relating to the Mazda 6F23 r.f. pentode, the vertical (anode and screen current) scale of the bottom left-hand set of curves should be doubled, i.e., each division should represent 5 and not 2.5 mA.

Personalities

Rear Admiral K. R. Buckley, M.I.E.E., M.Brit.I.R.E., Director of the Naval Electrical Department, Admiralty, since July 1958, assumes the new title of Chief Naval Electrical Officer under the reorganization of the material and personnel departments of the Admiralty. He also becomes Director of Engineering and Electrical Training. Rear Admiral Buckley commanded H.M.S. *Collingwood*, the naval electrical school at Fareham, Hants., for two years prior to 1957 when he was appointed Command Electrical Officer at Portsmouth.

Sir Willis Jackson, the 1959/60 president of the Institution of Electrical Engineers, has been Director of Research and Education with Metropolitan-Vickers since 1953. For the previous seven years he had occupied the chair of electrical engineering at the Imperial College of Science and Technology. From 1938 to 1946 he was professor of electrotechnics at Manchester University. Sir Willis, who was appointed a Knight Bachelor in last year's Birthday Honours, has served on many advisory councils and committees including the Scientific Advisory Council, Ministry of Supply (1947-1954), and the Research Council of the D.S.I.R. (since 1956).

Sir WILLIS JACKSON

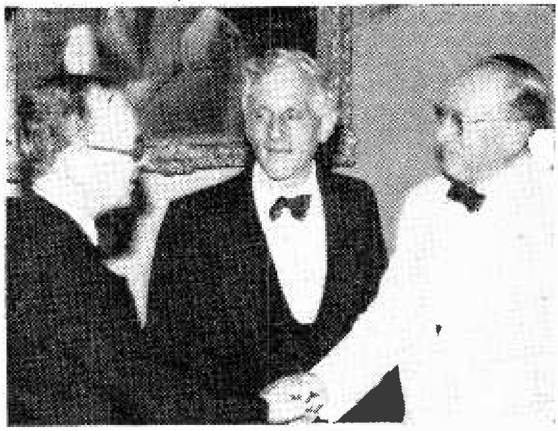
M. J. L. PULLING

M. J. L. Pulling, C.B.E., M.A., who is elected chairman of the Electronics and Communications Section of the I.E.E. for the ensuing year, is Controller, Television Service Engineering, in the B.B.C. He joined the Corporation in 1934 and was superintendent engineer (recording) from 1941 until 1949 when he took charge of the television side of the engineering division. After graduating at King's College, Cambridge, in 1928 and spending a further year in the University radio laboratory he was for five years in the radio industry before he joined the B.B.C.

J. A. Ratcliffe, C.B.E., F.R.S., the new vice-chairman of the I.E.E. Electronics and Communications Section, is reader in physics in the Cavendish Laboratory, Cambridge. He is chairman of the Radar and Signals Advisory Board of the Ministry of Supply Scientific Advisory Council and was appointed to the recently formed National Committee on Space Research.

F. E. Godfrey, assistant secretary of the Radio Industry Council for nearly eleven years, has retired. At the R.I.C., Mr. Godfrey has been concerned with education and training for the industry and administered the R.I.C. training scheme for technicians from its inception in 1952.

N. W. Hunt, chief engineer of Cathodeon Crystals, Ltd., of Linton, Cambridge, since its formation in 1953, has been appointed manager of the crystal division of Pye Proprietary Limited, of Melbourne, Australia.



Honorary Membership of the Brit.I.R.E. was awarded to E. K. Cole (left) and Dr. V. K. Zworykin (right) at the Institution's convention, held at Cambridge University (see page 335). Here they are congratulating each other just after the ceremony in the presence of Professor E. E. Zepler, president of the Institution.

Dr. Henry Boot and **Professor John Randall,** F.R.S., are among this year's recipients of the American John Scott Award for "developing inventions for the benefit of mankind." They will each receive $1,000 for their invention of the cavity magnetron. Dr. Boot, who was at Birmingham University, is now at the Services Electronics Research Laboratory, Baldock, Herts. Professor Randall is Wheatstone Professor of Physics at London University (King's College).

H. Carleton Greene, O.B.E., who is to succeed **Sir Ian Jacob** as Director-General of the B.B.C. at the end of the year, joined the Corporation in 1940 as German editor, in the European Service. For two years immediately after the war he was in charge of broadcasting in the British Zone of Germany. Four years ago Mr. Greene, who is 48, headed the commission set up to advise on the formation of a broadcasting organization in the Federation of Rhodesia and Nyasaland.

Martin Ryle, F.R.S., will be the first to occupy the Chair of Radio Astronomy established at the University of Cambridge. He will take up his appointment on October 1st. Mr. Ryle left Oxford University in 1939 with an M.A. degree and joined the Telecommunications Research Establishment where he worked on radar applications until the end of the war. He then went to Cambridge as lecturer in physics at the Cavendish Laboratory and more recently transferred to the Mullard Radio Astronomy Laboratory at the University.

Paul Adorian, M.I.E.E., M.Brit.I.R.E., managing director of Associated Rediffusion, Ltd., has had the Fellowship of the City and Guilds of London Institute (F.C.G.I.) conferred upon him for his work in the fields of radio relaying, flight simulators and tactical teachers. He studied at the City and Guilds College from 1927 to 1932.

George S. C. Lucas, O.B.E., M.I.E.E., director and chief engineer of B.T.H., has been made an F.C.G.I. "for radar and electronic research and services in technical education." He joined the B.T.H. research laboratories in 1925 and was head of the electrical and development section from 1932 until 1944 when he became head of the electronics engineering department.

Dr Manfred von Ardenne, who is well known for his television research work in the early 1930s, is now actively engaged in the field of medical electronics and read two papers at the recent Paris Medical Electronics Conference. He is now in a research institute in Dresden, East Germany.

Dr. Louis Essen, of the Standards Division of the National Physical Laboratory, which he joined in 1929, has been awarded the A. S. Popov Gold Medal by the Academy of Sciences of the U.S.S.R. This is the first time this medal, awarded for "the most distinguished scientific work in the field of radio-engineering performed during the period 1956-1958," has been given to a scientist outside the Soviet Union. The outstanding achievement which has won Dr. Essen this recognition has been his work leading to the establishment of an atomic frequency standard as a possible basis for the future standard of time.

Dr. L. ESSEN

E. E. ROSEN

Edward E. Rosen, managing director of Ultra Electric, has been elected chairman of the Radio Industry Council in succession to **G. Darnley-Smith** (Bush Radio), who has held the office for the past seven years and one year previously. Mr. Rosen joined Marconi's in 1913 as a pupil and after serving in the 1914-18 war in the Royal Flying Corps, started his own company (Edward E. Rosen & Co.) in 1920 for the manufacture of headphones and loudspeakers. The company became Ultra Electric, Ltd., in 1923. **Hector V. Slade** (Garrard Engineering) is the new vice-chairman of the Council. Mr. Slade is this year's chairman of the Radio and Electronic Component Manufacturers' Federation.

D. Q. Fuller, A.M.I.E.E., who in 1950 was made responsible for the early experimental work on transistors undertaken by the Pye Group, has been appointed director of engineering of Newmarket Transistors, a member of the group. Newmarket Transistors also announce the following appointments: **George Roman,** Dipl.Ing., who joined the company in 1956, becomes chief physicist; **John B. Haggis,** Grad.I.E.E., who has been with the Pye Group since 1945 and was working on television camera tube development with Cathodeon until 1954 when he transferred to Newmarket Transistors, is appointed chief production engineer; **T. D. Towers,** M.B.E., M.A., Grad.Brit.I.R.E., who joined the company as a circuit applications engineer early last year, becomes chief development engineer.

C. Ross, Grad.Brit.I.R.E., whose article on magnetic heads is on page 321, has been working on professional 16-mm magnetic recording equipment in the research and development laboratory of Kelvin & Hughes at Hillington, Glasgow, since 1957. After serving an apprenticeship with E.M.I. Engineering Development, Ltd., he worked as a technical assistant in the company's magnetic recording development laboratory specializing in magnetic heads until 1957, when, for a short while before joining Kelvin & Hughes, he was attached to E.M.I. Studios.

A. N. Thomas, who, as reported in our May issue, recently retired from the B.B.C., has joined Pye Ltd., as overseas consultant in the sales department of the Television Transmission Division.

F. Duerden, B.Sc.(Hons.), A.M.I.E.E., has been appointed manager of the electronics department of Bruce Peebles and Co. Ltd., of Edinburgh, in succession to **J. W. Haig Ferguson,** M.A.(Cantab.), A.M.I.E.E., who has become divisional director. Mr. Duerden graduated at Manchester University and started his professional career in Marconi's research and development department. He then served as a radar officer in the R.A.F. and after the war joined Ferranti's, where he remained until joining Bruce Peebles as chief electronic engineer in 1956.

BIRTHDAY HONOURS

Among the recipients of honours in the Queen's Birthday List are several who took a leading part in the organization of the International Geophysical Year. They include **Professor Sir David Brunt** (K.B.E.), **Professor W. J. G. Beynon** (C.B.E.), and **J. MacDowall** (O.B.E.).

Leslie C. Gamage, chairman and managing director of the General Electric Company, receives a knighthood; **A. V-M. Leslie Dalton-Morris,** who became Air Officer Commanding on the formation of the R.A.F. Signals Command, is promoted to K.B.E.; and **Group Captain G. R. Scott-Farnie,** managing director of International Aeradio Ltd., becomes a C.B.E.

Among the new O.B.E.s are: **Commander K. B. Best,** R.N.(Retd.), director of communications at the Home Office; **A. M. Beresford-Cooke,** head of planning and construction, Engineering Department, I.T.A.; **M. Davenport,** principal, London Communications Electronic Security Agency; **R. C. Harman,** head of operations and maintenance, Engineering Department, I.T.A.; **C. J. V. Lawson,** engineer-in-chief, Cable & Wireless; **H. O'Neill,** general secretary and treasurer, Radio Officers' Union; **C. J. Strother,** assistant to chief engineer, B.B.C.; and **W. A. J. Thorn,** deputy director (telecommunications), Ministry of Transport and Civil Aviation.

New M.B.E.s include: **A. L. Budd,** chief telecommunications superintendent, Air Ministry; **I. Davies,** lately communication officer, H.M. Embassy, Djakarta; **S. F. Hodge,** manager, International Aeradio Ltd., Sharjah; **W. H. Mitchell,** experimental officer, Royal Radar Establishment; **G. W. R. Robinson,** communications officer, H.M. Embassy, Washington; **R. E. G. Trembath,** International Aeradio's representative at Hargeisa, Somaliland; **N. Walker,** senior executive engineer, Engineer-in-Chief's office, G.P.O.; and **E. F. Woods,** assistant to superintendent engineer, lines, B.B.C.

Recipients of the British Empire Medal include: **A. L. Adams,** chargehand, Marconi's W.T. Co.; and **R. A. Grace,** instrument maker, E.M.I. Electronics.

OBITUARY

William Theodore Ditcham, A.M.I.E.E., who was associated with Capt. H. J. Round at Marconi's in the early development of direction finders during the first world war and with the experimental broadcasts from Chelmsford in 1920, has died in his 79th year. From 1925 to 1944 Mr. Ditcham was in charge of the development of Marconi's broadcasting transmitters, and was assistant engineer-in-chief when he retired in 1949 after 34 years with the company.

Geoffrey Bennett, manager of the Liverpool factories of Automatic Telephone & Electric Co. Ltd., died on April 27th aged 45. He started his career in telecommunications with the British Post Office and joined A.T.E. in 1945 after leaving the Royal Corps of Signals, in which he held the rank of Lieutenant Colonel.

Eric Frederick Kerridge, who was in charge of the technical publications department of Ferguson Radio Corporation, has died at the age of 45. He joined the company in 1942.

News from the Industry

Wharfedale Wireless Works, Ltd., the loudspeaker manufacturers of Idle, Bradford, Yorks, have been acquired by the Rank Organization. G. A. Briggs, the founder and managing director, who is well known also for his books and lecture-demonstrations, has agreed to remain in active management as have all the other executive directors.

Avo.—Changes are announced in the board of Avo, Ltd., which recently became a member of the Metal Industries Group. Sir Charles Westlake, chairman of Metal Industries, becomes chairman of the board of Avo with J. H. Rawlings, Avo's managing director, as deputy chairman. Other new directors are John Black, a director of M.I., and H. O. Houchen, managing director of Brookhirst Igranic, another M.I. subsidiary, recently formed to merge the interests of Brookhirst Switchgear, Ltd., and Igranic Electric Co. Mr. Rawlings is to be appointed to the board of Brookhirst Igranic.

The Plessey Company has concluded an agreement with Elettronica Metal Lux s.p.a., of Milan, Italy, providing for the manufacture of Metallux resistors in the U.K. Plessey, who for the past 18 months have been U.K. agents for these metal film resistors, will hold, in addition to sole manufacturing rights in this country, selling rights for both the U.K. and all Commonwealth countries.

Bendix Aviation Corporation, of America, has concluded an agreement with Cossor Radar & Electronics, Ltd., whereby it obtains from Cossor know-how and patent licences for the manufacture of secondary radar airborne transponders.

P.A.M. Ltd., of Merrow, Guildford, manufacturers of Nera large-screen television equipment, have been absorbed by Tyer and Co., of Dalston, who are moving to the Guildford factory where they will continue the work previously undertaken by P.A.M. Both companies are subsidiaries of the Southern Areas Electric Corporation.

Anglo-French Collaboration.—In October, 1957, Marconi's W/T Co. and Compagnie Générale de T.S.F. agreed to collaborate in certain aspects of N.A.T.O. work. Their proposals for the provision and installation of equipment for all stations in the Early Warning radar chain have now been accepted and contracts totalling nearly £7M are being placed by the governments concerned.

Ferranti, Ltd., have received an order from Bruce Peebles & Co., of Edinburgh, for a £60,000 Pegasus digital computer. Initially, the computer, which will be installed next year, will be used for fundamental research and design calculations, and although priority will be given to Bruce Peebles' own work, the machine will be made available to other firms or organizations wishing to make use of it.

E.M.I. Electronics Ltd., are to supply a large EMIAC II computer to de Havilland Propellers Ltd., Hatfield, as an additional aid to research into guided missiles and other problems associated with high-speed flight. The installation will consist of twenty-two modules and cost £52,000.

Electrode Welding Co., Ltd., of Cobbold Road, London, N.W.10, has been appointed sole representative in the United Kingdom for electron gun mounts manufactured by Superior Electronics Corporation, of Clifton, New Jersey, U.S.A.

Decca Navigator, Mk. 10, receiver has been re-engineered to the ARINC (Aeronautical Radio Inc.) specification to fit American aircraft racking. The new receiver will be known as the Mk. 10A (Type 900).

Armstrong Whitworth Aircraft Ltd., of Coventry, have taken over the Technical Developments Division of Gloster Aircraft Company. Both are members of Hawker Siddeley Aviation Limited. The merger brings together two departments producing a complementary range of equipment with a wide application in the fields of instrumentation, automation and radio communication as well as aircraft and guided missile systems as a whole. E. W. Absolon, who has been chief engineer at T.D.D., has been appointed manager of the new division and A. E. Martin, who has been in charge of A.W.A. Commercial Electronics Department, moves to Gloucester as deputy divisional manager.

Standard Telephones and Cables have received an order from Cable & Wireless for the supply of 92 submerged two-way repeaters and eleven equalizers for the Scotland-Newfoundland section of the proposed Commonwealth round-the-world telephone cable. The repeaters, each containing duplicate three-valve amplifiers, will be inserted in the cable at intervals of about 23 nautical miles. The equalizers, for correcting inequalities of signal strength at different frequencies, will be inserted in the cable at intervals of some 200 miles. The order is valued at about £1.8M.

COMPANY REPORTS

Ekco.—The Ekco group of companies, which includes E. K. Cole, Ltd., Ferranti Radio and Television, Dynatron, and Egen Electric, had a net profit after taxation of £459,225 in the year ended in March, an increase of £142,474 on the previous year.

Thorn Electrical Industries.—Group trading profits for the year ended last March amounted to £2,953,536. After deducting all charges, including taxation at £927,257, the net profit was £979,371 compared with £681,832 in the previous year.

Vickers, Ltd.—Reference is made in the annual review of Vickers to the Hollerith-Powers Samas merger in which the company now has a holding of 38 per cent of the equity in International Computers and Tabulators, Ltd., the new title of the merged companies.

Ferranti Ltd.—Consolidated profit for the year to March 31st was £2,419,865 compared with £1,252,971 for the previous year. After provision for tax the net profit was £1,104,572 against £575,971 last year.

Rediffusion, Ltd., which holds a $37\frac{1}{2}\%$ interest in the television programme contractors, Associated-Rediffusion, reports a group trading profit of £4.29M for 1958/59 which was £280,000 more than in the previous year. The group also includes Redifon, Ltd., and Rediweld, Ltd.

Elliott-Automation.—The accounts for the first full financial year of the Elliott-Automation Group show a net profit after taxation of £458,628. The Group was formed in August, 1957, with the merging of Elliott-Brothers (London), Ltd. and Associated Automation, Ltd.

Garrard.—Profit for the year ended in January was £545,590 of which £264,462 will be absorbed by taxation.

International Aeradio, Ltd., in which 17 international airline operators are shareholders, had a gross group turnover during 1958 of just over £2M, an increase of £200,000 on the previous year.

Ever Ready Company (Great Britain), Ltd., announce a consolidated net profit (after allowing over £1M for taxation) of £1,262,856 for the year ended in February. This was an increase of £342,757 on the previous year.

OVERSEAS TRADE

Radio link between Newfoundland and the Canadian mainland, used initially for television during the Queen's recent Canadian tour, includes the world's longest microwave over-water path. Standard Telephones and Cables' s.h.f. automatic space diversity equipment is used for the 70-mile relay across the Cabot Straits in order to combat the difficult transmission conditions caused by the rise and fall of tidal waters. In all, twenty-three S.T.C. relay stations are used to cover the 524 miles between St. Johns, Newfoundland, and Sydney, Nova Scotia. The link provides for 600 two-way telephone circuits in addition to a television link in either direction.

Facsimile equipment, valued at over £85,000 and supplied by Muirhead, has been installed by a Japanese newspaper publisher. The equipment is used to transmit by radio from Tokyo complete pages of the newspaper which when received at Sapporo, on the island of Hokkaido, 500 miles away, are used for off-set printing, so that the paper is available almost simultaneously in both places—the actual delay is said to be 75 minutes.

Autosonic inspection equipment to the value of £10,000 has been ordered from Kelvin Hughes for the Chomutov steel works in Czechoslovakia. The equipment will facilitate the automatic scanning of rolled mild steel bars of up to 7.9in diameter and will mark and reject any material containing internal defects in excess of a predetermined degree.

Sound and vision transmitters, combining filters and programme input and ancillary equipment for five new Band III television stations under construction in Sweden are to be supplied by Marconi's. One of the stations, at Borlänge, will have two sets of transmitters operating in parallel and will have a vision e.r.p. of 60kW. The remaining four stations will each have single transmitters feeding into a directional aerial. These will have different gain factors, so that the respective e.r.p.s will range from 10kW to 60kW.

Communication Receivers.—A contract for the supply of 350 radio-telephone receivers to the Canadian Department of Transport has been secured by Plessey International Ltd. The receivers, which will be used in aeronautical and other services, are designated PR51c and form part of the Plessey PR51 range of single-channel h.f. receivers.

Weather Radar.—Two international Swiss airports, near Geneva and Zurich, are to be equipped with Decca weather radar. Both installations will be on high ground some distance from the airfields, with radio links to relay the radar information to the airfield meteorological offices.

Closed circuit television equipment is being supplied by E.M.I. Electronics for installation in a large gold mine in Ghana. Three cameras, mounted at vantage points to scan the working area and linked to receivers in the offices of the security officer, are being installed as an added security measure against pilfering.

Airborne ILS/VOR equipment, for installation in the Soviet Aeroflot TU104 jets used on the Moscow-London route, has been ordered by the Russian Purchasing Authority from Standard Telephones and Cables.

I.L.S.—Two Pye instrument landing systems are to be installed at Moscow airport. The contract is worth about £100,000.

Radar for the double-ended ferries on the Manhattan-Staten Island service, New York, is to be supplied by Decca. This order, valued at over $106,000, is for twenty-three sets and brings the total to 37 supplied by Decca for the New York Ferry Services.

Communications equipment valued at £73,000 has been supplied by Racal Engineering Ltd., for the Canadian Government. The consignment includes over 100 RA.17 communication receivers and ancillary equipment.

Iran.—The representation in Iran of a British manufacturer of sound radio and television receivers is sought by Sherkat Nesbi Bafandegi Baradaran Jurabchi, near Saray Haj Hassan Bazar, Teheran. They ask for a descriptive catalogue and wholesale export prices.

Canada.—Ray Hamerton Ltd., of 317 Fort Street, Winnipeg 1, Manitoba, wishes to take up the agency for British-made loudspeakers, amplifiers and turntables which are not already represented in the province.

NEW ADDRESSES

Kelvin House, Wembley, Middx., is the new headquarters of the Aviation, Marine and Industrial Divisions of S. Smith and Sons, which includes Kelvin-Hughes and Smith's Aircraft Instruments.

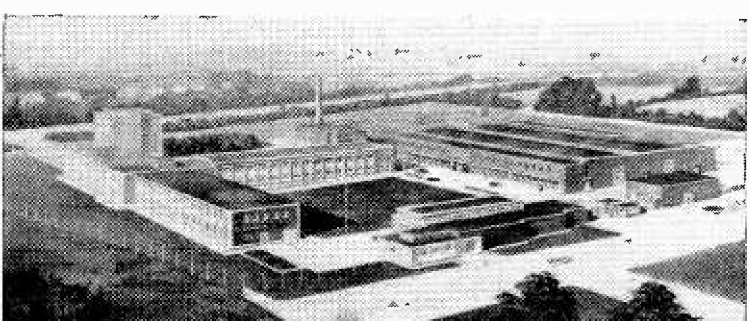
Technograph.—The new London office of Technograph Printed Circuits, Ltd., and Technograph Electronic Products, Ltd., is at Eros House, 29-31, Regent Street, S.W.1. (Tel.: Regent 5273.)

Siemens Edison Swan's London district office has been transferred to Crown House, Aldwych, W.C.2 (Tel.: Temple Bar 8040). The stores will remain at Tyssen Street, Dalston, E.8.

Telerection Limited, aerial manufacturers, have opened a new factory in Weymouth and closed their Cheltenham plant. The address is Antenna Works, Lynch Lane, Weymouth (Tel.: Weymouth 2140).

Decca Radio and Television Ltd., have moved their offices and factory from Brixton Road, London, S.W.9, to Ingate Place, Queenstown Road, London, S.W.8. (Tel.: Macaulay 6677.) The spares and service department is still at Brixton Road (Tel.: Reliance 6011).

CQ Audio, Ltd., manufacturers of sound reproducing equipment, whose premises in Sarnesfield Road, Enfield, were severely damaged by fire some months ago, have taken possession of a new factory at Bush Fair, Tye Green, Harlow, Essex (Tel.: Harlow 24566).



Headquarters of A.E.I. Electronics Apparatus Division (incorborating BTH and M-V) at New Parks, Leicester, opened by Rt. Hon. Aubrey Jones, M.P., Minister of Supply, at the end of June. With a total floor space of 180,000 sq ft, the new building comprising factory (right), offices and laboratories (T-shaped block, left and rear-centre) and canteen (front centre).

Magnetic Tape Heads

Factors Influencing Their Design and Construction

By C. ROSS, *Grad. Brit. I.R.E.*

MAGNETIC recording has a wide variety of applications, and the magnetic head can be considered the "heart" of the machine, for its performance governs to a high degree the capabilities of the recording machine. The advent of ferrites has made high-frequency recording possible, and improved the performance of the audio range recorders also. In general, the highest frequency that it is desired to reproduce governs the speed of the magnetic tape across the magnetic heads. Tape speeds for instance, of the order of 0.25 in/sec may be used for very low frequency recording or conversely, speeds of 200 in/sec and above are used for high-frequency work. For high quality sound recording, which this article is based upon, speeds of 7.5 to 30 in/sec are in common use. The replay head provides a limitation to the maximum number of cycles of magnetic signal per inch of recording media which can be resolved satisfactorily.

There are three main factors to be considered when dealing with tape heads and associated circuits. They are frequency response, distortion and signal to noise ratio. Good quality magnetic heads are now commercially available and with suitable circuits will perform satisfactorily up to a frequency limit of 1800—2000 cycles per inch per second.

Almost without exception in the high-quality professional field, the recording machine has three heads mounted on an easily detachable rigid plate. The tape is first demagnetized by the erase head. Saturation of the tape takes place at its gap, which is large in relation to the record and replay gaps, and the tape is taken through many cycles of magnetization which gradually decrease due to the motion of the tape past the head. The record head has two magnetizing components, one the signal and the other consisting of a high-frequency "bias" to reduce distortion. The signal produced on the tape is then reproduced by the replay head and fed into suitable frequency-corrected amplifier stages. This process is relatively well known.

The various types of magnetic head will now be discussed in detail, and the importance of various mechanical relationships illustrated; the three types are assumed to take the general form shown in Fig. 1.

Erase Heads.—The impedance of the erase head is chosen so that the voltage developed across it is not excessive when operating normally. The high frequency current required is usually derived from a tuned power amplifier stage driven by an oscillator of low distortion. The frequency of the oscillator is often 7-10 times the highest audio frequency which is to be recorded, the danger being heterodyne interference between a harmonic of the signal and the oscillator frequency. Harmonic distortion of the erase current (and bias current) waveforms should be kept as low as possible. Distortion causes noise to be kept on the tape; this is mainly due to the presence of even-order harmonics producing an unsymmetrical waveshape, hence leaving the tape polarized to a small extent. This noise is very pronounced when the tape has been erased using a plain permanent magnet in place of h.f. erasure. A figure of less than 0.5% total harmonic distortion is usually required in practice to give a clean, low noise tape background. Core losses can be minimized by using a ferrite material in conjunction with a non-conducting gap spacer. In practice it has been found that although a better flux distribution about the working gap is possible with a conducting gap spacer (phosphor-bronze, etc.), the heat generated due to eddy currents is excessive in "full track" erase heads and the insulator type is superior. The metal spacer tends to "throw out" the flux, whilst the poorer flux distribution about the non-conducting gap spacer is approximately balanced by the lower losses, and the heat generated is negligible. The gap length of the erase head is not critical, and a

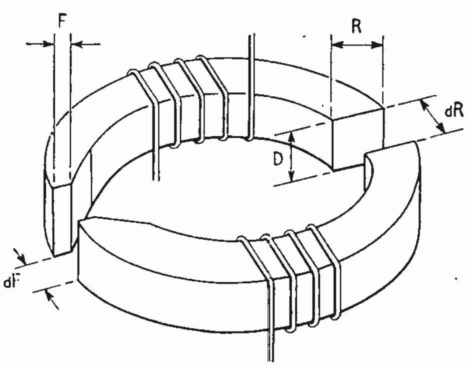


Fig. 1. Generalized sketch of a magnetic head with relevant dimensions

length of 0.012in to 0.020in is satisfactory for tape velocities of 7.5 and 15 in/sec.

Record Heads.—The basic requirements of a record head are a low reluctance magnetic circuit with small hysteresis and eddy-current losses, and a well-defined straight-edged front gap, its length being relatively unimportant compared with the replay head front gap. Ferrite material is inherently granular and unsuitable for the gap portion of the record head, although successful heads have been made by using pole shoes of high-permeability metal to form a clean straight gap.

The C.C.I.R. recording standard is widely adopted now. This means that the tape has been recorded to a definite induction/frequency characteristic. Taking the characteristic adopted for the tape speed of $7\frac{1}{2}$ in/sec as equivalent to that of a circuit with a time constant of 100 microseconds and providing that the replay amplifier has the

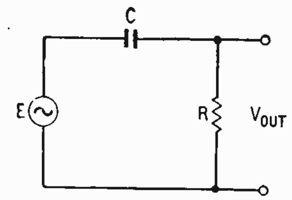


Fig. 2. Circuit with response equivalent to the C.C.I.R. recording standard

inverse of this response of 100 microseconds, the output would be constant over the band of frequencies recorded on the tape. This is only true if the replay head has no losses whatsoever and is in fact "ideal".

The response is conveniently described in microseconds, for it is the response of a simple R-C combination shown in Fig. 2. V_{out} represents the voltage across an "ideal" replay head winding when a tape is reproduced having the C.C.I.R. induction/frequency characteristic of 100 microseconds.

To produce a recording which has the required C.C.I.R. characteristic, a certain amount of high frequency pre-emphasis or "equalization" is incorporated in the recording amplifier to overcome losses in the tape magnetizing process and the record head. For a tape velocity of 7.5 in/sec approxmately +11dB of equalization is required at 10kc/s

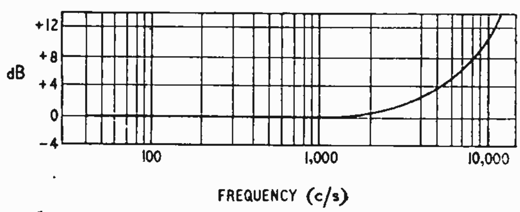


Fig. 3. Typical recording pre-emphasis circuit

(reference 1kc/s=0) to produce a recording which has the C.C.I.R. characteristic, given a good-quality record head. A typical current *versus* frequency curve is shown in Fig. 3, the record head working at peak optimum bias for a signal frequency of 1kc/s.

The efficiency of a record head largely depends on the front-to-back depth (F in Fig. 1) of the working gap and the type of tape used, but it is difficult to calculate accurately because it depends upon the leakage and fringing across the gap to some extent. In general, the back-to-front depth is made as small as possible consistent with reasonable working life of the head. This also applies to erase and replay heads.

The optimum bias required is governed by three major factors: high-frequency losses in the head itself, the nature of the tape coating and the signal frequency. Fig. 4 shows how the recorded signal varies when the bias current is altered from a low value to a high value and the dotted line indicates the recorded signal harmonic distortion (for a given signal level). This peak in the tape signal recorded is shown occurring at a bias current of 8mA, but this condition exists only at a certain signal frequency, i.e. 1kc/s. Inspection of the graph in Fig. 5 will show how this peak varies with signal frequency. Therefore it can be seen that the bias current governs to a large degree the performance of the record head. Operation of the record head with insufficient bias current can cause distortion and an accentuated high-frequency response. However, it has been found that it is advantageous to over-bias the record head so that the tape signal at 1kc/s drops by 2dB (from the peak value obtained using 8mA bias current as shown in Fig. 4). This ensures that the effects of any discontinuities in the tape coating, contact variation between head and tape, etc., are kept to a minimum. This necessarily affects the h.f. pre-emphasis required by the record head to produce a recording conforming to the C.C.I.R. specification, assuming the head was originally operated at peak optimum bias. The extra pre-emphasis required can be obtained by adjustment of the record amplifier characteristic, which is made variable in professional machines. Distortion of the signal on the tape can be caused also by an excessive magnetization level. The maximum signal level allowed in practice is one which produces 2% to 3% total harmonic content. The main component is usually the third harmonic due to the tape coating magnetization characteristic. Some types of tape can accept a higher level of magnetization than others for a given distortion, and if the signal-to-noise ratio of the system is to be as high as possible, the tape which can accept the maximum magnetization level for this given distortion level should be chosen.

Replay Heads.—The losses in a replay head can be split into two groups: frequency-dependent losses and wavelength-dependent losses.

Other factors to be considered are sensitivity, e.g. the voltage output should be as high as possible from a given signal level on the tape, and the voltage waveform an exact replica of the magnetic signal on the tape. There is a limitation to the number of turns of wire wound on the magnetic core, for high-frequency resonance with the self-capacitance of the winding is undesirable. High-frequency resonance is an extreme condition usually, although transformer coupling of a replay head to the input of the amplifier requires careful design of the transformer to avoid this condition.

The front-to-back depth F of the gap directly affects the sensitivity, because the shunting effect

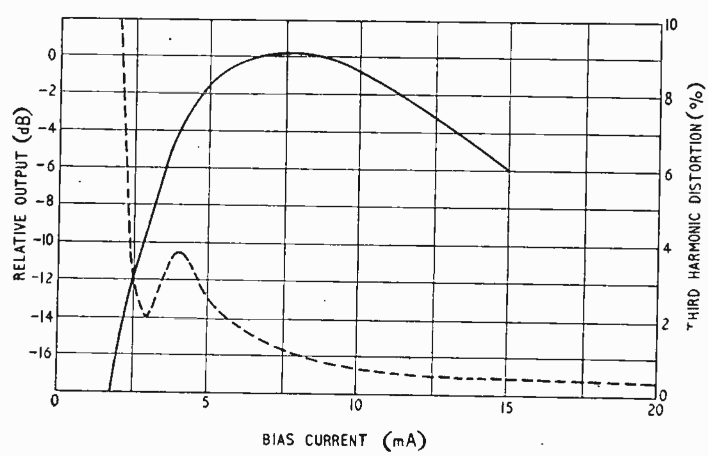


Fig. 4. Effect of bias current on the level and distortion of the recorded signal

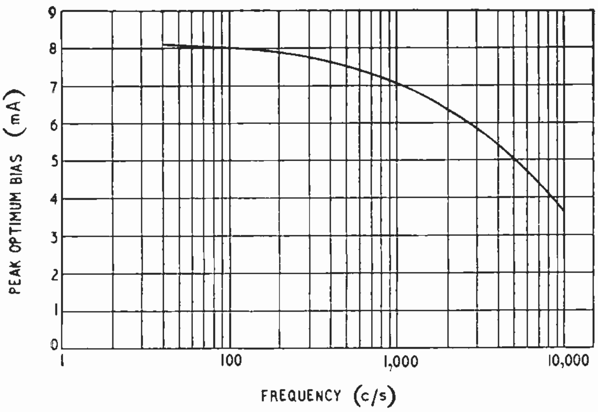


Fig. 5. Variation of optimum bias with signal frequency

is greater when the gap depth is large. This dimension is a compromise, the back-to-front depth being made as small as possible consistent with an allowance made for head wear during service. A figure of between 0.007in and 0.010in is commonly used in practice.

Effect of Front-to-back Depth on Sensitivity. A simplified equivalent circuit of a typical magnetic head is shown in Fig. 6.

Referring to Fig. 6.

E = magnetomotive force.
R_1 = reluctance of tape and tape contact with head.
R_2 = front gap reluctance.
R_3 = core plus rear gap reluctance.
i = flux entering poles from tape.
I = flux through core (and hence coil).
μ = mean permeability.
l = mean length of magnetic path.

$$\text{Now } i = \frac{V}{R_1 + \dfrac{R_2 R_3}{R_2 + R_3}}$$

$$\therefore I = \frac{V}{R_1 + \dfrac{R_2 . R_3}{R_2 + R_3}} \cdot \frac{R_2 R_3}{R_2 + R_3} \cdot \frac{1}{R_3}$$

$$= \frac{VR_2}{R_1 (R_2 + R_3) + R_2 R_3}$$

$$\text{From Fig. 1, } R_2 \propto \frac{dF}{D \times F}$$

$$R_3 \propto \frac{dR}{D \times R} + \frac{1}{D \times R \times \mu} = \frac{dR}{D \times R}$$

$$\left(\text{if } \frac{1}{D \times R \times \mu} \ll \frac{dR}{d \times R}\right)$$

Solving for I using two values for R_2, the change in output voltage of the winding can be found, due to the front-to-back depth being altered, say, from a small to a large dimension. The object is to make the magnetic flux mainly traverse the magnetic circuit around which the coils are placed, rather than taking the short-cut presented by the front gap reluctance R_2.

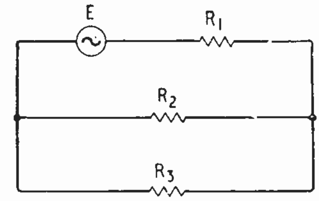


Fig. 6. Simplified analogue circuit of a typical magnetic head

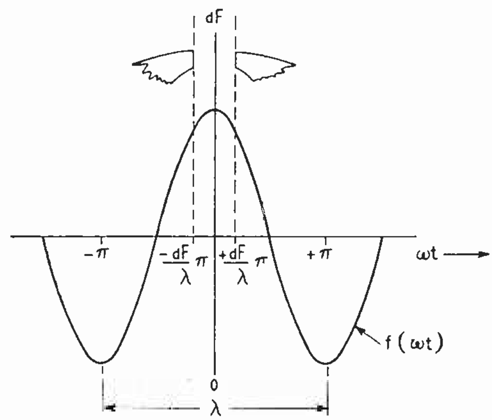


Fig. 7. Method of calculating gap loss

Effect of Gap Length dF on Sensitivity. This can be calculated in a similar manner to the previous example, thus using two values for R_2 again but incorporating different values for dF, the result is an increase of output when dF is changed from a small to a large dimension $\left(R_2 \propto \dfrac{dF}{D \times F}\right)$.

Summarizing: Output $\propto \dfrac{1}{F} \propto dF$.

Frequency Response—The gap length dF is the most important dimension. The gap loss can be calculated by simple integration. From Fig. 7, dF represents the effective magnetic gap which is usually 20% greater than the actual mechanical gap, due to "end effect," etc. The gap loss at

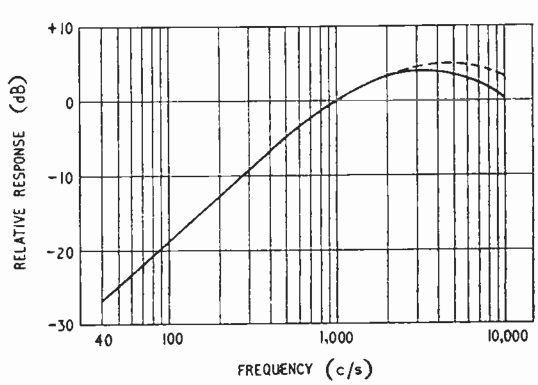


Fig. 8. Output from a good quality reply head with theoretical response from a C.C.I.R. recording at 7.5 in/sec

any given wavelength λ may be represented by the average value of the sinusoidal signal illustrated, between the limits set by the length of the effective magnetic gap dF. It can be seen that when this gap equals the wavelength λ the output will be zero, for the poles will have a similar polarity at any point along the curve. By taking the average value of the curve $f(\omega t)$ between the points $-dF/2$ to $+dF/2$ in terms of 2π a general expression is obtained. The reference axis " O " is placed where $f(\omega t)$ is a maximum, therefore $f(\omega t)$ becomes $\cos \omega t$. The average value is thus:

$$\frac{\lambda}{2\pi dF} \int_{-\pi dF/\lambda}^{+\pi dF/\lambda} \cos \omega t \, d(\omega t)$$

$$= \frac{\lambda}{2\pi dF} \Big[\sin \omega t \Big]_{-\pi dF/\lambda}^{+\pi dF/\lambda}$$

$$= \frac{\sin(\pi dF/\lambda)}{\pi dF/\lambda}$$

$$\therefore \text{Gap loss} = 20 \log_{10} \frac{\sin \pi dF/\lambda}{\pi dF/\lambda} \text{ dB}$$

The output of a good quality replay head from

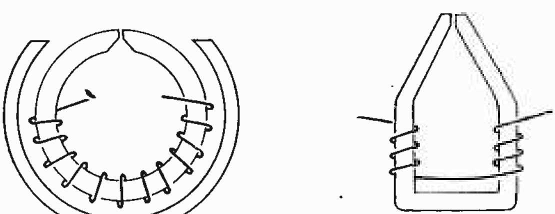


Fig. 9. Screening and poles with short tape contact affect the low-frequency response of replay heads.

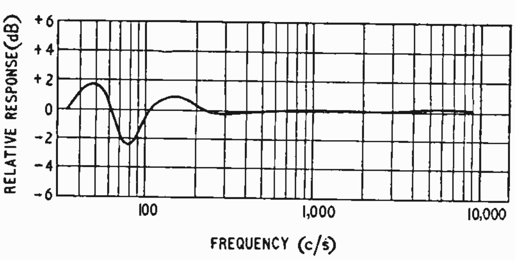


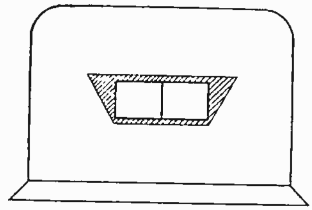
Fig. 10. Typical response irregularity at low frequencies.

a C.C.I.R. recording at 7.5 in/sec is indicated in Fig. 8, whilst the theoretical output is shown by the dotted line, the difference between the two curves represent the eddy and hysteresis losses, etc., of the particular head.

Effect of Screening Can and Pole Shape upon Low Frequency Response. The replay head is usually screened magnetically against hum pick-up from nearby motors, etc., in the machine, and also erase and bias pick-up from the erase and record heads, assuming in the latter case that the signal is being monitored by the replay head.

When the screening can is in close proximity to the tape and pole-pieces it can act as a secondary pole-piece and has the effect of increasing or decreasing the field from the tape according to the length of the tape embraced, and the signal wavelength.

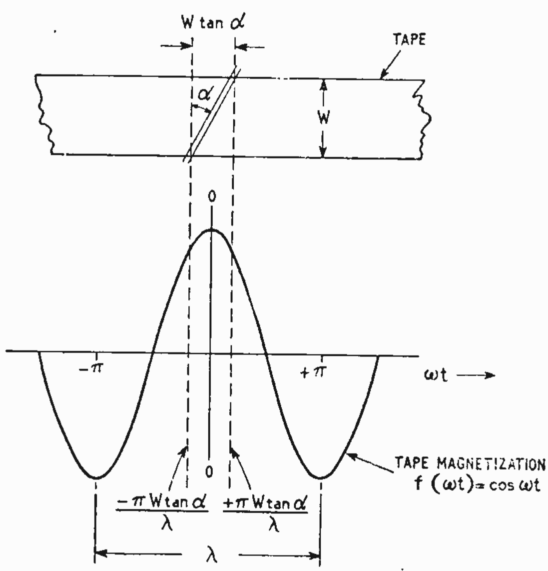
Fig. 11. Screening-can aperture shaped to reduce low-frequency response irregularities.



Any sharp discontinuity in the profile of the pole-pieces adjacent to the tape surface can also produce similar effects. Generally, these undesirable conditions can be reduced to negligible proportions by making any such discontinuity at least 5λ (max.) away from the gap, where λ (max.) is the longest wavelength that it is desired to reproduce. Typical examples of replay head are shown in Fig. 9 whilst the effect upon low frequency equalized replay response is indicated in Fig. 10. To completely overcome this type of poor low frequency response it is advisable therefore to make the pole-pieces of the replay head a smooth curve up to, and away from, the tape surface. Where a screening can is used, the edges of the aperture through which the pole-pieces protrude should be far enough away from the tape to prevent its influence upon the magnetic field of the tape, alternatively an angled aperture may be used (Fig. 11).

Alignment of Replay Head Gap to Recorded Signal Azimuth. Correct azimuth alignment is very important where good overall high-frequency performance is required. This is obtained by rotating the replay head about an axis, preferably located at the mid point of the gap width, normal to the tape surface. This mid-point location ensures that the lateral movement of the head during adjustment is kept to a minimum. The replay head is rotated until its gap is exactly parallel with the azimuth of the recorded signal on the standard tape. Adjustment is made at the high-frequency end of the audio-frequency band covered by the recording machine, i.e. where the wavelength of the signal

Fig. 12. Calculation of loss due to vertical misalignment of gap.



is approximately twice the length of the effective magnetic gap of the replay head. For example, alignment procedure can be outlined as follows. The machine (assuming a single-channel type with three heads), is set to "replay," loaded with the standard C.C.I.R. tape for the relevant tape velocity. The replay head is adjusted to give the maximum peak in output from the high-frequency azimuth band on the standard tape. Then with the standard tape removed and replaced with "clean" tape, the machine is switched to record and a tone of similar frequency recorded. The azimuth of the record head is then adjusted to give the maximum peak output from the replay head which is monitoring this signal. On a machine with two heads, e.g. erase and record/replay the latter test does not apply, but correct alignment is important where pre-recorded tapes are to be used and interchange of tapes from machine to machine is required.

The effect of azimuth misalignment can be calculated in a similar manner to the gap loss, given the angle of tilt away from correct azimuth, the width of the replay track and the signal wavelength. Referring to Fig. 12, the loss is given by:—

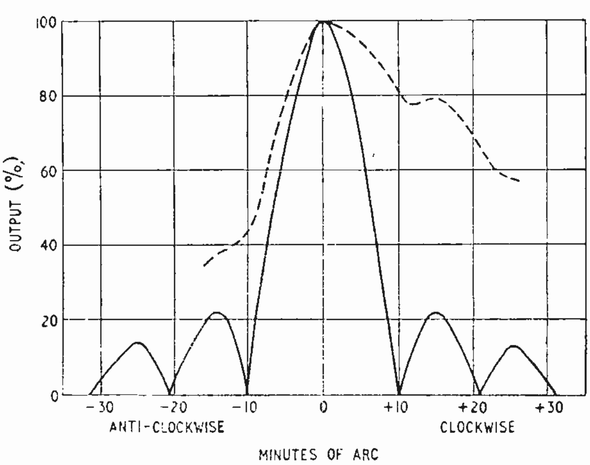
$$\frac{\lambda}{2\pi W \tan\alpha}\int_{-\frac{\pi W \tan\alpha}{\lambda}}^{+\frac{\pi W \tan\alpha}{\lambda}} \cos \omega t.d(\omega t)$$

$$= \frac{\lambda}{2\pi W \tan\alpha}\Big[\sin \omega t\Big]_{-\frac{\pi W \tan\alpha}{\lambda}}^{+\frac{\pi W \tan\alpha}{\lambda}}$$

$$= \frac{\sin \frac{\pi W \tan\alpha}{\lambda}}{\frac{\pi W \tan\alpha}{\lambda}}$$

therefore loss in dB $= 20 \log_{10} \dfrac{\sin \pi W \tan\alpha/\lambda}{\frac{\pi W \tan\alpha}{\lambda}}$

Fig. 13. Variation of output with deviation of gap from the vertical. Solid cure "ideal", dotted curve typical measured response where the gap is not straight and varies in length across the track.



It can be said that any misalignment of this nature has the effect of increasing the replay head gap to the amount W $\tan\alpha$ which of course is quite an additional effect to the actual gap itself, previously calculated.

For the machine running at 7.5 in/sec, a misalignment of only two minutes of arc at a recorded frequency of 10 kc/s will cause a reduction of output of 0.6db, assuming a full width recording on standard ¼in tape.

Using the above formula to display graphically the relation between head rotation and replay output for a given wavelength and track width, it can be seen from Fig. 13 that a number of peaks in output can be obtained, of differing amplitudes, the main peak accurring at the true azimuth. The solid line represents the ideal case, where the gap is perfect in every respect. In practice, however, various curve shapes are obtained, depending upon gap straightness, and variations in the gap length along the track width, etc. The dotted curve indicates a typical case in practice. In some cases, one of the secondary peaks may be quite large in amplitude compared with those illustrated in the ideal case, and may be mistaken for the true azimuth peak. Providing the magnetic head is rotated over a fair range, from about −2 deg to +2 deg (taking true azimuth to be 0 deg), selection of the major peak is not difficult.

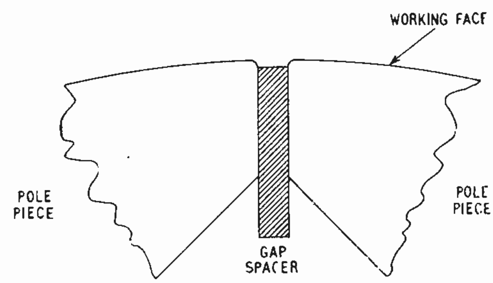


Fig. 14. "Dig-out" wear of the gap spacer.

Effects of Wear.—The performance of a magnetic head which is essentially in contact during its working life, for a.f. application, is subject to gradual change. The relationship of the various mechanical surfaces, gaps, etc., to performance have been discussed, and the back-to-front depth F is the main factor to be considered. This dimension gradually decreases with wear, until it may become zero, which is the end of the working life of the head. It was found that this dimension was inversely proportional to the sensitivity of the head, e.g., lower bias and signal currents required for a given tape level for a record head and higher output voltage from a replay head for a given tape induction (and frequency in both cases). Therefore, a magnetic head has its peak performance and efficiency just before the end of its useful life.

Spurious Effects.—Soft gap spacer material can cause a falling off in high-frequency response and, in some cases, azimuth change. The characteristic "dig-out" wear is illustrated in Fig. 14 representing a much enlarged view looking along the gap. Copper, aluminium and similar materials used as gap spacer shim exhibit this effect, for they are soft compared with the laminated pole-pieces. Beryllium copper, phosphor-bronze, etc., have been found suitable.

The pole-piece material governs the rate of wear to a large extent, and, in general, three types of alloy are in common use: "Radiometal," "Mumetal" and "Supermumetal." "Radiometal" has the greatest resistance to wear, for it is mechanically harder than the latter two alloys. It is also magnetically "harder," which reduces the sensitivity of the head to a small extent (compared with using Mumetal or "Supermumetal"), depending on the reluctances of the air gaps in the magnetic circuit. Pressure pads in many cases cause uneven head wear, and shorten the life of the head, and should be unnecessary for tape work providing the tensions are correct.

Poor finishing of the working gap face causing burring over of the pole-piece material which may bridge the non-magnetic gap spacer can cause rapid changes of response during the first few hours of operation.

Some types of magnetic head have a working face dimension which is greater than the tape width, and after some hundreds of hours use, a shallow channel of tape width is worn therein, which may cause amplitude flutter of high frequencies and in some cases frequency flutter or wow. Regrinding during the working life of the head is then desirable. At all events, it can be recommended that any new magnetic head should be "run-in" before tests are made, by passing a few thousand feet of tape across them.

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FERROELECTRICS

2.—DOMAINS: AND SOME APPLICATIONS OF CERAMICS

By J. C. BURFOOT, Ph.D.*

THE first article described the spontaneous polarisation P of a single domain of a ferroelectric, and its hysteresis loop, and showed that although ordinary ferromagnetism is due to *permanent* dipoles, in ferroelectricity *induced* dipoles can also be involved. The ferroelectricity disappears above a transition temperature T_0, and near that temperature, the dielectric constant ϵ and some of the piezoelectric and elastic coefficients show anomalously large values which can be related to the polarisability α. The dipoles and the large polarisabilities occur for different reasons in different materials; we cannot generalise.

Materials.—The earliest material known to be ferroelectric (1921) was the tartrate named Rochelle salt ($NaKC_4H_4O_6 . 4H_2O$); potassium dihydrogen phosphate (KH_2PO_4) followed in 1935, barium titanate ($BaTiO_3$) in 1944, and guanidine aluminium sulphate hexahydrate, familiarly known from its initial letters as gash, in 1955, and some alums. It will suffice to study the first three and allied chemicals, but ferroelectricity has also been found in ammonium sulphate and fluoberyllate, thiourea, colemanite, glycine sulphate, and others. The T_0 values range from $-260°C$ to about 600°C. Some values are given in Table I. Other members of some of these groups are anti-ferroelectric; that is, their individual dipoles are arranged in ways which produce zero overall polarisation, though dielectric anomalies remain.

In applications of ferroelectrics it is inconvenient to have to keep the *temperature* T such as to give particular values of the properties being used. So it is important to be able to select a *material* with which room temperature (or working temperature) is suitable. Similarly the values available for the given property should cover as wide a range as possible, and if the anomalies can be made either very peaky (against T) or flat, as required, there will be more applications. As one example of such versatility, here in single domain properties, consider replacing some of the barium in barium titanate crystals by lead. It happens that in this case all compositions of this solid solution are possible, and all are ferroelectric, and T_0 increases continuously from 120°C to

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490°C as the percentage of lead increases. Iron impurity deliberately introduced into barium titanate lowers T_0; 5% of iron lowers it 100°C; the resistivity is also altered. There are other possibilities when we consider polycrystalline forms.

The crystal structure of barium titanate and lead titanate ($PbTiO_3$) is shown in Fig. 7(a). Above T_0, the lattice cell is cubic, 4Å in size (254 million Å = one inch), and the titanium ion is at the centre. Below T_0 it is displaced by an amount x, equal to 7% of the cell-side, relative to the octahedron of oxygen ions (in $PbTiO_3$); the A ions are displaced 11% in the same direction. In barium titanate, the corresponding figures are 3% and 1½%, but in this case, the octahedron is also distorted, the ions marked I being displaced 1% in the opposite direction. It would not be correct to assume a dipole strength made up of terms like (4e times x) for the titanium for two reasons: (i) the crystal bonding is not all "ionic," so the effective charge on the titanium is less than 4e, (ii) each off-centred ion is in a local field which must distort the electron cloud surrounding it, because of *electronic* polarisability, so that each ion becomes itself a dipole at its displaced position, and of unknown strength. Notice that the extent of off-centring quoted is that which is observed; it gives no indication whether or not it is induced (by co-operative effects). Also below T_0, because of the spontaneous polarisation P now developed, the electrostriction discussed in the previous article in relation to Fig. 6(b) causes a spontaneous strain $S \propto P^2$; actually the cell becomes about 1% elongated in the direction of P, with very little change of volume. This elongation is many orders larger than similar effects in ferromagnetics.

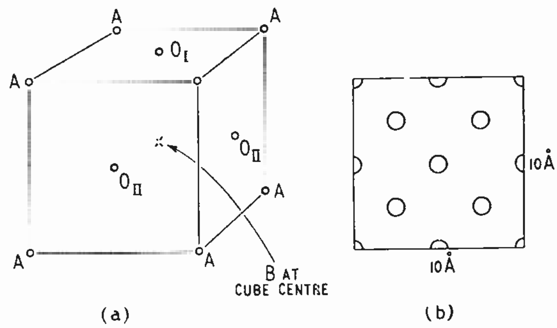


Fig. 7. (a) Perovskite cell ABO_3. A = Ba^{++} or Pb^{++} etc., B = Ti^{++++} etc., O^{--}. (b) Centres of PO_4 groups in KH_2PO_4, projected on horizontal plane.

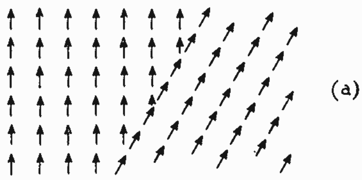
TABLE I

Material	T_0 (°C)	Max. P (μ coul. cm^{-2})	Material	T_0 (°C)	Max. P (μ coul. cm^{-2})
$BaTiO_3$	120	26	KH_2PO_4	−151	4.8
$KNbO_3$	415	30	KH_2AsO_4	−177	5
$PbTiO_3$	490	~100?	RbH_2PO_4	127	5.7
$KTaO_3$	−260		RbH_2AsO_4	−162	
$NaTaO_3$	475		CsH_2PO_4	−114	
$LiNbO_3$	>450		CsH_2AsO_4	−130	
$LiTaO_3$	>450				
$CdNb_2O_7$	−88	~10	Gash	—	0.6 at −180°C
$PbNb_2O_6$	570	~10?	Methyl ammonium aluminum alum	−96	0.6 at −107°C
Rochelle salt	24	0.25	Ammonium sulphate	−49	0.25 at −58°C
Lithium ammonium tartrate	−170	0.22	Ammonium fluoberyllate	97	0.19 at −110°C
Lithium thallium tartrate	−260	0.14	Thiourea	−105	3.1 at −110°C
			Colemanite	−2	0.5 at −38°C
			Glycine sulphate	47	2.2 at 15°C
			Glycine selenate	22	

Rochelle salt is unusual in that it also has a lower transition temperature, below which the ferroelectricity disappears. This will not be discussed in these articles. Gash decomposes before reaching T_0.

In Rochelle salt, the unit cell contains 4 each of the atoms given in the chemical formula, and is a very complicated structure. In KH_2PO_4, the cell containing 8 each of the formulae is about 10Å, 10Å, 7Å. The K atoms and PO_4 groups are centred 3½Å vertically apart, if we describe the 7Å cell dimension (the ferroelectric axis) as "vertical." But those PO_4 groups whose *projections* in Fig. 7(b) are neighbours are only separated vertically by half of 3½Å, so that the top of one PO_4 group is level with the bottom of a neighbour. Then in a PO_4 group each top O is only 2½Å from an O belonging to the bottom of another PO_4 group, the line of separation being almost horizontal. Midway between each of these close oxygen atom pairs is a hydrogen atom; its position has been discovered by neutron diffraction experiments. Below T_0, the hydrogen atoms move along the O-O line, 0.20Å from the midway position, in such a way that each PO_4 group finds two of the four hydrogen atoms closer than before; the P atom, in that PO_4 group which is approached, moves vertically away from that O atom by 0.05Å; the K atoms move 0.06Å vertically the other way. Thus the hydrogen displacements cannot cause the polarisation, because they are across the ferroelectric axis. But apparently their charge causes the necessary polarisation vertically in the PO_4 groups. Also below T_0, the spontaneous P together with the piezoelectric effect causes a distortion of the 10Å × 10Å base so that its angles are now ½° different from right-angles.

These structures are relatively simple, and indicate the very different natures of the dipoles in different ferroelectrics. The ferroelectricity of gash and others with H_2O groups could be associated with H situated between O-O as in KH_2PO_4. But there may also be effects due to N-H-O combinations, and in ammonium sulphate, for example, only the latter is possible. Ammonium fluoberyllate ($(NH_4)_2BeF_4$) shows the O is not essential. In non-ionic thiourea (NH_2CSNH_2), the responsible structure is N-H-N or N-H-S. Notice that in KH_2PO_4 there is one unique crystal direction for the ferroelectric axis, whereas in the barium titanate type, there are three equivalent directions (six senses) and the co-operative



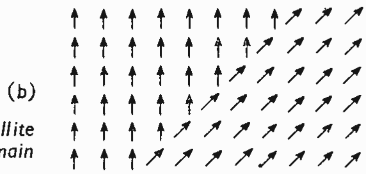


Fig. 8. (a) A crystallite boundary, (b) A domain wall.

effects select one, either at random or under pressure of the piezoelectricity. These "easy" directions are determined by the forces controlling the crystal structure as we have now seen, and by the piezo-electric effects. We saw one example of this "anisotropy" in the previous article when discussing the values of the dielectric constant ϵ in different directions.

Domains.—We have so far discussed the ferro-electric material as though it were a perfect crystal lattice, with aligned dipoles, extending in all directions. But in fact many of its most interesting properties occur because this is not true. Just as in magnetics, the material contains domains, i.e., regions defined by the dipole alignment; in each domain the alignment is different. You must distinguish carefully between a domain and a crystallite (in polycrystalline material). Crystallites are differentiated by a break in the lattice, domains by a "break" in the direction of alignment. The distinction is shown schematically in Fig. 8. Usually domains are the smaller entity. Ferromagnetic properties are largely determined by the domain structure. We shall see that there is special interest in materials in which the grains are so small that separate domains cannot form in them.

In Fig. 9(a) the field E shown will bodily reverse the polarisation in the domain Y. The simple theory which disregarded domains, will show how large E must be to do it, and this field value (which is often enormous) would be the coercive field. But if domain walls are present, they can move, and in Fig. 9(a), E will tend to cause the wall to move to the right, till the whole crystal is one domain instead of two. This may be a much easier way to do it than the other, so that the measured coercive field is very much smaller than the value from the simple theory. If a wall is not present (Fig. 9(b)), one may nevertheless form, say at the left edge, if this "nucleation" of a wall happens to be easier than reversal. The wall shown is a "180° wall"; more complicated structures usually occur.

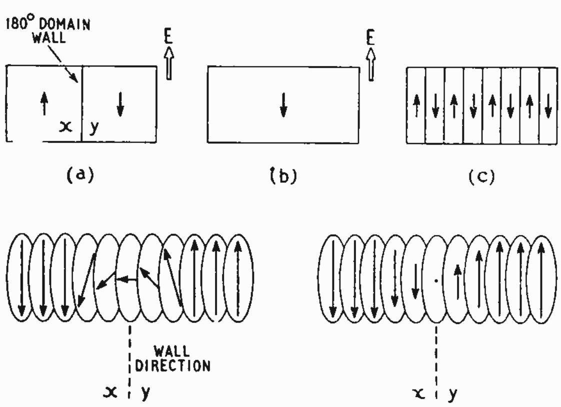


Fig. 9.

A wall between domains may not be a happy thing, in spite of there being (Fig. 8(b)) no lattice misfit there. (For the moment I ignore the differences of cell size in neighbouring domains due to polarisation.) It depends on the details of the way P changes over its direction and magnitude from the one domain to the other. In addition, the changes of cell size due to polarisation may be different in neighbouring domains, so that some lattice misfit does after all occur. There must be some distortion of the ideal lattice near the boundary to conform with this, and since this may extend some distance from the boundary, the wall must be regarded as having a thickness. In magnetics this may be a hundred lattice cells; in some ferroelectrics, less than one.

The interplay of these factors affects the polarisation "in" the wall thickness, either in direction or magnitude, in a complicated way. Figs. 9(d),(e) show details of two of the possibilities in the simple case Fig. 9(a). Here I have supposed there are only two easy directions of polarisation: up and down; if this anisotrophy is strong the detail suggested in Fig. 9(d) is a strong violation, and the material may prefer 9(e). But the cell sizes change with polarisation, and 9(e) may involve more elastic "discomfort."

These microscopic details of the wall are usually summarised by a single number, calculated if possible from the detailed knowledge above, and called the wall energy per unit area of wall, e.g., in cobalt the wall energy is $\sigma = 8$ ergs./sq. cm. The purpose of this is to be able to discuss domain changes on a relatively large (macroscopic) scale, temporarily forgetting the microscopic detail. σ is defined as the work that would have to be done if we could form the *wall** deliberately, and it is used, for prediction of domain behaviour, by the well-tried principle that the total work done must be as small as possible (principle of minimum energy). However, the figure used can be different for a wall in different situations, so that σ must be used with caution. Often in practice, σ is deduced from experiment, rather than calculated, and is then used to predict the results of of other experiments.

Wall Movements.—The work done (hypothetically) in forming an imagined *domain structure* (compare above*) differs according to where any particular wall is supposed to be. This is partly because the wall area may differ, partly because impurities and local imperfections of the lattice may alter σ, and partly because the bulk of the material would be harder to force into state y than into state x (Fig. 9(a)) when E is present. Also because of the polarisation, there may be "free pole" at the crystal faces, and in some cases also at domain walls; this may be regarded as the source of disturbing fields which affect the work necessary. Ferroelectrics differ from ferromagnetics in this respect because, since they are not perfect insulators, charge carriers can migrate through the material to compensate any free pole if given sufficient time; this

(*Continued on page 329*)

does not occur in ferromagnetics, because carriers of single magnetic poles do not exist. The wall position adopted is the one (A) needing minimum work, but there may also be positions (B) corresponding to local minima, i.e., neighbouring positions to (B) may be less favourable than (B), but position (A) would be better. A wall may become trapped at (B), unable to reach (A) because intervening positions correspond to higher energies. Nucleation of a new wall may be easier than intrinsic reversal, but more difficult than moving an existing wall. Here also we can regard nucleation as being difficult because there is a high-energy situation intermediate between the states " before " and " after."

When a field causes an existing wall to begin to move, it does so at a measurable rate, and the account may be made simpler by using an effective " mass " for the wall, to describe this sluggishness or inertia. Other macroscopic concepts are adopted also, such as an " elastic " binding to position (B). This can be broken and there may be " frictional " and "viscous" oppositions when the wall is moving.

Much of the modern mastery of magnetic materials in production is through techniques to control these factors influencing the wall motions, for example by controlling the nature and distribution of the impurities. Above the coercive field, the viscous impedance to wall motion controls the rate at which the walls move. For magnetic walls it is due to eddy current damping, magnetic relaxations, or other effects, and is rather imperfectly understood; in ferroelectrics it has as yet hardly even been measured.

The coercive field is that field which only just provides sufficient drive to move the walls across material containing traps. Until that occurs, the viscous impedance cannot operate. To account for the coercive field, however, it is not knowledge of the viscous impedance which is needed but an evaluation of that factor which makes the driving field H inoperative below a certain value. This is explained for magnetics in terms of the local trapping already described; we saw that the external field affects the energy functions which control the wall; when H is as great as H_c, the neighbouring positions are no longer energetically unfavourable and the escape is made. Control of the impurities therefore controls H_c. At smaller fields, the wall may still move slightly, while remaining bound, and will return to (B) when the field is removed. This gives the bottom part of the hysteresis loop.

If the traps are not all equally deep, the escape may allow the wall to move only to a neighbouring trap, unless a slightly larger H is applied; thus the steep side of the hysteresis loop is not usually vertical. But if a barrier against nucleation must be overcome first, and is a higher barrier than any trap barriers, the loop side becomes vertical. This is seen in some ferroelectrics. If in addition the only P directions involved are those parallel and antiparallel to E, then higher E cannot cause further slight increases of the overall P by turning it from the easy direction towards E, as happens in magnetics. So no rounding of the loop corners occurs—the loop is " square."

There is another point to consider, however, *viz.* that thermal random motions may overcome barriers without such large applied fields. This becomes *very* rapidly impossible as we consider higher barriers, but in any case when the barrier (against escape from a trap, or against nucleation) is low enough for this possibility to be worth considering, we have to recognise the fact that it leads to results whose characteristics are quite different. For when thermal activation is a possibility, the passage from (B) to (A) will always occur, given only sufficient time. This appears to be the case in some ferroelectrics, and we shall see later that it leads to important restrictions on the use to which we can put the material.

We have seen that the breadth $2E_c$ of the hysteresis loop is not a simple intrinsic property of the crystal lattice, but is strongly influenced by the domain structure. So are many of the other properties previously discussed in terms of single-domain theory. For example, in Fig. 9(c), the overall P may be very small, although P for each layer is large. The dielectric constant ϵ, which measures changes of P in response to changing E, would be unaltered in such a structure; it may even be a little increased if the walls are free to move sideways so that in a given field the favoured layers increase in size at the expense of the alternate ones. (This contribution of wall motions to the dielectric constant would disappear at higher frequencies because of the inertial property of the wall.) However, the piezoelectric effect of E is opposite in alternate layers, so that they impede one another's changes of shape and the P changes are reduced; this reduction in ϵ is a clamping effect additional to that which occurs even in a single domain if the frequency used is above the mechanical resonance frequency of the piece of material. Clearly the apparent piezoelectric coefficient of such a structure is also less than the intrinsic one and this decrease will be greater the thinner the layers are.

Domain Structures.—The domain structures in ferromagnetics may be very different from those in ferroelectrics. For we saw that the spontaneous distortions are very much less in magnetics. Also because carriers of free pole do not exist, ferromagnetics often have " closure domains," which are domains in the crystal surface oriented to avoid free pole at the surface. Similarly, powdered materials in which the particles are too small to break up into domains (because the wall energy would form too large a proportion of the total energy) are unable to become polarised spontaneously, and so always retain the cell sizes typical of temperatures above T_0. This is because of the self-depolarising effect at the surfaces of the particles, an effect which is 1000 times bigger than in magnetics. This " unnatural " cell size is observed for KH_2PO_4 particles smaller than six-millionths of an inch. But in a conducting liquid, even particles as small as two-millionths have the normal cell size, because the surface polarisation can be neutralised by charges migrating through the liquid. KH_2PO_4 is a very good insulator, so that migration through itself is relatively slow.

Magnetic domains can be made visible because suitable tiny magnetic particles floated on to the surface will move into the fields at the domain interfaces and a similar technique has recently been reported for ferroelectrics. Most investigations have made use of the fact that plane-polarised light, sent through ferroelectric material in a direction across the ferroelectric axis, travels differently according to the orientation of its polarisation, so that a polarising microscope will show up domains differently. This method will not distinguish domains with antiparallel polarisation, and for these it is usual to etch the crystal faces; a suitable etchant will attack the positive ends of domains more than negative ends and the resulting pits can be seen in an ordinary

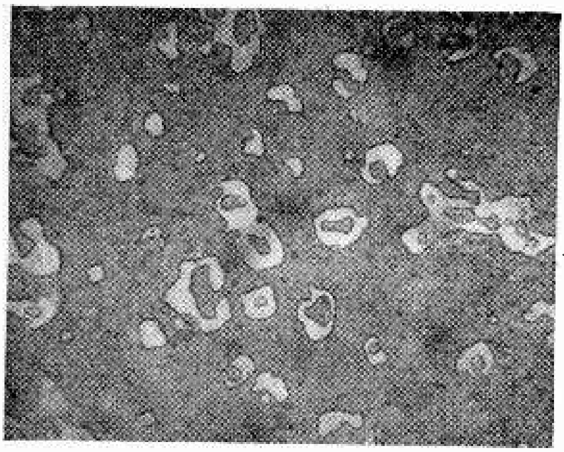


Fig. 10. 180° domain walls in a barium titanate crystal.

microscope (Fig. 10). None of these methods will display rapid alterations of domain structure.

Ceramics.—Ferroelectric devices have mostly used barium titanate, with or without additives, because of the high values of its various coefficients (ϵ, d, . . .) though Rochelle salt has been used a good deal for transducers. A few words about crystal material will serve to show why ceramic forms are often used instead.

Crystals of barium titanate are grown by crystallisation from potassium fluoride flux, a highly unpleasant material, in platinum crucibles, with the addition of tungsten trioxide or perhaps iron to obtain large crystals, that is, up to 1 cm across. The process depends on the correct thermal gradients and concentration gradients, and often only a small proportion of the extract consists of good crystals. Sodium carbonate and barium chloride fluxes have also been used, in carbon crucibles, and in inert atmospheres, and crystals have been grown also by special techniques from the pure liquid, but a hexagonal or cubic lattice which is not ferroelectric readily results instead. When successful, the crystals are about a tenth of a millimetre thick and exceedingly fragile. A good crystal should have the ferroelectric axis everywhere directed through its thickness. There are unwanted " twinning " domains for which this is not so. These can usually be removed by " poling" with a temporary d.c. field, for a small voltage applied between the faces of these crystals gives a field of several kilovolts per centimetre. But even this process can easily fracture the crystal, because of the high stresses set up by the piezoelectric effect at the edges of these twinned areas. The geometry is such that these stresses do not occur at the 180° walls discussed earlier.

The ceramics are made by grinding barium titanate (or its components) and any additives, and by extrusion or pressing with or without a binder, and sintering at high temperature, say 1200–1400°C, to make a glassy product. The result may be regarded as a very complicated polycrystalline material, with the crystallites randomly directed, unless the manufacture included the application of special fields. Many of the crystallites will have grown into one another at their corners by a diffusion process. In general, each crystallite contains several domains, and the domain walls can move under electrical or mechanical stimulus in ways similar to those for single crystals. The one-directional properties discussed earlier will be " averaged out " in the virgin material and though this may be altered by applying fields, it is clearly not so easy to explain simply the properties of such materials. But the ceramics are hard and resistant and can be made any reasonable size or shape. Solid electrodes can be fixed on to them in a number of ways, including evaporation, printing, or the firing-on of metallic pastes. Finally they may be given protective coatings, especially if they are at all porous.

Each crystallite is in a polarised state and may be highly stressed because of its surroundings. Without electrical treatment, the polarisation will average out to zero. A small field will lengthen some grains and shorten others during the time it is applied, so that the apparent piezoelectric coefficients (d, etc.) will also be small or zero. But the effect of that field on the intrinsic polarisation of the various parts, is to increase it where it is positive (say) and decrease it where it is negative. Thus *these* effects do not average out, so that the dielectric constant ϵ can be measured and used as an index of the extent to which the ceramic properties approach those of the single-crystal material. Usually more intense sintering makes for higher ϵ, an improvement which can also be followed by watching the density of the ceramic. The crystal density is 6.0 gm/cc. and ceramic densities about 5.7 cm/cc. are common.

" Poling " the virgin ceramic causes some degree of alignment, so that hysteresis loops and the other properties we have discussed can now be observed. The polarisation now lies, not all parallel as in a single crystal but along the nearest easy direction (to the poling) in each crystallite. It can be shown that the maximum P possible should then be 86.6% of the single-crystal value (26 microcoulomb/cm² in barium titanate). But the high d together with stresses left in manufacture and stresses introduced by poling, and the gaps between crystallites, means that only about 7 microcoulombs/cm² is achieved as retentivity. The saturation value may be twice as much, so it is clear that the loop no longer has the " good " square shape.

Similarly, the piezoelectric coefficients are, say, a quarter of the single-crystal values. It is interesting too that when the applied field causes thickness expansion of a disc of the material, the accompanying radial contraction, quoted as a fraction, is often *less* than half the fractional thickness change, because thickness expansion of the crystallites shows up as an expansion of the disc, whereas to some extent radial contraction of the crystallites can occur without full corresponding contraction of the disc. In a crystal, the contraction in each of two directions is half the expansion in the third, so there is no volume change; in the ceramic there is an *apparent* change of volume.

As in the crystalline forms, T_0 and the other properties can be altered by suitable additives, and now the state of sub-division and the nature of the annealing provide further controls since they alter the internal stresses. In this way one can make the curves of the various anomalies (against T) less peaky for applications where this is desirable; usually the maximum value will then be less. If the internal stresses are not very uniform throughout the material, there will be a spread of T_0 values, and the flattening may be thought of as due to the superposition of these. In barium titanate ceramics ϵ

increases as grain-size decreases. Added calcium titanate lowers P and raises the coercive field E_c; 10% raises it from $2\frac{1}{2}$ to 5 kV/cm. Admixtures of strontium titanate give values of T_0 which differ under different heat treatment during preparation, as the barium and strontium ions rearrange themselves; the strontium ion is 11% smaller than the barium ion so that certain special regularities of arrangement will occur if temperature conditions allow. Addition of antimonates is said to reduce ϵ at T_0. It would be impossible to summarise all the possibilities. I shall merely quote arbitrarily some of the many materials which have been used.

Applications.—Some uses of ferroelectrics depend on the large values of some of their properties near T_0; others depend rather on the non-linearities, e.g., P plotted against E is not a straight line as in ordinary dielectrics, and the small-signal ϵ is not constant against signal size and bias. In general, the first group has been well developed over a number of years so that devices are commercially available, while the second group is largely represented by development work, and "one-off" models to be found in various laboratories.

In the first group the non-linearities are usually a nuisance to be minimised if possible, and the valuable high coefficients, as we have seen, depend strongly on temperature. The hysteresis loop in particular, for applied voltages large enough to traverse it, causes losses due to the energy dissipated as heat, and this in turn is likely to cause drifts in the coefficient being exploited (ϵ, d, etc.), due to the temperature changes. Questions of temperature stability therefore become important. Many well-known electro-mechanical transducers use ferroelectrics because of the large values of d available, and miniature capacitors may use ferroelectric dielectrics because of the high ϵ.

The second group *depends on* the non-linearities, and here there is one large subgroup which does not use the hysteresis and another which does. Each covers a range of possibilities, but for the first we may use the envelope name "dielectric amplifiers," and the hysteresis uses are largely of interest in digital computers, either as memory devices or for switching purposes.

Transducers.—Devices which convert small mechanical oscillations or impulsive motions into electrical signals include microphones, gramophone pickups, vibration detectors, accelerometers, detectors for ultrasonic waves, strain-gauges, and detectors for small displacements. Those which convert electrical signals into mechanical motions include vibrators, loudspeakers, sonic pulse generators in delay lines, and generators of ultrasonics for non-destructive probing of solids, for determinations of physical properties, for cleaning of surfaces during various processes, and for cutting difficult materials. We must consider also the use of piezoelectric crystals to determine and control oscillator frequencies, and their use in narrow-band wave filters, e.g., to remove an r.f. carrier from the sidebands; these uses depend on the fact that a piezoelectric crystal has a natural frequency of resonance determined by its geometry, and that with electrodes it behaves electrically for nearby frequencies as an impedance often represented as a series LCR combination and parallel capacitance. The effective Q factor can be made very high by careful mounting, sometimes in a vacuum and the device is used as the heart of the filter.

We saw that ferroelectrics exhibit an effective piezoelectricity below T_0 due to the spontaneous polarisation P acting as a bias, so that they may be used in any of these piezoelectric devices. The ceramic forms must be poled to produce the P. The time and temperature instabilities of ferroelectrics mean that where high frequency-stability is sought, quartz is still used. But in many of the other devices, ferroelectrics have been used for many years, initially Rochelle salt, but increasingly barium titanate and its derivatives. This is so particularly in view of the versatility of the ceramic forms, which are made in blocks, discs, hollow cylinders, and many other shapes, and in sizes up to several inches; shapes can be arranged to focus radiated acoustic energy. Fig. 5 last month showed d values around 10^{-6} statcoul./dyne, 100 times larger than quartz values. (Divide by 30,000 for values in coulomb/newton.) In addition, the high ϵ values of ferroelectrics give the devices lower capacitive impedances than with traditional materials, so that the charge measurement at low frequencies is easier.

The cutting and plating of piezoelectric materials is a well-documented subject. The piezoelectric uses of ferroelectrics do not differ in principle, and this is not the place to repeat the details. We have already discussed the various piezoelectric coefficients. Briefly, when in use to produce mechanical stress or motion, the mechanical impedance of piezoelectrics is high enough to match well into liquids or solids. For use in air, the lower mechanical impedance and greater motion of a bimorph unit or "bender" is used (Fig. 11); the variations of response

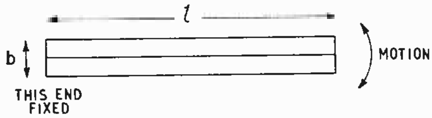


Fig. 11. Bender unit. The components are cut so as to vibrate longitudinally in opposite directions. They are cemented together and the motion shown is 3l/b times greater than the longitudinal motions.

with temperature are then less. Twister units are also used. The *natural* frequency of any piezoelectric device is altered by altering its dimensions; the natural frequency of a bender is relatively low, so that they are in use for audio-frequency devices. For ultrasonics (say 100 kc/s) a simple longitudinal vibrator may be used, and a more perfect single resonance is then generally obtainable. For work in the megacycle regions one may use the thickness vibrations of a suitably cut plate of the piezoelectric (transverse vibrations are also used). For this mode, the mean frequency used will correspond to a wave length $2b$ if b is the crystal thickness (e.g., b about 1/20 mm in X-cut quartz for fundamental 60 Mc/s). Here the requirement is usually that over the required frequency range as much of the electrical power as possible should be transferred. Suitable design may give 70% transfer over a frequency range of 10%. The input signal to a ferroelectric must remain small enough to avoid disturbing the spontaneous P so a high E_c is an advantage. 4% lead titanate in barium titanate ceramic has allowed transfer of 1 watt per sq. mm. For microphones, on the other hand, power is not so important as uniform response over a large frequency range. 5% barium zirconate (itself not a ferroelectric) in ceramic barium titanate is suitable for transducers, its natural frequency changing 4% over 50C°.

In pickups, a 30-mil 2-cm element will give signals of 1 volt. Ceramic barium titanate benders now replace Rochelle salt, which cannot survive high humidity. For pressure-sensitive microphones, double strip designs include cases in which the ferroelectric is the diaphragm disc, and others where a metal diaphragm actuates the free end of the strips. Vibrators and accelerometers may often be used in combination, to excite vibrations in engineering structures at selected frequencies and to detect the amplitude of the response; when the structure is part of a rotating machine, both devices must often be light; an ⅛in × 10-mil barium titanate strip has

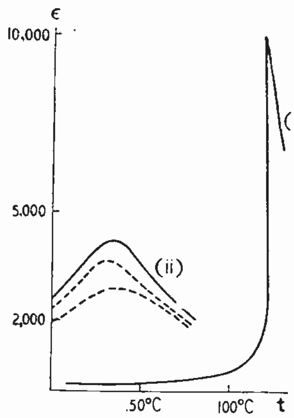


Fig. 12. Dielectric constants. (i) Barium titanate crystal, along ferroelectric axis; (ii) A typical ferroelectric ceramic. Dotted curves, effects of bias (10 and 14 Kv/cm).

produced 10 millivolts for movements of 1 part in a million of its size. This is an order more than resistance strain-gauges, and a vibration strain-gauge giving 100 mV for 1 in a million has been reported more recently.

Capacitors.—The high dielectric constant of ferroelectrics near T_0 leads to their use in capacitors wherever high value or small size is required and temperature stability is not too important. Fig. 12 shows the dielectric constant of barium titanate crystals and the results achieved in ceramics by additives such as strontium titanate or calcium titanate. In these the high ϵ range has been brought down to a convenient temperature, and flattened to improve temperature stability. The ϵ peak values indeed are lowered, but the value at operating temperatures is not. The high ϵ values allow capacitors to have smaller dimensions and they can be in any of the standard shapes. Pressing is used for the familiar disc-shape, and extrusion for capacitors of cylindrical shape. Power factors are usually about 0.01. For capacitors, of course, the non-linearity is a disadvantage, and results in the ϵ value increasing if measured with a larger a.c. voltage, and also altering if there is any bias across the capacitor. Fig. 12 shows the effect of bias. The non-linearity is less marked away from low frequencies and T_0. Mixtures of zirconates and niobates are also used, particularly when higher temperatures are encountered; T_0 is high for such materials as lead titanate, potassium and lithium niobate (see Table I), and some antiferroelectrics, but it is often falling resistivity of ceramics which limits their use at high temperature.

Very small components are made with ceramic films only a few mils thick. These have working voltages around 300 volts d.c. and breakdown at about 1 kV, for values up to 0.01 μF; higher values are made by packing several such films together, as in mica capacitors. The lead inductances can be kept low since the components are small. The leakage conductance varies strongly with temperature, but it has been kept up to 200 megohms well above 100°C for 0.1-μF film capacitors.

The ϵ and the power factor of ceramics "age" over several months, ϵ (and also d) decreasing 20%, while Q increases. For most purposes, the values are stable enough several weeks after manufacture, or appropriate heat treatments will remove the aging. We saw that ϵ is partly due to the domain walls moving when a field is applied. In a ceramic the walls are subject to more stringent interference by irregularities than in a crystal. We may expect it to be more difficult to escape from a temporary trap B to the "deepest" trap A, and this will take place only after some time. Once there, the motions are more restricted, so that ϵ is then smaller. The power factor, for frequencies below 10 Mc/s, also ages and has been ascribed to movement between traps.

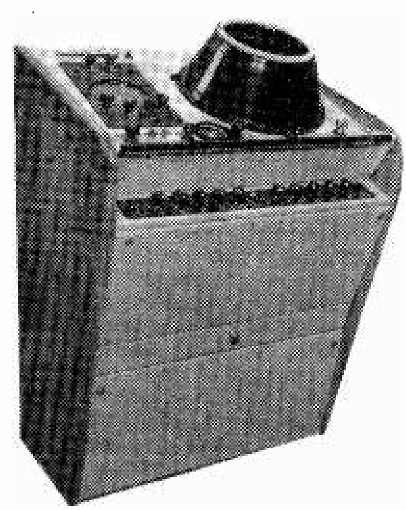
Poor electrical strength means that ferroelectrics are not very suitable for power capacitors. The instability with time and temperature results in their being used for by-pass and blocking capacitors, and also as smoothing capacitors at higher voltages, rather than in tuned circuits.

Acknowledgements

A section of the photograph Fig. 10 was used in a paper by the author in *Proc. Phys. Soc.*, 1st April, 1957. Fig. 12 (i) is taken from a paper by W. J. Merz in *Phys. Rev.*, **76**, 1221, 1949, and (ii) and the dotted curves from Fig. 7 of a paper by P. Popper in *Journ. Inst. Elec. Eng.*, **2**, 450, 1956.

(To be continued)

RANGE OF MARINE RADARS



"Unit System" has been adopted by Kelvin-Hughes for their new range of marine radars. Standard scanner and transmitter receiver are combined with alternative displays, power supplies and motor-generators to form range of radars to suit most requirements. Photograph shows largest display unit (Type 14/16P) which uses 16-in c.r.t. and provides reflection-plotter and true-motion facilities.

PARIS AIR SHOW

NAVIGATIONAL AND COMMUNICATIONS EQUIPMENT AT THE 23rd SALON

A PREDOMINANT impression gained from a brief visit to this year's Salon International de l'Aeronautique at Le Bourget airport was the extensive use of transistors in all kinds of aircraft radio equipment. As an example the French firm C.S.F. showed a light, fixed-loop radio compass which weighed only 12 lb, compared with the 40 lb of previous models, and measured only 14.6cm × 16.5cm × 11.4cm. It has push-button selection of four pre-set frequencies and the directional accuracy is ±2°. Current consumption is less than 400mA. This firm also had an f.m. radio altimeter which was transistorized except for the transmitter oscillator. The weight was 20 lb. Accuracy of measurement was 10% above an altitude of 100 ft. On the Air-Equipement stand an automatic pilot equipment was noticed which used silicon transistors throughout, and this design has already been installed in a good many American military aircraft.

On the communications side an outstanding example of what can be done by transistorization was the neat Bendix RA-21A v.h.f. receiver. This provides for 560 channels at 50kc/s spacing in the range 108-136Mc/s. It is a triple superhet circuit, transistorized except for four valves in the front end, and uses printed wiring and inductors. There is an automatic tuning system utilizing rotary stepping solenoids, and the selected frequencies are displayed by a digital indicator. The receiver unit, including power supplies, weighs only 8 lb, and measures 7¾in × 2⅜in (front panel) by 12¼in deep.

This receiver can be used for communications alone or as an input to a navigation unit, which is a fully transistorized equipment of corresponding size giving VOR (v.h.f. omni-directional radio range) and "localizer" information. The companion v.h.f. transmitter for these receiving equipments gives an r.f. power output of 25-30 watts. It is transistorized in the i.f. circuits and the switching relay circuits and weighs 14½ lb including power supplies

It is well known, of course, that transistors are now being used in the electronic circuits of guided missiles, where their small size, reliability and low power consumption are particularly advantageous. As an example, G.E.C. were exhibiting a transistorized version of the guidance equipment for the Royal Navy's ship-to-air guided missile Seaslug. The equipment is made up of 40 units, each of which is readily replaceable. Printed circuits are used in these units and also in the "cable form" which consists of two double-sided printed boards extending along the whole length of the equipment. The system is said to be about half the weight and size of the equivalent valve equipment and to require only one third of the operating power.

A transistor pre-amplifier, designed as a replaceable plug-in unit, is used in a Murphy airborne tape reproducer which operates at 3¾in/sec and weighs 20 lb. This equipment has separate heads for the two tracks on the tape and when the tape is automatically reversed at the end of its travel (by a microswitch control system) the appropriate head is switched to the pre-amplifier. The reproducer is intended for use in conjunction with a passenger announcement equipment, and there is an automatic fade-up and fade-down system to avoid abrupt changes between the recorded programme and the announcements.

Incidentally, this firm also displayed their "leader cable" equipment which is used in the blind landing system recently developed by the Royal Aircraft Establishment. The principle of this azimuthal guidance system, based on the magnetic fields picked up from two cables laid either side of the runway, was described in our December, 1958, issue (p. 579). The a.c. signal frequencies in the two cables are 1,070c/s and 1,750c/s respectively. After separation by filters in the airborne receiver the two signals are applied to a cathode-follower comparator circuit. Any inequalities in amplitude, due to the aircraft being displaced from the runway centre line, cause the comparator to produce an unbalance voltage which is fed as a correcting signal to the aircraft's automatic pilot.

A good many radar equipments were on show, of course, some of them being associated with computer-controlled systems for automatic navigation and fire-control in fighter aircraft. Such a system was shown by the French firm S.I.N.T.R.A. for use with the famous fighter aircraft Mirage III. In the sphere of ground-based radar an interesting development of special value to traffic controllers was demonstrated by C.S.F. This was an image transformation equipment by which radar displays can be presented with enhanced brilliance on television screens. The heart of this equipment is a special storage tube, TMA 403, with a p.p.i. "writing" section at one end and a television-scan "reading" section at the other end. Storage time can be varied by an operator from a few seconds to several minutes.

The idea of the system is to avoid the need for viewing radar screens in a darkened room—often a source of difficulty in airports because the control tower staff cannot always leave their posts to look at the radar. Furthermore, because of the storage facility provided by the image transformer, it becomes possible to see the routes of aircraft by the tracks they leave on the screen.

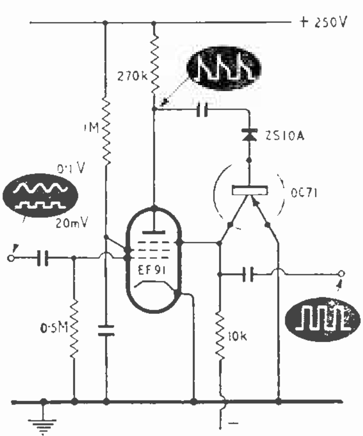
The demonstration by C.S.F. at Le Bourget was actually a television display of a p.p.i. radar picture generated at Orly airport (to the south of Paris)—showing that transmission or distribution of radar pictures over long distances is a practical proposition. The transformation was done at Orly and the 625-line television picture was transmitted northwards to Le Bourget by microwave links.

Apart from the advantages mentioned above, this system, which has already been installed in a good many American airports, offers the possibility of mixing other sources of display information with the radar picture. For example, distance marker rings or "electronic maps" can be superimposed on it.

Technical Notebook

High Efficiency Class-C Power Amplifiers are by no means new: indeed, there is a German patent of 1917 (by G.D.T.) which deals with the use of harmonic resonators in the anode-circuit of a class-C stage as a means of broadening and flattening the anode current pulse—and so improving efficiency. Although superficially similar, the arrangement described by V. J. Tyler in a recent *Marconi Review* (Vol. XXI, No. 130), differs in that the grid-drive to the amplifier does not contain the harmonics for which resonators are provided. In its simplest form Tyler's amplifier is driven by a square wave (containing only the odd harmonics) and has two "loss-free" parallel-tuned circuits, which resonate at the second and fourth harmonics of the signal frequency, in series with the tank: these resonators aid the anode-voltage waveform to take up a shape not unlike the output from a single-phase rectifier without reservoir capacitor. Two experimental amplifiers, one of high power rating, one of low, are quoted as giving anode efficiencies of 93.8% and 90.4%. Output powers as much as three times that given by a normal class-C stage are obtained with ordinary transmitting valves and a further example quotes KT45 valves (television line-output pentodes) as producing 200 watts of r.f.—an increase of power output of over 400% of the normal class-C output. Another favourable point is that mistuning of the anode circuits does not produce a sharp rise in anode dissipation, also the arrangement is capable of high linearity with anode modulation because the output voltage and supply voltage are rigidly inter-related.

Hybrid Monostable Circuit, using a valve and a transistor, has been designed by E. Patterson, of English Electric Aviation, to produce pulses for binary circuits from the small signals given by photocells in an optical shaft encoder. Since ten of these circuits were required for each encoder—one per channel—it was desirable to have a circuit containing the minimum number of components, with no transformers, and operating from existing power supplies. The output impedance of the photocell circuit was of the order of 0.5MΩ, requiring a high impedance input to the device. A regenerative hybrid circuit, in which a pentode suppressor grid was controlled by a transistor switch driven from the pentode anode via a diode, was found to give the required high gain and monostable switching characteristic. The circuit produced rectangular pulses on the suppressor greater than 10 volts from 0.1-V sine waves or 20mV pulses. Triggering



pulses could be obtained from the anode by suitable filtering. Pulse rise times of the order of 3μsec were obtained, and investigation has shown that faster rise times are possible. Since this circuit was developed, the designer has become aware of an article in *Electronics* for April, 1959, "Series Diode Increases Multivibrator Sensitivity," in which the author, M. M. Vojinovic, shows how the stability of the circuit is controlled by the diode in the feedback path. The high impedance offered by the diode before breakdown is sufficient to prevent the loop gain from exceeding the critical value. However, when the anode voltage is sufficiently high the diode breaks down and regenerative action commences. For the best performance of the circuit shown, component values must be chosen to suit the frequency and amplitude of the input signal in order to avoid frequency multiplying or dividing effects.

Parametric Limiters are discussed by A. E. Siegman in a letter to *Proc.I.R.E.* for March 1959. The signal to be limited is applied as the pump input signal to a parametric oscillator. For input pump powers below a certain level, no oscillations are produced and the pump output increases with the pump input. For input pump powers above this level, oscillations are produced and the pump output is limited at a fixed level. An advantage of this method of limiting is that it can theoretically be made phase distortionless.

Ophitron, from the Greek for a serpent, has been chosen by the G.E.C. as the name for a backward wave oscillator using a new type of electrostatic focusing in which the electrons travel in a wavy path. The electron path shape and electrode configuration are similar to those used for slalom focusing (see *Technical Notebook* for May 1958), the electrodes consisting of two charged flat plates one in front of and the other behind a ladder-like slow-wave structure. The relative potentials of the various electrodes in an Ophitron are, however, different from those used for slalom focusing; the two plates now being at unequal potentials with one much more positive than the other; although, as for slalom focusing, the ladder line is made more positive than either plate. With these changed potentials, the electrons in an Ophitron remain always on the same side of the ladder line so that the crests of the wavy electron path now lie between the ladder rungs rather than in front of or behind them as with slalom focusing. This results in better interaction between the electrons and slow-wave ladder line than with slalom focusing. The curves in the wave-like beam path result in focusing forces which counteract the space-charge repulsion. It is expected that because of the removal of ions to the focusing plates, the noise will be less than with magnetic focusing, the usual method of focusing used. Ophitrons should also be

less susceptible to stray magnetic fields than magnetically focused valves. The first Ophitron made by the G.E.C. is for the 10,000 Mc/s band and delivers a few tens of mW power over a 40% bandwidth. Its weight and dimensions are only 7oz and 6in by ¾in diameter respectively.

Scientific Uses of Television

ONE ASPECT OF THE BRIT.I.R.E. CONVENTION AT CAMBRIDGE

DOMESTIC television development, though not exactly at a standstill, certainly seems to be passing through a phase of marking time. At the present juncture nobody but an incurable optimist would think of running a technical conference on this subject alone. The Brit. I.R.E., though undoubtedly optimistic in outlook, was realistic enough to give its recent Convention, held at Cambridge University, the carefully worded title of "Television Engineering in Science, Industry and Broadcasting." The net was therefore cast wide and some interesting fish were caught, including a psychologist talking on subliminal perception, an American on space television, two Russian engineers on various aspects of Soviet television and the well-known television pioneer, Dr. V. K. Zworykin, who gave the Clerk Maxwell Memorial Lecture and surprised everyone by not talking about television at all.

As to the scientific applications of television, it was quite obvious that a great deal of specialized study has been devoted to what is generally known as "industrial television" or "closed-circuit television" equipment. A few years ago, when the potentialities of television as a "remote eye" for viewing in difficult positions were first realized, there was an enthusiastic rush to couple television cameras on to everything possible connected with visual inspection. This enthusiasm has now been tempered with the knowledge of what can happen to such equipment when it is subjected to heat, moisture, radioactivity and so on, and out of this experience new designs have evolved. The photoconductive pick-up tube owes its present high state of development largely to industrial television, and now the normal range of visual observation is being extended into the infra-red, the ultra-violet and to regions of extremely low light levels.

One example of observation at low levels of illumination occurs in astronomy, and here one is thinking in terms of individual light quanta rather than in the more familiar light units. The great problem is in examining celestial bodies through the semi-transparent layer of the earth's atmosphere. For a good many years photographic plates and photoelectric devices have been used for integrating the light from very weak sources, and more recently special electronic image converter tubes have been developed in which electron-sensitive photographic film is enclosed in the vacuum chamber. These methods, however, tend to be cumbersome and complicated in practice, and as a result television has been tried as a possible alternative. A paper by B. V. Somes-Charlton described what has been achieved since about 1951 when the author, in collaboration with P. B. Fellgett, first carried out tests with television cameras coupled to telescopes at the Cambridge Observatories.

The image orthicon pick-up tube was used because of its high sensitivity, and in 1956 some tests indicated that there was a gain in light sensitivity by a factor of 3 over the best photographic film available. This is not a great deal, and it is possible that film emulsions have caught up in the meantime, but the television technique still has the great advantage of electronically variable contrast, which is of tremendous value in clarifying the detail of images.

To give an idea of the performances of light detectors Mr. Somes-Charlton said that ideally each photon of the incident light should effect the reduction of one grain of silver halide in a photographic emulsion or liberate one electron from a photocathode. This would represent a "quantum efficiency" of 1. In fact the best approach to this was given by the photomultiplier tube, with an efficiency of 0.05-0.1 (the human eye having a maximum of 0.05), while the image orthicon tube gave a figure of 0.02-0.03 and photographic films 0.001-0.01 (with a reported recent improvement to as high as 0.1). However, some recent experiments had been conducted by R.C.A. in America on modified image orthicon pick-up tubes containing special image intensifiers using phosphor-photocathode stages and electron accelerating voltages. With these it was claimed that an image of 400 lines definition could be produced with a photocathode illumination of only 10^{-6} or 10^{-7} foot candles.

Incidentally, Mr. Somes-Charlton demonstrated a simple apparatus which he had used for testing the relative performances of pick-up tubes and photographic plates in sensitivity and resolution. It consisted of a metal plate perforated with holes of graded diameters having behind them grey filters of graded densities. The whole mask was illuminated from behind by a cold light source and viewed from the front by the television or photographic camera. The performance of the camera, television or photographic, could then be judged by which particular holes were just on the limits of visibility due to their reduced contrast (dense filters) and resolution (small diameters).

Space Television

Another method of mitigating the effects of the earth's atmosphere on astronomical observations was mentioned in a paper by B. I. Sardiko of the U.S.S.R. (read by B. A. Berlin). This was the use of stereoscopic television on telescopes spaced widely apart. But probably the most advanced idea of all is to get outside the earth's atmosphere altogether by means of space vehicles. One proposal has been for an astronomical telescope orbiting in space and fitted with a television scanning system controlled from a ground observatory. At the Convention A. J. Viterbi, who has been connected with recent satellite launchings in the U.S.A., discussed some of the important design criteria for such a television system, which, for close observation of some of the planets, would have to work over ranges of the order of 25 million miles.

Because of the low received signal power (estimated at 10^{-18} watt) and the high noise level, the channel bandwidth has to be severely restricted—in fact, to as narrow as 1c/s. Bandwidth compression to this extent is achieved by recording the video information on magnetic tape at normal speed then replaying and transmitting it over a long period of time (for example, one 200-line image would take about 1.85 hour to transmit). Another problem arises from the fact that the carrier frequency of the transmitter is varied by the Doppler effect as the vehicle travels rapidly through space. This means that simple frequency modulation cannot be used for overcoming the noise in the transmission channel. Instead the video information is used to frequency modulate a sub-carrier, and the sub-carrier modulates the phase of the carrier signal.

At the receiver the Doppler-shifted carrier is recovered from the noisy signal by a "coherent tracking filter." This is a form of servo-mechanism called a "phase-locked-loop" containing a variable-frequency oscillator which is kept locked in phase and frequency to the incoming signal by control from an error signal. The output from this oscillator is then mixed with the received signal to recover the original frequency-modulated signal, and this is passed to a discriminator to give the final video information. The discriminator has to deal with a very noisy signal and it again takes the form of a "phase-locked-loop" servo-mechanism. The local oscillator is controlled by an error voltage and it is this voltage which provides the video output signal.

Radiation Problems

Compared with space projects, nuclear energy has become almost a common-or-garden application for television techniques. Here the transmission problems may not be difficult but the environmental ones certainly are. For observation purposes in a nuclear reactor the television camera has to contend with heat and radioactivity. The heat problem can be tackled by gas cooling and, according to a paper by P. Barratt and I. M. Walters, nothing practicable can be done about radiation shielding. Lead shields for protection against gamma rays would be far too big and heavy, while neutron-absorbing materials would have undesirable effects on the operation of the reactor.

The paper includes an interesting table showing the effects of radiation on the electrical and other properties of electronic components. Resistors and capacitors are changed in value by only a few per cent (varying with the materials used in their construction), television pick-up tubes suffer a temporary increase in dark current and semiconductor devices show much higher leakage currents than normal. It emerges, however, that the most serious effect of all is not electrical but optical—the discoloration of the glass in the camera face-plate and lenses due to changes in its molecular structure. It is only necessary to replace the affected glassware and the camera is fit for use again.

Another paper, by E. C. Sykes, dealt with the use of television for microscopical examination of nuclear fuel samples which have been irradiated in a reactor. The camera is coupled to the microscope in such a way that the optical image is directly focused on to the sensitive area of the pick-up tube, so that no camera lenses are required. Apart from allowing safe observation of the specimens by several people simultaneously, the television system offers a useful facility for the accurate size measurement of details such as hardness indentations. Two electronic cursors, consisting of vertical and horizontal black lines, are generated on the picture by a system of black-out pulses and time delays. These can be moved across the picture by calibrated controls, and since the overall magnification of the microscope-television system is known it is possible to make accurate size measurements—actually to within $\pm\frac{1}{4}$ micron at an overall magnification of 3,000 times.

Incidentally, this paper discussed some interesting practical experience on the use of stereoscopic television for observation of manual operations carried out remotely by master-slave manipulators. It was found that stereo television was not so helpful to the operator in achieving speed and dexterity as single-channel television with strong oblique lighting from two directions which gave visual positioning information by means of the shadows.

Medical Observations

The development of medical colour television was reviewed in a paper by R. D. Ambrose and A. R. Stanley, who also discussed future possibilities in the particular field of endoscopy. The endoscope is an optical tube which permits observation of the interior of the body without recourse to surgery. Normally it is only possible for one person to make observations, unless photography is used, so the possibility of coupling a television camera to the external end of the endoscope tube offers some distinct advantages. The main problem is in getting enough illumination into the interior of the body, particularly for colour television. It is also desirable to have smaller and more manœuvrable cameras than are available at present, and there has been work on the development of miniature transistorized cameras for this purpose.

Another aspect of medical television mentioned in a paper by J. H. Taylor was the use of infra-red light, with a television equipment designed for this region, to examine the inside of the eye. The point here is that the eye pupil does not close in infra-red light. In other parts of the body it becomes possible to study details of the superficial venous system because the skin is transparent to infra-red radiation. Mr. Taylor described a high-grade television equipment using a special vidicon-type pick-up tube with a spectral response of 4,000 to 10,000 angstrom units (the visible region being 4,000 to 8,000). Another tube, for the ultra-violet region, has been developed with a response giving down as far as 2,350 angstrom units.

Television techniques are now being used for image amplification in X-ray fluoroscopy, and here one is dealing with very low light levels in the region of 10^{-4} to 10^{-1} foot-lambert. E. Garthwaite and D. G. Haley described a special image orthicon tube developed for this work.

Finally, if we have not made any mention of the papers on the domestic side of television it does not necessarily mean that we agree with a certain speaker at the Convention banquet who made fun of the Convention title "Television Engineering in Science, Industry and Broadcasting." He said it was problematical whether there was any science in Industry or even any industry in Science, but he was quite certain from personal experience that there was neither science nor industry in Broadcasting!

LETTERS TO THE EDITOR

The Editor does not necessarily endorse the opinions expressed by his correspondents

Monophonic or Monodic?

"FREE GRID" makes a reasoned plea in your June issue for "monodic," but he has misled you by saying that monophonic reproduction means "one-sound reproduction." This is not at all the intention of those who, despite "Free Grid's" diverting contribution and your weighty editorial, are still in favour of "monophonic."

The primary meaning of φωνη is not "sound" but "voice"; an educated friend tells me that the original Homeric meaning was "voice" and that only much later did the word acquire the derived meaning of "sounds from inanimate objects." What could be more appropriate than "monophonic" to refer to the use of a single-channel reproducer, which, like you and "Free Grid," speaks with one voice?

Having established the semantic propriety of "monophonic," let us bear in mind its two great advantages:

(1) it is already well established, particularly in America, and

(2) it makes a convenient pair with stereophonic.

Incidentally, "Free Grid" cannot claim the paternity of "monodic"; it was suggested in my letter published in the January issue of *Electronic & Radio Engineer*, as an alternative to "monophonic."

London, N.2. E. L. E. PAWLEY

"*Free Grid*" *Comments* :

Even if Mr. Pawley's remarks about the Greek word φωνη were correct, I do not see how the case for the use of "monophonic" is thereby strengthened. As for his argument about this word being well established in the U.S.A., must we follow American usage in this matter as we have done in the terminology of household sanitation? But Mr. Pawley obviously bases his main argument on the original meaning of the word φωνη, and so I had better confine myself to that.

Going right back to the obsolete verb phao (φαω), meaning, *inter alia*, to speak, we find several words associated with it, but the only two which concern us here are φονη and φωνη, both of which are transliterated into our alphabet as "phone." The first of these words started life meaning "mouth," and was used figuratively in such expressions as "to put to the mouth (or edge) of the sword." A handy example is to be found in Exodus, XVII, 13, where, in the Septuagint, occur the words εν φονη μαχαιρας to describe the rough house which Joshua gave the Amalekites.

Φονη eventually came to mean the effect of putting to the sword, namely, slaughter. While φονη originally meant the *mouth* of the sword, its stable mate φωνη meant the *voice* of the sword (poetical fellows these Greeks), which was a picturesque way of saying the *sound* of slaughter, and in particular the noise of battle.

Now the noise of battle is a confused jumble of sound, and in those days the first thing that would be heard would be the clash of arms, a very inanimate sound. Thus the primary meaning of φωνη was obviously an inanimate sound, but I will, of course, admit that it would soon be followed by the thoroughly animate sound of the cries of wounded horses and men; but the inanimate meaning of φωνη beat the animate one, even if only by a short head!

London, S.E.1. "FREE GRID"

IF "monophonic" is to be excluded because it does not ". . . . call to mind . . . . the rich polyphonic sounds of music and well modulated voices . . . .", then can we permit the transmission of monodic works through a stereophonic system?

Furthermore, if it seems incongruous to transmit polyphony over a "monophonic" system, would it not be even more so to employ a "monodic" system, since the term "monody" means "a song for one person." It is derived from the Greek word for an ode sung by a single actor in the ancient Greek tragedy, and is also used in connection with early opera in distinction from polyphonic style.

Whilst paying due homage to the erudition of your cognoscenti, may I suggest that the term monodic be left alone since it already has a perfectly sound connotation. Keeping the prefix "mono," and I am sure that "mono" and "stereo," once accepted, will always be recognized terms, may I suggest that one might do worse than take from biology the term monophyllous (single-leafed), and change it to monophyllic. In spite of its "ph" and "ll" the word is easy to say and there is less likely to be confusion with a term borrowed from a more remote science or art. Monothetic is another fairly neutral alternative. "Monophonic" is still the best sounding term, however irregular the derivation.

Eccles, Lancs. Wm. THURLOW SMITH,
"Eroica" Sound Recording Services.

I THINK the B.B.C. have found a very pleasant sounding word in "monophonic," and whatever its origins and whatever it means we will enjoy using it. Your "monodic" sounds like a cold in the head.

Lausanne, Switzerland. R. H. WILLIAMS.

Mavars

I HAVE just read the excellent and entertaining article on MAVARS by "Cathode Ray" in the May issue of *Wireless World*.

In the discussion of names for the parametric device, reference to my article in the September 26, 1958, issue of *Electronics* gives the erroneous impression that I am the originator of the term MAVAR. Although I wish I could claim credit for this, such is not the case. Unfortunately, a search of my notes fails to disclose who was the first to use this term, so I cannot set the record completely straight.

Another name which has been proposed and which has some merit is the REACTATRON (*Proc. I.R.E.*, January 1959, p. 42). This term is intended to describe specifically the diode parametric amplifier, although I see no reason why it cannot be extended to other forms. It avoids the use of the term "mixer" which "Cathode Ray" feels so strongly about.

New York. SAMUEL WEBER,
Associate Editor, *Electronics*.

Facsimile Television

IN connection with the recent experiments in transatlantic television *via* the cable*, it is interesting to recall some very early history. I understand that the present technique is to transmit the successive frames of a film at slow speed by means of a special telecine machine and record them on the other side of the Atlantic. The film is then televised in the normal way after processing.

In 1934, on the occasion of the London to Melbourne Air Race, the G.B. Newsreel Company used the normal Radio Facsimile Service to transmit from Australia the separate frames of a cinematograph film of the winners arriving in Melbourne. The received pictures were rephotographed on to cine film in London. I believe it took about 20 hours facsimile transmission for a few seconds of film projection, but the attraction of seeing the film in the cinemas the day after the event more than justified the means. As in the present case some "compression" of the signal was achieved by omitting alter-

* See pp. 314 and 362 of this issue.—Ed.

nate frames of the film at the transmitting end and replacing them by repeats of the previous frame in the final printing process.

Mr. Castleton Knight, who pioneered this experiment, expressed surprise to me some time ago that "Wireless Pictures" as he called them, had not become a daily occurrence. His record has remained unchallenged for 25 years and it would be a pleasant gesture if the results of his efforts were taken from the vault where they now rest and televised for our enjoyment along with those of the present experiment.

Enfield, Middlesex. L. C. JESTY,
Sylvania-Thorn Colour Television
Laboratories, Ltd.

Wide-Band Aerials

I HAVE read with interest the two articles by Mr. F. R. W. Strafford in the April and May issues entitled "A Second Band III Programme?—The Aerial Problem."

I think it should be pointed out to your readers that a very satisfactory solution to this wide-band aerial problem exists. The type of aerial to which I make reference is known commercially as the Labgear "Spacematch," which became available on the market in August 1958.

The "Spacematch" aerial, at Band III frequencies, is essentially a form of long wire array having "V" configuration. The length-to-diameter ratio has been made quite low by adoption of the skeleton cone principle. By a proper choice of element diameter and included angles the impedance at the extremities of the aerial may be made to approximate the characteristic impedance of free space. Under ideal conditions, using this technique, the gain normally associated with a "V" beam type of aerial may be further enhanced to the extent of 3 dB. I agree with Mr. Strafford that a wide-band aerial providing a gain of about 9 dB would be extremely valuable and, indeed, it would suit most applications in-between circumstances permitting the use of simple inside aerials and those requiring extremely elaborate high-gain fringe arrays. Naturally television broadcasting stations have been so situated as to minimize the number of fringe arrays required.

In practice, individual elements of the "Spacematch" aerial have been made approximately $1\frac{1}{4}$ wavelengths long on Band III, which brings the unit into $\frac{1}{2}$-wave resonance just outside the low frequency end of Band I. However, because of its fan-like construction, it exhibits the broad width associated with this type of aerial and provides remarkably uniform response not only over Band III but also over the whole of Band I. Naturally, the excellent gain yielded on Band III (8 or 9 dB) cannot be maintained on Band I and its performance is similar to that of a simple dipole. Models are available, however, which incorporate the addition of a channelized Band I reflector where reception conditions make this necessary.

Cambridge. S. R. KHARBANDA,
Labgear Limited.

Displaying Valve Characteristics

I WAS most interested to read of Mr. R. G. Christian's method of displaying valve characteristics and their axes in the June issue.

The author appears to be satisfied with presenting what are, in effect, dynamic characteristics, and a change in anode load therefore affects these characteristics. From the students' point of view this is undesirable, and it is much better to use the actual anode voltage to give the X deflection, rather than the supply voltage, since the static characteristics would then be given as shown by the accompanying Fig. 1.

If a step voltage waveform is applied to the grid, the valve load line can be displayed as a shortening of the high-voltage ends of the traces. (Fig. 2). This property extends the usefulness of the demonstration because dis-

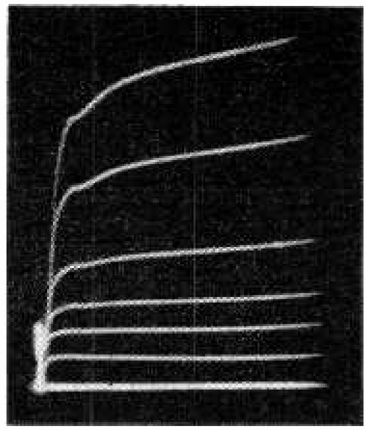


Fig. 1. Beam tetrode characteristics.

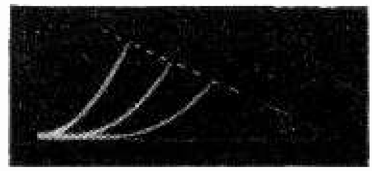


Fig. 2. Triode anode characteristics, showing load line.

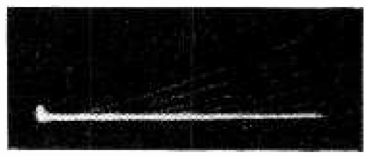


Fig. 3. Triode anode characteristics with current negative feedback.

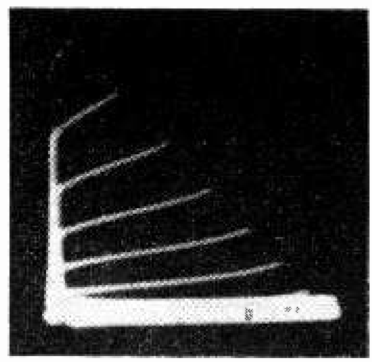


Fig. 4. Low-power transistor emitter characteristics.

cussion can be made of the choice of a suitable anode load. The effect of negative feedback on the characteristics can be shown by the use of feedback circuits in common use. In particular, the effect of current negative feedback on output impedance can be demonstrated if a series resistance is used in the cathode lead. (Fig. 3).

In addition, if the step voltage is applied through a high resistance, a step current waveform can be obtained, which may be used to show the emitter input characteristics of transistors (Fig. 4). A high resistance should be put in series with the collector supply to ensure that the thermal runaway point is not exceeded.

The problem of the return trace, as mentioned by Mr. Christian, may be overcome by flyback blanking.

The accompanying photographs were obtained from a device showing several anode characteristics simultaneously, which has proved most useful in the work of the B.B.C. Engineering Training Department and it is described in the *Bulletin of Electrical Engineering Education*, Vol. 20, June 1958 (published at the College of Science and Technology, Manchester).

Wood Norton, Worcs. D. J. HENMAN,
B.B.C. Engineering Training Dept.

Resistors in Parallel

CHART FOR USE WITH PREFERRED-VALUE RESISTORS

By M. A. HAMMOND

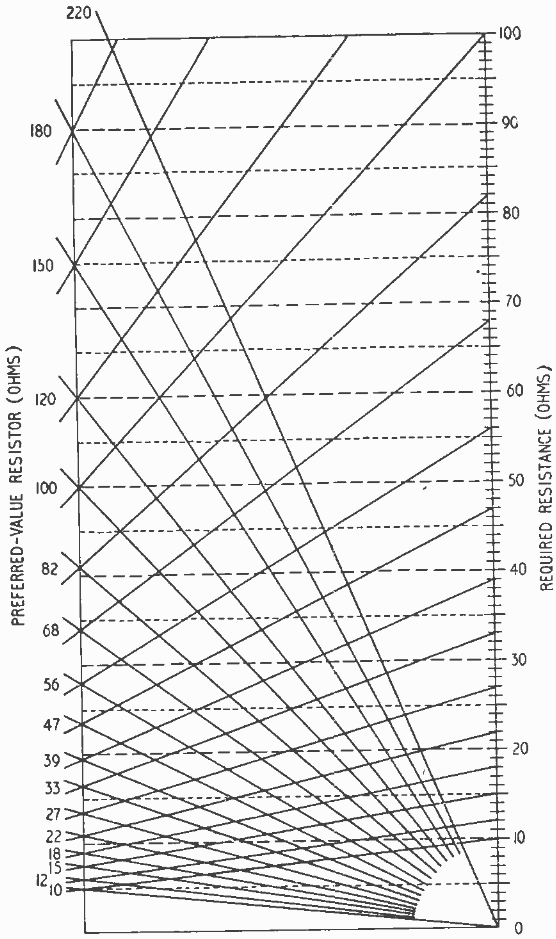
THE accompanying chart provides a quick reference to the preferred-value resistors which, when connected in parallel, give a required non-preferred value of resistance.

Example: A resistance of 30Ω is required. At the 30-Ω point of the right-hand scale move horizontally to the left until a point of intersection of two diagonal lines is encountered. By following each of these diagonals from the intersection to the left-hand scale, it will be seen that 47Ω and 82Ω are the required preferred values to be paralleled for a resultant 30Ω.

Alternative points of intersection can be found very close to the 30-Ω line formed by intersections of the 39-Ω and 120-Ω lines and of the 56-Ω and 68-Ω lines respectively (left-hand scale).

It is obvious that this will apply to the higher decades also if the necessary "noughts" are added to the significant figures and providing both resistors to be paralleled are in the same decade. For example, the resistance resulting from paralleling 18kΩ and 180Ω cannot be extracted from the chart.

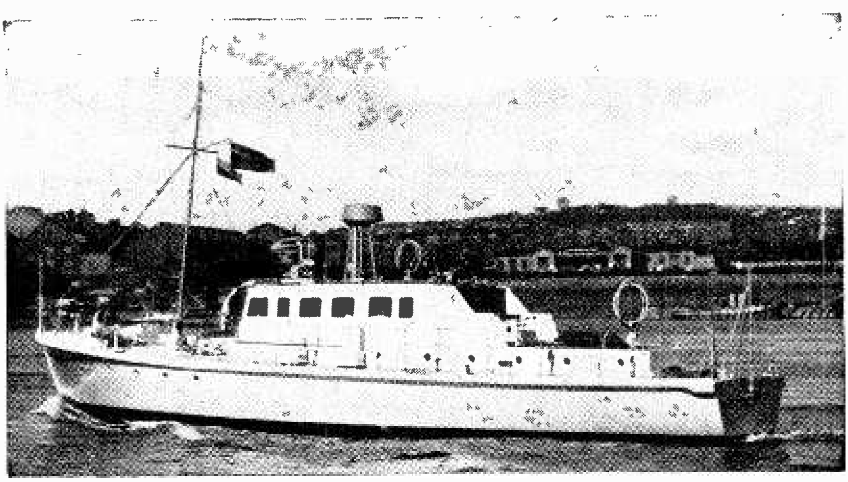
Acknowledgement is made to J. W. D. Cunningham and L. F. Poole, for observations made while compiling the chart.



Small Radar for Small Ships

AS the "mains supply" most usually available on a small vessel is a nominal 24-V d.c. derived from accumulators, power consumption must be kept to a minimum and the radar must work from an input which may vary between 20V and 32V. The voltage-variation problem is overcome in the new Marconi Marine "Consort" by the use of a transistor regulator which reduces the input to a constant 19-V d.c., and e.h.t., h.t., negative bias and special supplies (such as the c.r.t. heater power) are derived from this 19-V d.c. by a transistor oscillator.

To reduce the power demand the equipment is normally kept in the "stand-by" condition in which the valve heaters only are energized and the current consumption then is 4A. A "press-to-view" button, mounted on the display unit, switches on the remaining supplies and the scanner motor, when the current consumption rises to about 10A. After roughly two minutes (governed by the heating and cooling of a bi-metal strip)



Radome-protected scanner on its tripod base installed on Marconi-Marine's demonstration yacht, Elettra II.

the radar reverts automatically to the stand-by state.

Voltage regulator, power supplies, transmitter and receiver are all contained in one case and printed wiring is used as far as is possible for its advantages of low cost and exact correspondence between boards.

The scanner employs a 3-ft-long slotted-waveguide array driven by a 1/24-horse-power motor. The use of this small drive power is made possible by enclosing the array in a fibre-glass radome which also prevents the ingress of sea spray. Fibre-glass is used, too, as the support for a "lens" formed from thin close-spaced vertical wires. This is mounted at the mouth of a short horn section extending from the waveguide aerial and it is used to reduce the amplitude of residual side-lobes.

Scanner-mount height limits the maximum range realisable to about 14 miles: other scales are 8, 4, 1.5 and 0.6 miles. Only a relatively small transmitter power is required to give effective cover to 14 miles so the peak-power output (p.w. 0.15μsec, p.r.f. 2,000/sec) of about 2.5kW is sufficient. Because the magnetron does not heat up appreciably at this low rating, its frequency does not drift seriously. This initial stability, together with a greatly-improved version of the 723AB local-oscillator klystron (English Electric) and a little "spare" bandwidth in the receiver, enables the complications of a.f.c. to be dispensed with. In fact, the fine-tuning control is preset, mounted on the display-unit rear panel.

The display unit, which is designed for mounting on the deckhead, bulkhead or table, uses a 5in-diameter c.r.t. This is fitted with a magnifying lens to increase the effective diameter to about 8in. Rotating-coil scanning is used for which the drive is obtained by a direct mechanical link (Bowden cable) to the scanner and the only "user control" fitted on the display unit is the press-to-view switch.

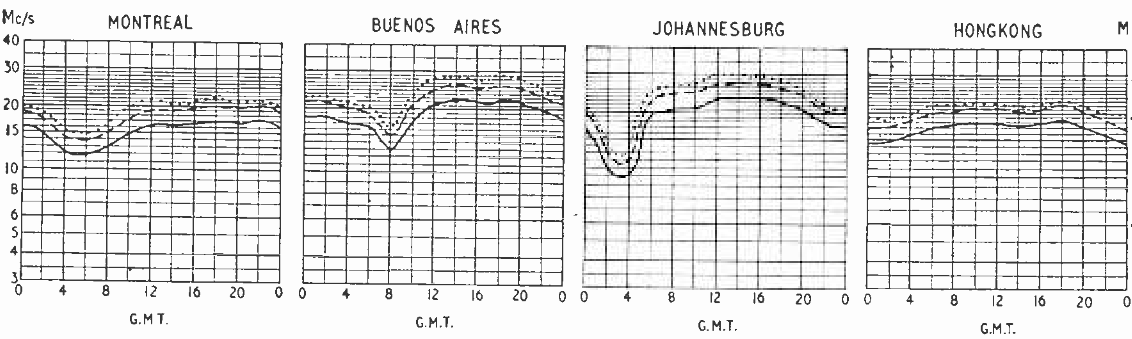
A complete installation weighs just over one hundredweight and costs about £800.

Sound Equipment at Stratford-on-Avon

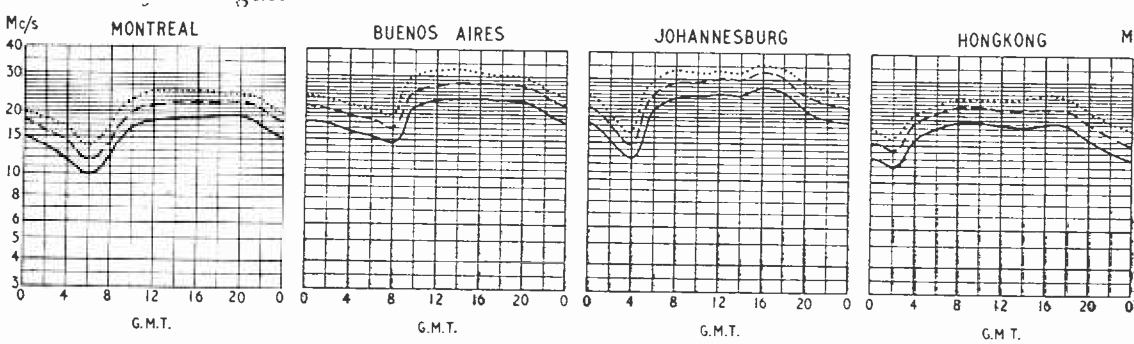
NEW sound-amplifying equipment has been fitted at the Shakespeare Memorial Theatre, Stratford-on-Avon. Designed and installed by R.C.A. (Great Britain), Ltd., the equipment provides single-channel speech reinforcement from three microphones on the stage and a 40-W amplifier feeding four line-source column loudspeakers placed in the auditorium, a two-channel sound-effects system (fed from two tape decks) with two amplifiers and five loudspeakers which may be placed anywhere on the stage, another single "effects" channel feeding a loudspeaker mounted over the stage, and a stage/orchestra liaison system through which the orchestra can follow the action although they are unable to see the stage. The signal to each of the five loudspeakers can be raised and lowered in turn, so that an impression of movement may be created. All four amplifiers are identical and they can be inter-switched so that a failure in one is not obvious to the audience.

SHORT-WAVE CONDITIONS

Prediction for July



Prediction for August



THE full-line curves indicate the highest frequencies likely to be usable at any time of the day or night for reliable communications over four long-distance paths from this country during July and August.

Broken-line curves give the highest frequencies that will sustain a partial service throughout the same period.

·········· FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE FOR 25% OF THE TOTAL TIME

— — — PREDICTED AVERAGE MAXIMUM USABLE FREQUENCY

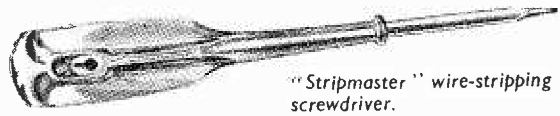
——— FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE ON ALL UNDISTURBED DAYS

Manufacturers' Products

NEW ELECTRONIC EQUIPMENT AND ACCESSORIES

Wire-stripping Screwdriver

THE "Stripmaster" is a screwdriver which carries in its shatterproof moulded-plastics handle a metal cutter with a keyhole-shaped aperture. The cutter forms a quick and effective wire stripper: in use the wire is passed through the large end of the "keyhole", forced down the slot and then pulled out, so stripping cleanly the insulation without "nicking" the wire. The overall length of the screwdriver is 6in and the screwdriver



"Stripmaster" wire-stripping screwdriver.

blade-width is $\frac{1}{8}$in. Retailing at 3s 6d, the "Stripmaster" is distributed by L. J. Hydleman and Co., Ltd., Grove Park, London, S.E.5.

Sub-miniature Wire-wound Resistors

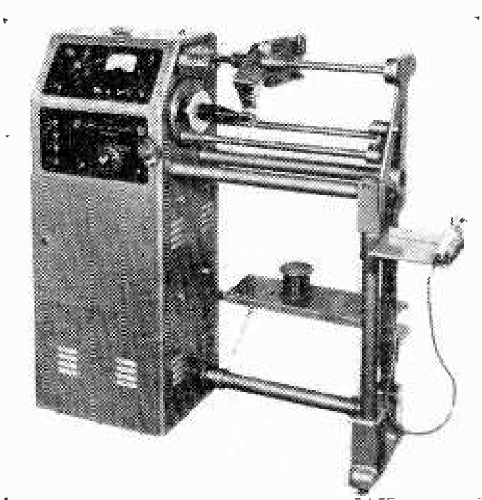
THE Alma Components Type RM2 precision subminiature wire-wound resistor is rated at $\frac{1}{10}$W and is designed to fit into both the 0.1-in and 0.15in printed circuit grids. Only 0.25-in in diameter and slightly over 0.3-in long, this resistor is available in values from 100Ω to 200kΩ, and with two standard tolerances (±1% and ±0.1%) at 20°C. The temperature coefficient is less than ±0.002% per °C and a stability of 0.05% over 1,000 hours running time is achieved. Manufacturers: Alma Components Ltd., 551, Holloway Road, London, N.19.

Electronic Coil Winder

PRECISION winding of multi-layer coils without paper interleave and with wires down to 0.002in in diameter (No. 47 s.w.g.) is one of the features of the new Douglas electronic coil winder described as the "Supermatic Layer Winding Machine."

Separate electrical drives are used for the headstock and for the wire traversing mechanism and any deviation from exact layer winding with adjacent turns touching is immediately corrected by means of a "sensing" head on the traversing carriage and associated electronic apparatus. Another feature of the new coil winder is that it can be set up to wind single-layer coils with precise spacing of the turns, the spacing being maintained as predetermined by the electronic equipment.

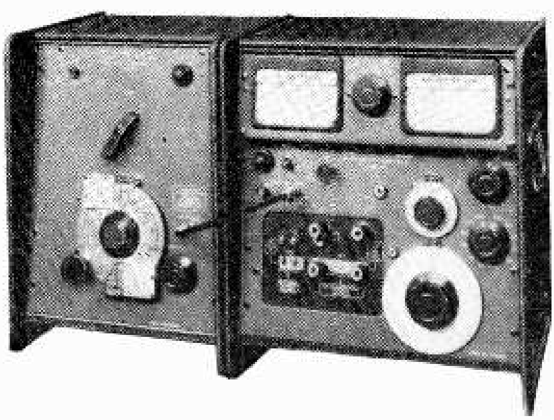
The makers are Avo Ltd., Avocet House, 92-96. Vauxhall Bridge Road, London, S.W.1.



Douglas (Avo) electronic-controlled coil winder.

Q-meter

THE new Marconi Type TF1245 Q-meter incorporates separate low and high frequency circuits to enable Q values from 5 to 1,000 to be measured at frequencies between 1kc/s and 300Mc/s with an accuracy which decreases with increasing frequency from ±5% at 100Mc/s to ±20% at 300Mc/s. Both the l.f. and h.f. measurement circuits are of the usual series-resonant type in which the Q is obtained from a measurement of the voltage across the tuned circuit capacity. The signal voltage is injected across a 0.02Ω resistor in the l.f. circuit and a 0.1mμH inductor in the h.f. AδQ range of ±25 is also provided. An external oscillator is necessary to make measurements, and two specially designed units are available, the TF1246 covering 40kc/s to 50Mc/s and the TF1247 covering 20Mc/s to 300 Mc/s. Matching transformers may be obtained to allow these oscillators to be used also as general-purpose signal generators.

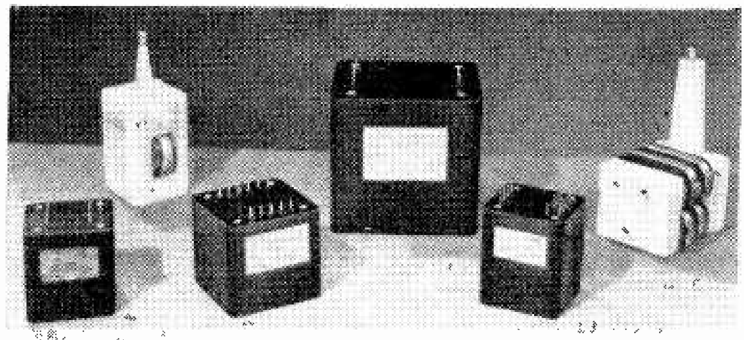


Marconi Q-Meter Type TF1245 (right) with external oscillator Type TF1247 (left).

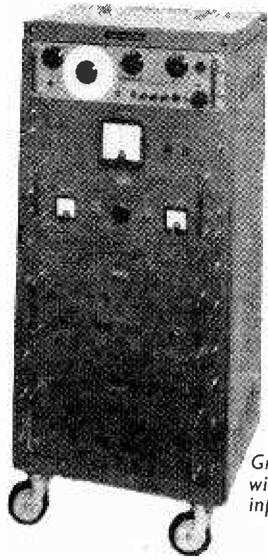
The TF1245 Q-meter costs £176 and the address of its manufacturer is Marconi Instruments Ltd., St. Albans, Herts.

Low-frequency Power Amplifier

A SINE-WAVE output power of 100 watts (r.m.s.) with a distortion less than 2% may be obtained at any frequency from 10c/s to 5kc/s from the Grampian v.l.f. amplifier. The input inpedance is 10kΩ and 3V is required for full output. Output impedances between 10Ω and 100Ω are available according to requirements, and the frequency response is flat within ±½dB. This amplifier costs £360 or more according to the number of



Examples from Wayne-Kerr's new range of resin-cast transformers.

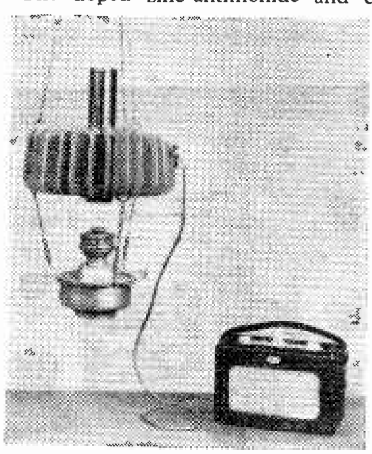


Grampian v.l.f. amplifier with Ediswan Type R666 input oscillator.

output tappings or other special modifications required. The address of its manufacturer is Grampian Reproducers Ltd., Hanworth Trading Estate, Feltham, Middlesex.

Paraffin Power for Portables

A NEW version of the thermo-electric, receiver power supply (Type T.E.G.1) previously illustrated on p. 227 of our May, 1956, issue is now available in this country. The doped zinc-antimonide and constantan



Thermo-electric generator supplying power to an "all-dry" portable receiver.

couples normally give outputs of 80 to 90V at 10 to 11mA, 1.0 to 1.2V at 0.21 to 0.52A and 8 to 10-V grid-bias: it is thus suitable for many "all-dry" receivers. The T.E.G.1 is imported from the U.S.S.R. by International Technical Developments, Ltd., of Willow Road, Poyle Estate, Colnbrook, Buckinghamshire, and it costs £16, or £20 with lamp.

Resin-cast Transformers

WAYNE-KERR LABORATORIES have introduced a range of resin-cast transformers in ratings between 5 and 350W. Designed to replace oil-filled units where the possibility of oil leakage cannot be tolerated, the transformers use C-core construction and comply with the requirements of R.C.S.214. Vacuum impregnation with a polyester resin enables insulation resistances of better than 100MΩ at 130°C to be achieved and the black epoxy-resin encapsulation material does not support combustion. Also a range of pulse transformers developing between 7kV and 50kV at up to 60MW peak power is available. The manufacturers are Wayne-Kerr Laboratories of Roebuck Road, Chessington, Surrey.

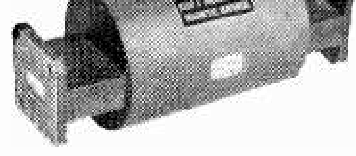
Fixed Capacitors

A RANGE of isolation and suppression capacitors covering values between 470pF and 10,000pF is announced by T.C.C. The dielectric is high-permittivity ceramic and a non-cracking heat-resistant protective coating prevents the ingress of moisture and provides insulation sufficient for the capacitor to be mounted in contact with other components or the chassis, whilst still complying with the requirements of B.S.415—1957. The maximum rating is 500 d.v. (300 r.m.s. a.v.), capacity tolerance is -20 $+80\%$ and the capacitors also comply with B.S.2818—1957 (for fluorescent-lighting interference suppression).

A new T.C.C. range of low-working-voltage paper-dielectric capacitors has each foil electrode wound with two thicknesses of paper; but with improved machinery and new materials the physical size is comparable with that of the metallized-paper type. With a maximum d.v. rating of 150, the Type 143 is made in capacities from $0.02\mu F$ to $0.5\mu F$, the sizes ranging between $\frac{5}{8}$-in long by $\frac{1}{4}$-in diameter and $1\frac{1}{8}$-in long by $\frac{9}{16}$-in diameter respectively. The capacity tolerance is $\pm 20\%$ and the temperature range is -30 to $+60$°C. Manufacturers: The Telegraph Condenser Co., Ltd., London, W.3.

Two X-band Isolators

ONE of the new Sanders (Electronics) ferrite isolators is a small-size unit for use in commercial systems. It has an isolation of better than 35dB over a ± 500Mc/s bandwidth around any required frequency between 8.2 and 12.4kMc/s. Its insertion loss is 0.7dB, and its input voltage standing wave ratio better than 0.9 to 1. Up to 150W mean power can be handled by this unit, and it costs £35. The other isolator is for laboratory use over the broad frequency band from 8.2 to 12.4kMc/s. Its isolation is at least 30dB, its insertion loss less than 1dB and its input v.s.w.r. better than 0.87 to 1. Up to 15W can be handled by this unit and it costs £85. Both these isolators are manufactured by W. H. Sanders (Electronics), Ltd., of Gunnels Wood Road, Stevenage, Herts.



Sanders broad-band microwave isolator.

Equatorial Sunset Effect

Observations Over a Whole Sunspot Cycle Point to an Unexplained Propagation Anomaly

By A. M. HUMBY,* M.I.E.E.

IN August, 1947, a year of high solar activity (Fig. 1), the writer observed at Singapore that teleprinter operation of the Admiralty circuit to London became extremely difficult, if not impossible, from about 1900 to 2100 local time Singapore, i.e., 1200 to 1400 G.M.T., a condition which the operating personnel (often only too ready to blame the man at the *other* end) referred to, in those days, as the "Whitehall Lunch-time Effect"!

The circuit had been equipped with suitably directive aerials at each terminal for operation on a number of frequencies between 4Mc/s and 22Mc/s, according to the time of day, season and epoch of the 11-year solar cycle.

For distances exceeding 4,000km propagation takes place by a number of complex modes, and it has been found empirically that, for a given frequency, propagation via the F_2-layer is usually practicable so long as the ionosphere at "control points," distant 2,000km from each terminal (Fig. 2), supports transmission at that frequency irrespective of the condition of the ionosphere elsewhere along the great-circle path. If this condition is not satisfied at each "control point" a change to a lower frequency is usually necessary.

*Royal Naval Scientific Service.

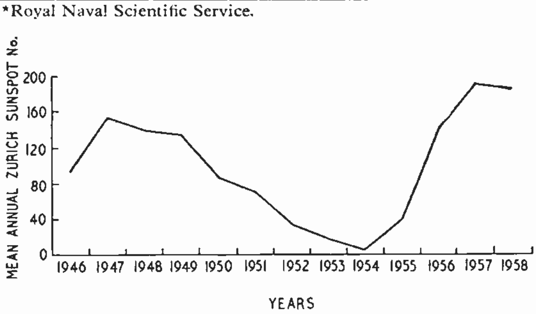


Fig. 1. Mean Zurich sunspot numbers for the years 1946 to 1958 inclusive.

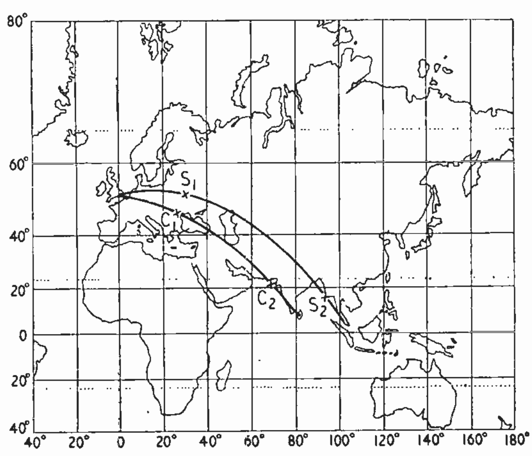


Fig. 2. The "control points" mentioned in the text; S_1 S_2 on Singapore/London and C_1 C_2 on Colombo/London great-circle paths respectively.

In certain cases E-layer propagation may be possible, the investigation of which involves two additional "control points" distant 1,000km from each terminal.

The extent to which the frequency may be lowered depends upon such factors as the effective radiated power of the transmitter, absorption of signal, and the level of atmospherics and the type of aerial at the receiving terminal. The condition of the ionosphere at any given location is assessed from regular ionosphere soundings carried out at a large number of measuring stations throughout the world, and from this data groups of charts are prepared on a month-to-month basis representing world-wide variations

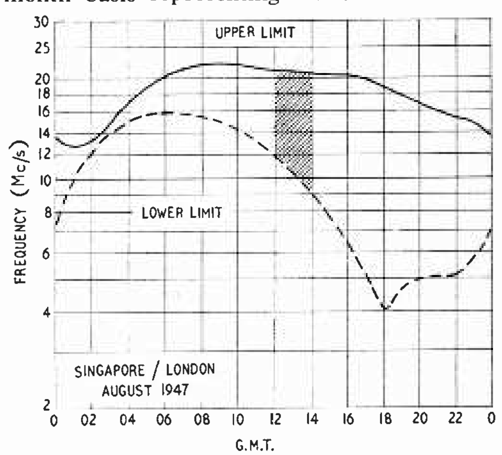


Fig. 3. Upper and lower predicted frequency limits for radio-teleprinter operation between Singapore and London, August 1947.

of ionization with the time of day, season and solar activity.

Considerable success is now being achieved by ionospheric forecasters in determining the most probable upper- and lower-frequency limits in any given case, and fortunately for the radio engineer discrepancies between prediction and practice are gradually being eliminated.

Predictions of the type referred to above for the case of the Singapore/London circuit for August 1947 are shown in Fig. 3, from which it would appear that a wide band of frequencies should have been suitable for teleprinter operation between 1200 and 1400 G.M.T.; in point of fact although communication on several frequencies within the predicted limits was attempted, this period, as stated

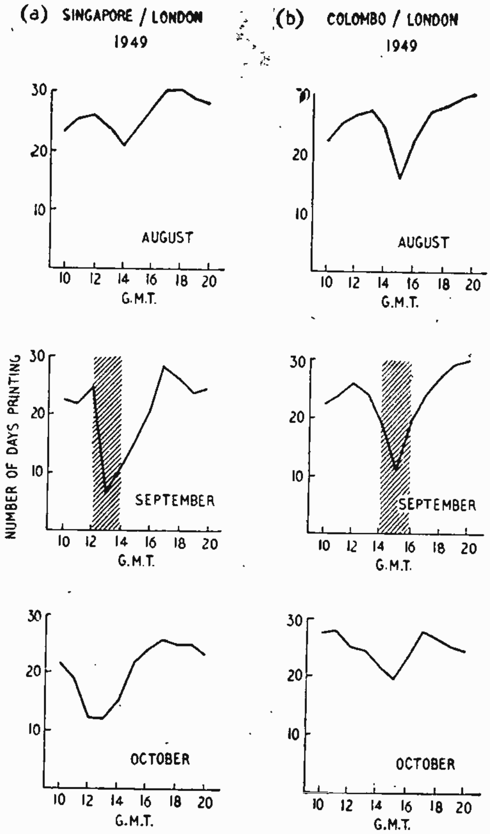


Fig. 4. Communication conditions on Singapore/London and Colombo/London radio circuits near local sunset (equatorial region) for equinox months of 1949.

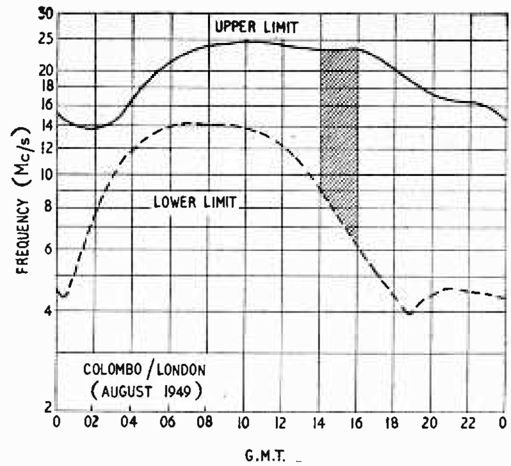


Fig. 5. Upper and lower predicted frequency limits for radio teleprinter operation between Colombo and London during August 1949.

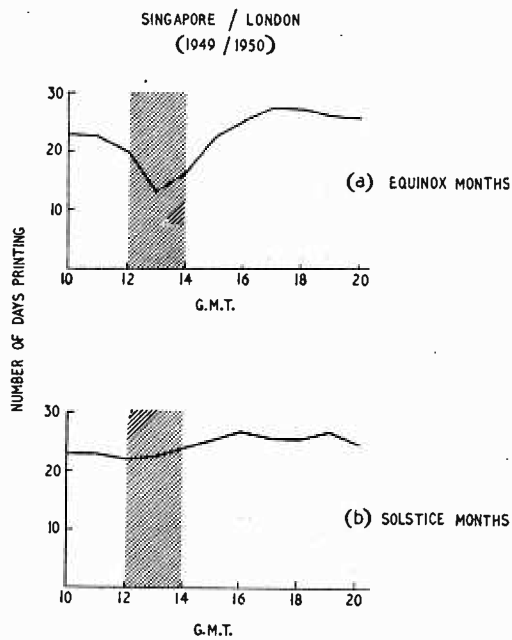


Fig. 6. Number of teleprinter operating days on Singapore/London radio circuit for equinox and solstice months of 1949/1950.

earlier, was one which proved in practice to be one of extreme difficulty.

The period 1900 to 2100 local time Singapore, i.e., shortly after sunset, was characterized by:—

(*a*) A reduction of signal intensity in each direction of the Singapore/London circuit.

(*b*) Excessive multipath distortion arising from the reception of a number of echo signals arriving over different radio paths with sufficiently large time delays to prohibit operation of the circuit at normal teleprinter speed (50 bauds).

However, on many days the signal-to-noise ratio was adequate to permit Morse operation at slow speeds (e.g., 15 to 20 bauds), where, on account of the much longer time intervals between transmitted signal elements, multipath effects were less troublesome. Reception in these cases was carried out either by ear, or by undulator recorder, methods which in themselves are less sensitive than the teleprinter one to multipath distortion.

(*c*) Direction of arrival of incoming signals being diffused, or "flat," suggesting considerable azimuthal scattering of the received energy.

With the introduction in the autumn of 1949 of hourly circuit-merit figures indicative of the diurnal performance of all Admiralty radio-teleprinter circuits, it became apparent that a similar, though somewhat less pronounced, difficult period was also being experienced daily on the Colombo/London circuit from about 1900 to 2100 local time Colombo, i.e., 1400 to 1600 G.M.T.

Figs. 4(a) and 4(b) show the deterioration in performance of these two circuits near local sunset at Singapore and Colombo respectively for the months of August, September and October, 1949.

As in the case of the Singapore/London circuit, frequency predictions for the Colombo/London circuit based on the "two control-point" method (C_1 and C_2 of Fig. 2) indicated that a reliable teleprinter circuit should have been practicable during the above period of the day (Fig. 5).

Further investigation disclosed that the above difficulty on each circuit was essentially a condition peculiar to the equinox as distinct from the solstice. Let us compare, for example, the performance of the Singapore/London circuit for the six equinox months [Fig. 6(a)], with that for the six solstice months [Fig. 6(b)], of the twelve-month period August, 1949, to July, 1950, inclusive.

The continuation of such records throughout the period 1949 to 1958 inclusive has provided confirmation that the effect under discussion was substantially non-existent in solstice months.

The performance of the Singapore/London and Colombo/London circuits for equinox months are compared in Fig. 7 for each year commencing 1949 and ending 1958, and it will be seen, by reference to the annual solar indices shown in Fig. 1, that the equatorial-sunset effect under discussion was associated with years of high solar activity.

To summarize.—The effects described above relate to difficulties of communication with terminals situated in equatorial areas, the salient feature being a considerable azimuthal scattering of signals for about two hours near local sunset at the equatorial terminal, notably during the equinox months of years of high solar activity.

Directly related to this phenomenon would appear to be that reported by Osborne[1], as part of the work of the Radio Research Board. He has drawn attention to the disintegration of the F_2 layer at Singapore near the time of local sunset during equinox months; and has referred to the possibility of the frequency of occurrence of this equatorial scatter being greatest at the maximum of the 11-year solar cycle. The effect in practice, he states, is that reflected signals from the F_2 region are not always intelligible, even though the signal strength may be high, whereas at the solstices propagation conditions are better at these hours, when the layer often remains intact throughout the evening.

Some light on the extent to which circuits to other equatorial points are affected in this way has been thrown by Hitchcock[2] who has drawn attention to the fact that during the autumn of 1956 many radio circuits operating in low latitudes suffered severe propagational difficulties shortly after local sunset. This took the form of severe fading, or weakening, of signals sufficiently serious to degrade, or interrupt, the services. In all cases, he states, the normal operating frequency, and the alternative frequencies used in an attempt to maintain communication, were well clear of the predicted upper and lower limits. And he adds, moreover, that the effect was not generally noticeable on circuits during sunspot minimum years.

In view of the apparent correlation between the circuit data from various sources and the results of ionospheric soundings, it is possible that there is a fundamental obstacle to the sky-wave operation of tropical, or partly tropical, circuits under the conditions which have been referred to.

Since the last war the number of high-frequency circuits has considerably increased, and the period 1947 (high solar activity) through 1954 (low solar activity) to 1958 (exceptionally high solar activity) has thus afforded an excellent opportunity of studying many of the effects of the solar cycle on communication by ionospherically reflected rays.

In this connection it is perhaps not without interest to recall the following statement made by Appleton in 1947[3] "Sir Edward Appleton (in reply): I strongly support Dr. Smith-Rose's plea for continued, and indeed extended, post mortem examination of operational results. Only in this way is it possible to check the accuracy of our ionospheric predictions. Moreover, nature has many surprises for us in work of this kind, and, with a laboratory as large as the earth itself, it is only with the co-operation of an army of radio operators that we can ensure that many interesting abnormalities do not escape attention."

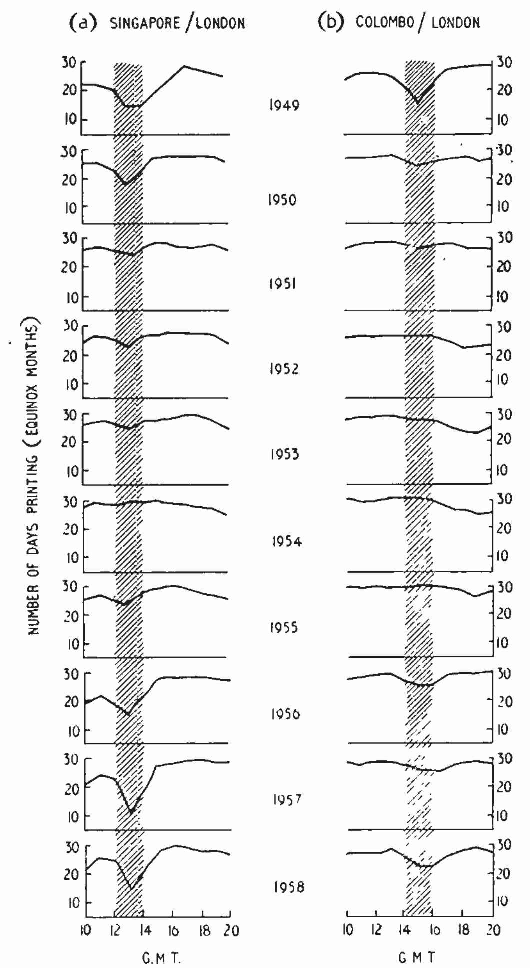


Fig. 7. Number of teleprinter working days on Singapore/London and Colombo/London circuits during equinox months from 1949 to 1958 inclusive.

Acknowledgments.—The author wishes to thank Miss S. S. Aucken and B. W. Smith, of the Royal Naval Scientific Service, for their assistance in the presentation of the data in this article, which is published by permission of the Admiralty.

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[1] Osborne, B. W. "A Note on Ionospheric Conditions Which May Affect Tropical Broadcasting Services After Sunset." *Journal of the Brit.I.R.E.*, Vol. 12, No. 2, February 1952.

[2] Hitchcock, R. J. "Propagational Difficulties on Radio Routes Operating Near the Magnetic Equator." (Private communication, 30th January, 1957.)

[3] Discussion on "The Investigation and Forecasting of Ionospheric Conditions," by Sir Edward Appleton; *Journal I.E.E.*, 1947, Vol. 94, Part IIIA, p. 878.

Elements of Electronic Circuits

4.—USE OF SHORT TIME CONSTANT CIRCUITS WITH DIODES AND TRIODES

By J. M. PETERS, B.Sc. (Eng.), A.M.I.E.E., A.M. Brit. I.R.E.

WE have seen in Part 1 (April issue) that the application of a square waveform to a CR circuit of very short time constant compared with the recurrence period results in a distorted waveform across the resistor. In the extreme case, when the time constant is very much less than the period, the output becomes a spike and approximates to the mathematical differential coefficient of the input wave. In other words, the shape of the output wave corresponds to the rate of change, with respect to time, of the input voltage wave; hence the term "differentiation."

Now let us examine what happens when a diode is connected in parallel with such a CR circuit (Fig. 1). The recurrence period of the square wave

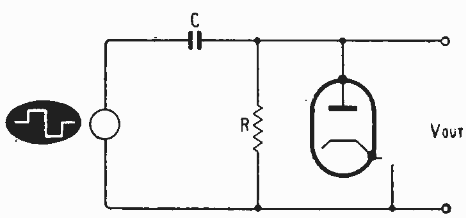


Fig. 1.

input is assumed to be 1 millisecond whilst the time constant is 1 microsecond.

Immediately the diode anode is driven positive by the square wave the diode conducts. As the rise time of the applied wave is finite, i.e., cannot occur instantaneously, the spike X shown dotted in Fig. 2

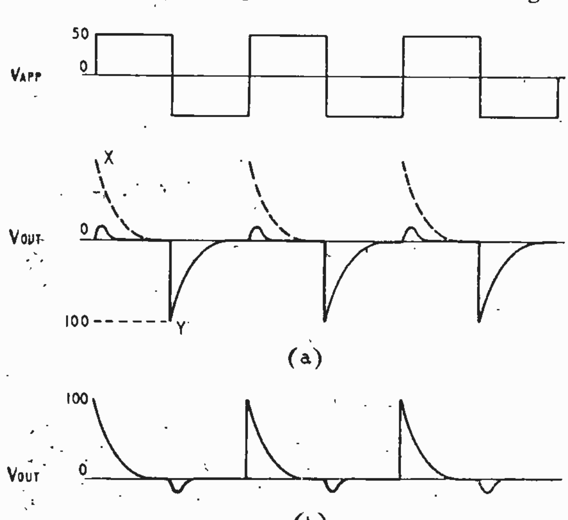


Fig. 2.

does not appear in practice and a small positive "blip" results. In effect, the diode clamps the positive excursion of the input wave to zero (Fig. 2 (a)). The negative excursion of the differentiated wave remains; the portion YZ is the result of C discharging through R. If the diode connections are reversed the spike appears all positive, as shown in Fig. 2 (b).

By means of this simple device it is therefore possible to derive waveforms consisting of very sharp positive- or negative-going spikes of the repetition frequency of the applied square wave.

If the same short time constant CR circuit is connected in the grid circuit of a triode (Fig. 3)

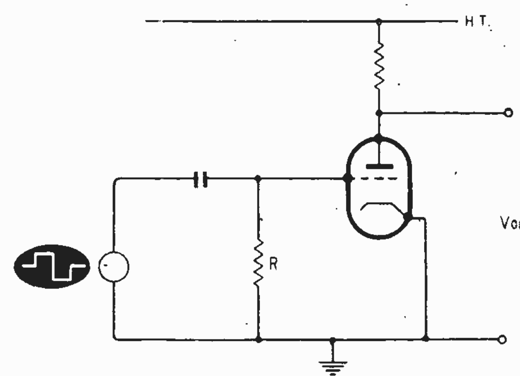


Fig. 3.

and a square waveform applied as before the result is as shown in Fig. 4. The triode's grid and cathode take the place of the diode's anode and cathode respectively and the spiked waveform now appears at the grid. As the negative excursions of the spike

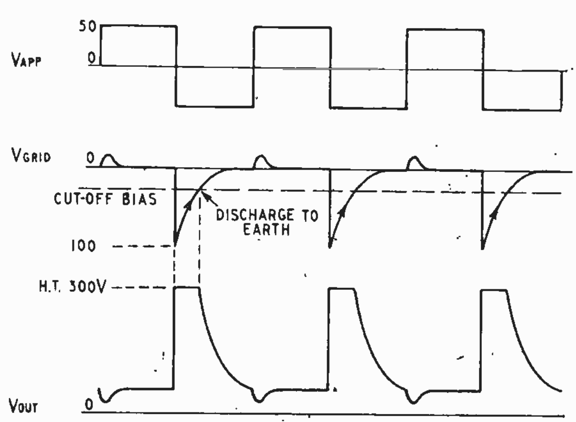


Fig. 4.

drive the triode beyond cut-off the resultant waveform at the anode appears as short positive-going square-topped pulses. The valve therefore performs a "squaring" function.

If instead of coupling the grid leak to earth it is taken to h.t. (Fig. 5), then an even narrower

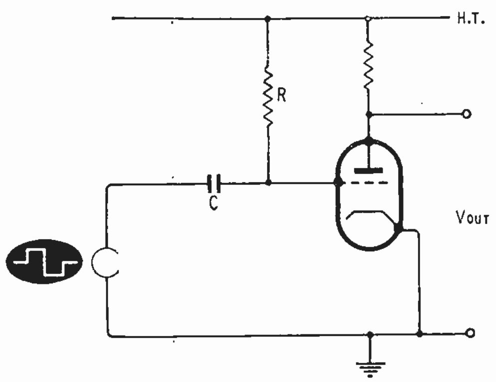


Fig. 5.

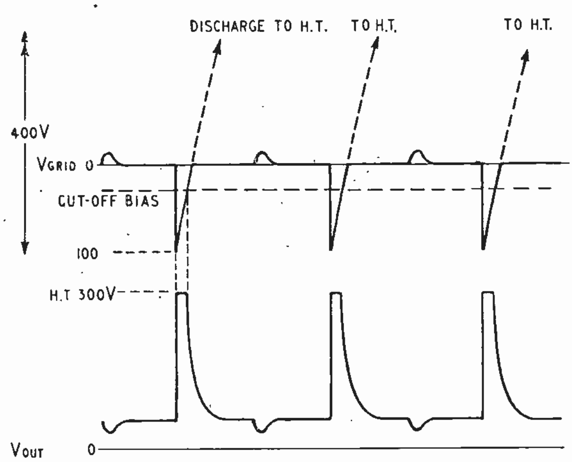


Fig. 6.

square-topped anode voltage pulse can be obtained (Fig. 6). In this arrangement C discharges exponentially towards the h.t. voltage. The voltage/time gradient is steeper than when R is connected to earth and the anode voltage pulse is consequently narrower.

In the examples shown the maximum excursion of the square pulse is ±50 volts, C is instantaneously charged to 100 volts, while the h.t. voltage is assumed to be 300 volts. It will be seen that the effective voltage in Fig. 6 is therefore 400 volts, compared with only 100 volts in Fig. 4.

Short Pulses from a Sine Wave.—It is possible for a distorting amplifier followed by a stage of bias differentiation (Fig. 7) to convert a sine wave into a narrow square-topped trigger or sync pulse. This is illustrated in Fig. 8.

Grid limiting by the distorting amplifier V1 produces an approximately square waveform at the anode of V1. Differentiation by the short time constant CR circuit and squaring of the spike by V2 results in the V2 anode voltage waveform shown.

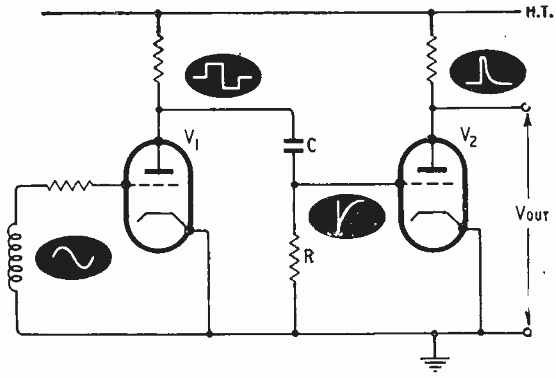


Fig. 7.

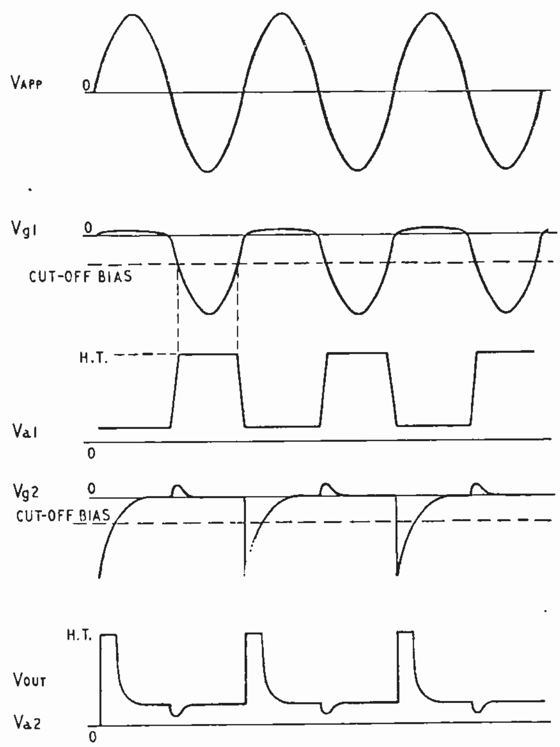


Fig. 8.

The repetition frequency of this pulse, which can be used for triggering or synchronizing purposes, is that of the applied sine wave.

The usefulness of a pulse of this kind will be appreciated later when its application as a trigger pulse for circuits such as the multivibrator will be described. As already described, a narrower pulse can be obtained by connecting R to h.t. instead of to earth.

Technical Digests are again to be issued monthly by the D.S.I.R. Each month's digest will consist of fifteen summaries of ideas and techniques recently published in this country's 300 or so technical periodicals. Each summary will be presented on a separate sheet. A year's subscription costs three guineas and particulars are obtainable from the D.S.I.R. Charles House, 5-11, Regent Street, London, S.W.1.

International Transistor Convention

1.—NEW SEMICONDUCTOR TECHNIQUES AND APPLICATIONS DESCRIBED

ALTHOUGH the seats in the Earls Court lecture halls gave more the sensation of a surface barrier than a comfortable diffused junction as one would have wished, it is a tribute to the quality of the papers presented at the I.E.E.'s Transistor Convention that all sessions throughout the six-day event had large and attentive audiences. There were about 2,000 delegates altogether, of whom 400 were from 26 overseas countries. Particularly crowded was the opening session, which had the special attraction of introductory lectures by the joint inventors of the transistor, Professor Bardeen, Dr. Brattain and Dr. Shockley—a triumvirate which the Supporting Chairman, G. Millington, mysteriously linked with Faith, Hope and Charity.

While Professor Bardeen and Dr. Brattain outlined the history and recent development of the transistor, Dr. Shockley seized the occasion to talk about the principal product of his company, the four layer p-n-p-n junction diode, or "transistor diode" as he called it. This device, with its negative resistance characteristic (see October 1957 issue, p. 502), is becoming an important competitor to the conventional transistor in switching circuits because of its much greater power handling capacity. Dr. Shockley predicted that in two or three years transistor diodes will attain power levels 10 to 100 times higher than equivalent transistors with comparable frequencies and efficiencies. One recent experimental device was capable of switching on 1kW in 20 millimicroseconds (or nanoseconds, as Continental speakers preferred it).

The great problem in this high power work, Dr. Shockley explained, was to produce a uniform avalanche current multiplying effect over large-area junctions, and he mentioned two new operating principles, called impulsive charging and majority carrier extraction, by which this effect could be achieved.

Many organizations are developing the basic p-n-p-n structure and in some cases a third connection is made, analogous to the grid of a thyratron valve, to give a controlling or gating action. One example is the controlled silicon rectifier, of which some applications in industrial power control were described by H. S. Lowry. As distinct from the thyratron, the silicon controlled rectifier (as it is called) needs current pulses of about 1A for triggering purposes, and circuits were described using Unijunction transistors (January 1957 issue, p. 40) to provide them. One method of manufacturing p-n-p-n devices was presented in a paper by R. Freestone. This consisted of forming an n-p-n structure by the "melt-back" system, in which impurities are segregated by controlled cooling in a furnace, and then adding the extra p-type layer by alloying a pellet of indium on one end.

While some delegates were probably surprised to hear talk about switching hundreds of amperes by semiconductor devices, others must have been equally astonished at the discussions on transistors working at hundreds of megacycles (one was described for 3,000 Mc/s). This very high frequency operation is made possible largely by diffusion manufacturing techniques, in which extremely thin base layers are produced by diffusing impurities into the surface of the semiconductor. The supreme example of this at the moment is the "mesa" transistor (see p. 350). Diffusion technique also makes possible the grading of impurities to give accelerating electric fields in the base layers of drift and alloy-diffused transistors. Unfortunately the high concentration of impurity on the emitter side leads to low emitter-base breakdown voltages, which can be a problem for circuit designers. One paper, by W. Fulop, suggested how this could be overcome by inserting an extra layer of high resistivity material between the emitter and the graded base. Analysis showed that the breakdown voltage would be improved without unduly affecting the frequency response.

Diffusion techniques are also important for another reason. They are very convenient for manufacturing "solid circuits," in which integrated circuit assemblies of transistor, diode, resistance, capacitance and conducting elements are produced electro-chemically on extremely small wafers of semiconductor material. A paper by T. M. Liimatainen described the use of photo-lithographic and photo-engraving methods for etching away selected areas of a semiconductor wafer into which a base layer had been previously diffused. When metal contacts and electrodes have been deposited and alloyed with the semiconductor the result is a "printed transistor". It can take the form of an individual package or be part of an integrated circuit assembly. Multiple units can be produced on a single semiconductor wafer. Typical examples have common-emitter current gains of 15 and alpha cut-off frequencies of 48Mc/s.

Dielectric Devices

An entirely new class of semiconductor devices, known as dielectric diodes and triodes, is likely to arise out of recent research by various workers on space-charge-limited currents through insulating crystals (see p. 350). These currents are analogous to those flowing through the insulating vacuum of the thermionic valve. A paper by G. T. Winch described experiments on crystals of cadmium sulphide, through which steady current densities of several amperes per square centimetre had been obtained with only a few volts applied.

The idea of space charge also came into a group of papers on the theory and measurement of transistor parameters. Ever since transistors began to be used extensively for switching and pulse work it was realized that the established small-signal a.c. theory, based on such things as alpha cut-off fre-

and Exhibition

AT THE CONVENTION

quency, effective base resistance and collector capacitance, was not very helpful for non-linear operating conditions. In 1957, Beaufoy and Sparkes, who presented papers at the Convention, introduced a new approach to transistor operation based on the concept of charge control. The central idea of this was that a number of current carriers (say holes in a p-n-p transistor) was necessary between emitter and collector to sustain the current, and this number represented a stored "charge" which varied with the working point.

The so-called charge-control parameters worked out on this basis proved a very convenient way of dealing with large-signal transients in switching circuit design, and at the Convention several speakers paid tribute to its usefulness. J. J. Sparkes presented a paper on the measurement of these parameters (e.g. collector time constant is defined as Q_B/I_C, base charge over collector current), while R. Beaufoy showed how they are used in switching circuit design. Another paper, by A. Kruithof, demonstrated that the charge-control concept lends itself very well to a graphical representation of transient response.

Charge-Control Theory

Taking the idea even further, R. D. Middlebrook expounded a whole new theory which integrated the valve and the transistor on the basis that both are fundamentally charge-controlled devices, not voltage-controlled and current-controlled, respectively, as we are accustomed to regard them at present. One example of the approach is that in a charge-controlled device the transit time of charge carriers across the active region is inversely proportional to the nth power of the total charge in transit; n being 0 when the current is diffusion limited in semiconductors, $\frac{1}{2}$ when it is space-charge limited in vacuo and 1 when it is space-charge limited in semiconductors.

Professor Middlebrook also conducted an experiment in subliminal perception by presenting about a dozen lantern slides loaded with mathematics in quick succession, but in spite of this his interesting paper was very favourably received. It should be well worth studying in more detail when the Proceedings are published by the I.E.E. Particular praise came from speakers who were concerned with the present unsatisfactory state of technical education in semiconductor, as compared with valve, theory and practice.

On the manufacturing side, one or two papers discussed the relative advantages of the three basic junction-forming techniques—alloying, growing and diffusion—in such factors as cost, complexity and reproducibility. It emerged that the diffused base transistor was likely to be the great thing of the future. There was no doubt that this device had a wider field of application than the others. It was more complex and costly to produce at the moment, but the possibility of processing the junctions in large batches, combined with the wide market, would undoubtedly bring down the price in the future. The alloy junction transistor was notable for its design flexibility but showed potential disadvantages in cost and was poor in reproducibility. By contrast the grown-junction transistor had cost advantages due to reduced complexity and better reproducibility, but was lacking in design flexibility.

Reliability of transistors also came in for some discussion, and certain speakers were obviously worried by conflicting evidence in the papers concerned with it. For example, R. Brewer and W. W. D. Wyatt, in a reliability appraisal based on life tests, stated that there was no evidence of any major changes taking place which would constitute a "wearing-out" process in semiconductor devices. On the other hand, F. F. Roberts, J. C. Henderson and R. A. Hastie, describing an accelerated ageing experiment on germanium alloy transistors, mentioned that a rapid increase of collector-base leakage current (and noise) had occurred in some units at little more than 2,000 hours. This had been almost the sole cause of failure; current gains had shown deterioration only after the onset of the excessive leakage.

Two other deleterious effects, with the sinister names of "creep" and "wiggle," were mentioned. The first is a variation of reverse current produced when a sustained reverse bias is applied to a p-n junction. The second is a variation of transistor input capacitance (and conductance) with frequency, probably due to electron storage in the emitter—the "wiggle" being the distorting effect on pulse and switching waveforms.

Incidentally, one speaker made a strong plea to manufacturers to give more comprehensive technical data on semiconductor devices, particularly on their performance at different temperatures. He remarked that the tabular data usually presented was quite inadequate for design purposes. (Loud applause from the audience.)

On the applications side, there were very few papers concerned with domestic radio, television and audio circuits, and none on hearing aids, but d.c. amplifiers received some attention. A large number of contributors, however, dealt with the applications of transistors in line communications and data processing. In both of these fields, where amplifying or switching devices are needed in large quantities, the small size and low power consumption of the transistor make it an ideal component. The communications papers covered digital speech transmission systems as well as straightforward amplification in carrier telephony, while the data processing papers covered telephone switching as well as digital computing.

In the field of computing, circuits are now being developed to operate at pulse rates of 50Mc/s and above, with pulse rise times of only 1 or 2 millimicroseconds. As examples, G. B. B. Chaplin described a 50-Mc/s binary scaler using micro-alloy diffused transistors and showed a transistor-generated pulse of a few millimicroseconds on a 30-mμsec transistor-generated c.r.o. timebase.

At these frequencies transistors have the advantage over valves, not only because of their lower impedances but because they can be packed very much closer together to minimize transmission time delays of pulses. There is, in fact, a limit on the dimensions of a computer for such work since the transmission time delays of the wiring become significant and the required timing arrangements and speed of operation could be adversely affected. Mr. Chaplin demonstrated this fact most effectively by causing his millimicroseconds pulse to travel down a line a few feet long and be reflected from a short circuit to appear on the 30mμsec timebase at some distance from the generated pulse.

Many different types of switching and computing circuits were described in other papers. The discussion on them was wound up by a general plea from one speaker that there should be some kind of agreed standardization and simplification in such circuit techniques. This would enable manufacturers to concentrate on producing first-class transistors with the best possible characteristics for switching work.

2.—INTERESTING THINGS SEEN AT THE EXHIBITION

Dielectric Valves being investigated by the Electrical Engineering Department of Birmingham University are similar to ordinary valves except that the electrons flow through a dielectric rather than a vacuum insulator. Normally currents cannot be made to flow through a dielectric insulator as through a vacuum for two reasons: potential barriers are set up at any external contacts, and in addition, imperfections in the dielectric crystal lattice structure trap any electrons which may flow initially so that an electric field is produced which inhibits any further flow. However, these two difficulties have now been overcome. Thin plate crystals of cadmium sulphide have been grown with a sufficiently perfect lattice structure to pass currents of tens of amperes per square centimetre at a few volts, and in addition, external contact potential barriers have been avoided by diffusing indium contacts into the surface of such crystals. Dielectric valves offer a number of general advantages over ordinary valves or transistors. They should be much easier to construct than either transistors or ordinary valves, although, for a given high frequency response, the dielectric valve, like the transistor, will have to be much smaller than the corresponding ordinary valve. Also, the current/voltage characteristics of dielectric valves can be modified by altering the characteristics and number of the remaining imperfections in the crystal. No heater is needed in a dielectric valve since the free electrons in the metal contacts flow directly into the dielectric.

Alcatrons shown by the French C.S.F. are experimental field-effect majority-carrier devices similar to the Tecnetron in consisting of a piece of n-type semiconductor material with a very narrow (about 10 microns wide) constriction in it. The supply voltage is applied between two terminals referred to as the source and drain on opposite sides of the constriction. Along the constriction is formed a p-n junction called the gate across which the input signal is applied. This signal modulates the current between the source and drain so as to produce an output in the external circuit connecting them. In the Alcatron there is, however, an additional much longer p-n junction from the gate to the drain parallel to the gate junction but on the opposite side of the constriction. This extra junction acts rather like the screen grid of an ordinary valve and also reduces the effects of surface variations at the gate. The geometrical arrangement of the electrodes in the Alcatron is also different from that in the Tecnetron. The Tecnetron consists of a long cylinder with the source and drain at its ends and the gate in the middle. The Alcatron resembles a Tecnetron rotated about its drain, and consists of a flat disc with the drain at the centre, source at the circumference and ring-shaped gate between. Since the volume at the constriction for a given narrow width is thus much greater in the Alcatron than the Tecnetron, the Alcatron offers a higher allowable power dissipation and transconductance than the Tecnetron in its original form.

Mesa Transistor base layers thin enough (a few microns) to give a short transit time between the emitter and collector, and thus a high cut-off frequency, are made by gas diffusion of the appropriate base impurity into the surface of the collector. Such diffusion also produces a gradual change of the resistivity through the base from the pure base-type semiconductor to the collector type, from n-type to p-type material or *vice versa* as the case may be. This gradual change results in an electrostatic "drift" field in the base region which still further reduces the transit time between emitter and collector, and increases the cut-off frequency by a factor of five or more over that of a transistor with a similar base thickness but in which the base material is uniform. In the mesa transistor the emitter and base connections are applied to the base surface close together so as to minimize the resistance between them, but edge on to each other to keep the capacity between them low. Finally the material outside the emitter and base connection area is etched away around the base to reduce the collector capacity, the material near the collector being left unchanged so as not to reduce the allowable collector dissipation. The name mesa is derived from the characteristic shape of a flat base plateau on a larger collector produced by this process. The highest quoted α-cut-off frequency for a mesa was 600Mc/s for the Texas Instruments 2N1142; prototype and experimental mesa transistors were shown by Sylvania-Thorn and the French C.S.F. respectively.

Power Transistors.—Fairly high powers at a fairly high frequency—a few tens of watts at a few Mc/s—are offered for example by the Texas Instruments 2S012 or 2S013 and experimental silicon transistors shown by the French C.S.F. and Ferranti.

The highest power audio transistors seen were the Westinghouse silicon TS10 to TS26 series in which the allowable collector dissipation falls to zero at 150°C and in which the derating factor or thermal resistance is quoted as 0.7°C/watt. The extent to which the current gain decreases at high-current levels depends on the emitter injection efficiency and hence the impurity level in the emitter region. By adding to the normal indium emitter material some substance such as aluminium which is more soluble in germanium than indium this injection efficiency can be improved. This process is used in the Mullard OC28 and OC29 for example.

(*Continued on p.* 351)

Tetrode Transistor giving a power gain of 20dB at 70Mc/s was shown by Texas Instruments (3S004). In this transistor the thin base is sandwiched between the relatively much thicker collector and emitter. The extra bias electrode is placed on the edge of the thin base opposite the base connection. The bias current which thus flows through the base at right angles to its narrow dimension reduces its effective area. Although this reduces the current gain it has two overriding advantages. It reduces the base resistance and thus decreases the necessity for neutralization at high frequencies and, in addition, it increases the cut-off frequency by a factor of about five. A convenient method of varying the current gain available in such tetrodes is to vary the bias current.

Switching Devices.—A number of manufacturers were showing p-n-p-n multilayer sandwich constructions. If a sufficiently high potential (about 100V) is applied across such a device the normally reverse-biased central junction breaks down and switches the total forward resistance from a high to a low value. The width of the central p and n regions determines the voltage required for switching, a higher voltage being required for a wider region. The Westinghouse Dynistor has similar characteristics to such devices except that its reverse resistance is low.

A recent development of these p-n-p-n devices shown by Westinghouse (as the Trinistor) and also by the B.T.-H. Research Laboratories and International Rectifier is the addition of a third control electrode at one of the central regions, generally the p-region. This electrode can be used to switch the device independently of the external circuit and at a lower switching power level, a control signal of a few tens of milliamperes at a few volts switching currents of up to a few tens of amperes Such devices thus have properties similar to those of thyratrons or grid-controlled rectifiers, but in addition have a number of advantages. These advantages include the absence of a heater and its attendant warm-up time and standby power requirements, a much lower voltage drop (about 1V) in the conducting state leading to a higher efficiency, and a faster triggering time (about 1μsec). Like thyratrons these devices can only be switched off by reducing the operating current below a certain value.

In the R.C.A. Thyristor currents of a few tens of milliamperes can be switched off as well as on from the control electrode with a control signal of a few milliamperes at a few tenths of a volt, and a triggering time of about 0.1 μsec. The Thyristor is a modification of a mesa transistor with the base used as the control electrode. Its action depends on the fact that the collector can become an electron injector at high current levels.

Diodes for Special Purposes.—Zener diodes shown by International Rectifier included a 5-W range for use up to 160V and a very stable 8.4V, 10mA unit in which the voltage changes by only 0.001% per °C. A very wide operating temperature range of from −65°C to +325°C is possible in an 800mW gallium arsenide regulator introduced by Texas Instruments. Forthcoming additions to the range of Lucas semiconductor diodes recently made generally available will include both Zener and clipper diodes—the latter are Zener diodes with equal sudden current overload characteristics at a certain voltage for both forward and backward voltages.

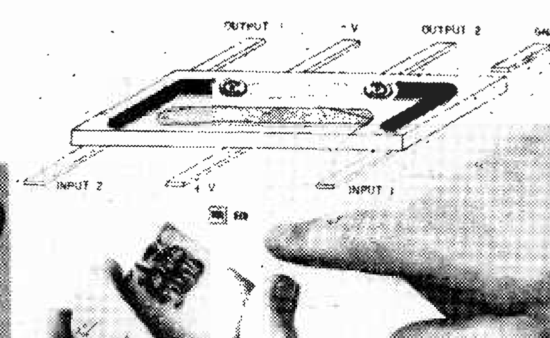
Small photodiodes with diameters of less than 0.1in were shown by Sylvania-Thorn and Texas Instruments. A photocell shown by the German Te-Ka-De consisted of two n-type germanium regions separated by a very narrow p-type dislocation, so that a movement of the illuminated region of only 10^{-4}cm across the dislocation reverses the direction of current flow. This device is grown from two n-type crystals butted together at a small angle. This method of producing an impurity layer offers possibilities of avoiding temperature variation effects.

A variable-capacity diode usable for a.f.c. up to 250Mc/s was shown by Siemens Ediswan (Y100).

Silicon Carbide for making semiconductor devices which can operate up to 600°C is being investigated by Raytheon. Although it is difficult to make crystals larger than about 0.01in across, diodes have already been constructed.

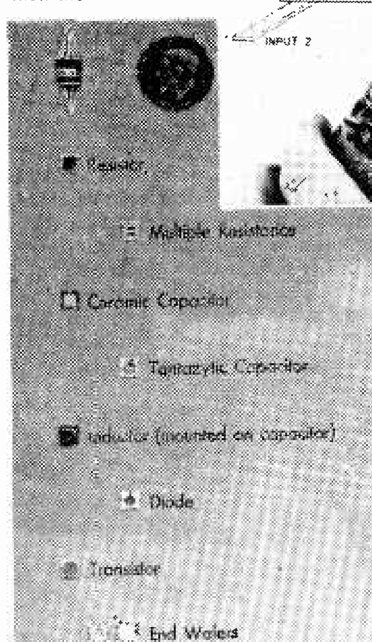
Hall Effect Devices for multiplication, modulation and magnetic field measurement were shown by the German Siemens and Halske. These included a unit with an effective air gap of 5.5×10^{-4}in for reading magnetic tape. With this method of reading, the output is, of course, proportional to the flux rather than the rate of change of flux, and is thus independent of the tape speed.

Miniaturization Techniques were shown by the R.C.A and Texas Instruments. Texas have succeeded in forming together in a single piece of semiconductor all the components of a circuit, including transistors, diodes, resistors and capacitors. Component densities of about 20,000 per



Texas Instruments miniaturized multivibrator. This incorporates two transistors, two capacitors and eight resistors made in a single piece of silicon less than ¼in by ⅛in by 1/32 in. The finger points to two such units, the one on the right being hermetically sealed They can be compared in size with a conventional transistorized printed circuit multivibrator held in the other hand. A greatly enlarged drawing of the Texas unit is shown above.

R.C.A. separate Micromodule components with complete stacked circuit at the top near a penny to show the size.



cu in can be obtained by this method as compared with, for example, 30/cu in using sub-miniature printed circuit techniques. R.C.A. form their components separately in the shape of thin wafers 0.3in square which are then stacked on top of each other to give the required circuit. Component densities of about 300/cu in can be obtained by this method.

Small transistors of about 0.10in diameter by 0.15in long for use in hearing aids were shown by Raytheon and Brush.

Transistor Test Set shown by Siemens Ediswan (Type R2285) uses variable feedback from the collector to the base of the transistor to be tested to produce oscillations which are made audible by a loudspeaker. When the oscillations just cease the overall gain round the feedback loop is unity so that the transistor gain can be determined from the setting of the variable feedback control. Collector leakage currents can also be measured.

As many as seven dynamic and five static n-p-n and p-n-p transistor parameters can be measured at any collector potential up to 30V and any emitter current up to 5mA by means of the compact (8½in by 6½in by 4½in) Telefunken Teletrans 1. The seven dynamic parameters are measured at 1kc/s and are the standard "h" and "y" parameters. These include the current gain, inverse voltage transfer ratio, two transconductances and three resistances. The five static parameters include four cut-off currents and the base voltage. A bridge measurement circuit eliminates any effects due to mains voltage variations, and the measurement accuracy is ±5%.

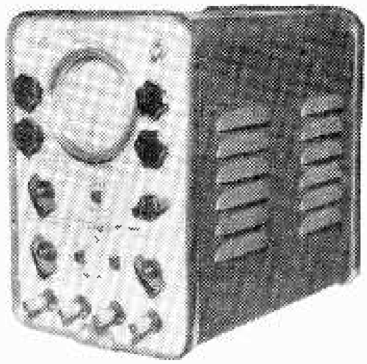
A series of adaptors is now available from Wayne-Kerr for enabling various transistor admittances to be measured from 100c/s to 5Mc/s to within ±3% using their TA100 and B601 transformer ratio-arm bridges. These adaptors automatically set up the appropriate transistor and power supply configurations while avoiding stray capacitances and couplings and unwanted loading due to the supplies. The three-terminal facility of transformer ratio-arm bridges by which the impedance between two points can be measured independently of the impedances between these two points and a third is particularly useful for transistor measurements.

In an automatic tester shown by S.T.C. the various parameters are measured in turn by integration for two successive five-second periods. Integration simplifies the measurement of small currents and reduces the effects of switching from one parameter to the next, while short-term drifts are detected by comparing the two successive five-second integrals.

Semiconductor Measurements shown by Siemens Ediswan included that of the three hybrid-π transistor equivalent circuit parameters using the equivalent circuit and transistor in two arms of a bridge. If a broad frequency band input signal such as a square wave is used, the balance point will determine three parameters rather than the usual two.

Current gain measurement using a transformer ratio-arm bridge was illustrated by the B.B.C. A variable fraction of the collector current is fed to one ratio arm, and the emitter current with a variable phase shift is fed to another ratio arm. The outputs from the two ratio arms are arranged to act in opposition in the secondary detector winding. The settings of the variable phase and amplitude controls for no secondary detector output then determine the phase and amplitude of the current gain.

G.E.C., Newmarket and Texas Instruments used the variation with temperature of certain semiconductor parameters such as reverse leakage currents to give, after calibration in an oven, a measure of junction temperature in the measurement of permissible ratings for a given temperature. The semiconductor device was continually switched between the temperature measurement and permissible rating test conditions.

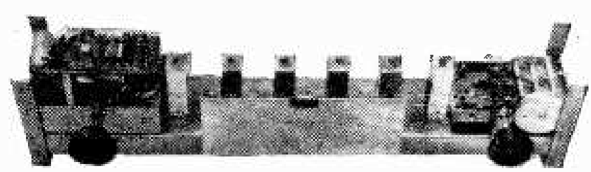


Dawe prototype transistor oscilloscope Type 720 using only eight transistors.

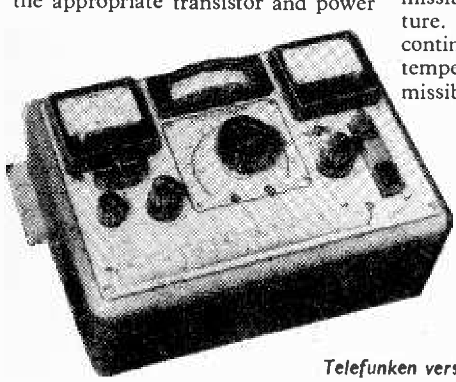
When a diode is switched from the forward to the backward direction a reverse current flows temporarily until the remaining current carriers are removed from the material—a phenomena known as hole storage. The decay time constant of the reverse current pulse varies considerably with the particular operating conditions so that it is more useful to specify the total charge in the pulse. As shown by the G.E.C. this charge can be measured by charging up a condenser from a repetitive pulse and measuring the mean current produced, since this current is equal to the repetition frequency multiplied by the required charge.

Analogue Circuits for investigating system performance data which are too difficult to calculate are, of course, a very old idea, but two of the circuits shown had unusual general features. Mullard showed a large-signal analogue of a high-frequency transistor which used transistors to provide some of the non-linear capacities required. S.T.C showed an analogue circuit of an alloy-junction transistor which was made three dimensional to take account of the fact that the minority carrier flow between emitter and collector is not exactly in parallel lines across the base but spreads out somewhat from the emitter.

Oscilloscopes using transistors were shown in experimental form by



B.B.C. experimental v.h.f./f.m. receiver incorporating balanced crystal mixer.



Telefunken versatile compact transistor test set "Teletrans I".

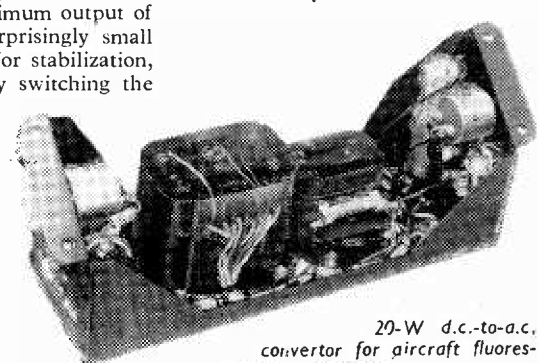
Cossor (on the Livingstone Laboratories stand) and B.T.-H, and in prototype form by Dawe. The Dawe Type 720 uses only 8 transistors. Its Y-amplifier has a maximum sensitivity of 30mV/cm falling by 3dB at 5c/s and 50kc/s, and a high (for transistors) input impedance of 1MΩ. Although the response in the two experimental models extended to at least 500kc/s, they each used about 20 or more transistors.

Receivers for the v.h.f./f.m. band were shown in experimental form by the B.B.C. and Texas Instruments. The transistor cut-off frequency must be higher for r.f. amplification than for oscillation so that because of the difficulty of obtaining sufficiently high frequency transistors only the Texas receiver incorporated an r.f. stage. This used a 2N1142 transistor, and a 2N623 is used in the combined mixer-oscillator stage. The B.B.C. receiver used a 2N247 as an oscillator feeding two GEX66 diodes forming a balanced mixer to reduce local oscillator radiation.

Miniature a.m. receivers which included short-wave bands extending up to 12Mc/s were shown by the two Japanese exhibitors Sanyo and Tokyo Shibaura. Thermistors for stabilizing the push-pull output stage against temperature variations are incorporated in the Sanyo receivers.

Stabilized Power Supplies.—In this field it would seem that the transistor has created a direct demand for itself. For experimental work with transistors a stable supply variable between about 1 and 30V at a current of the order of 1A is often necessary, and it is to the stabilization of such supplies that the small power transistor is peculiarly suited. Many manufacturers were showing mains-derived power supply units of this nature which were broadly similar: most used a form of emitter-follower circuit with the reference potential derived either from gas-filled stabilizer valves or Zener diodes. Output impedances of the order 0.05Ω are generally achieved.

When delivering a current near the maximum rating at a low voltage the major part of the supply's power is dissipated in the output transistors. To enable the use of an economically-sized output stage most of the power units were fitted with a coarse voltage switch selecting two or three taps on the mains transformer, but G.E.C. were showing a unit capable of continuous variation between 6 and 20V at 10A. Two firms (Elliott and Hatfield) had adopted special means of utilizing a smaller output stage than was usual. The Hatfield L.E.400 is rated at 30V 1A but the single output-voltage control varies not only the proportion of the reference voltage used (this time derived from Zener diodes) but also the input voltage by means of a continuously - variable transformer. Elliott use a rather different approach in their Type B.673 supply. This has a maximum output of 50V at 1.5A and surprisingly small transistors are used for stabilization, which is achieved by switching the supply into large-value electrolytic capacitors. A drop in voltage below a preset limit switches the supply on, and a rise switches it off: this is achieved by a bistable circuit whose reference voltage is derived from Zener diodes and the switching rate varies between about 3c/s and 300c/s for the minimum and full load conditions.



20-W d.c.-to-a.c. convertor for aircraft fluorescent lighting (G.E.C.).

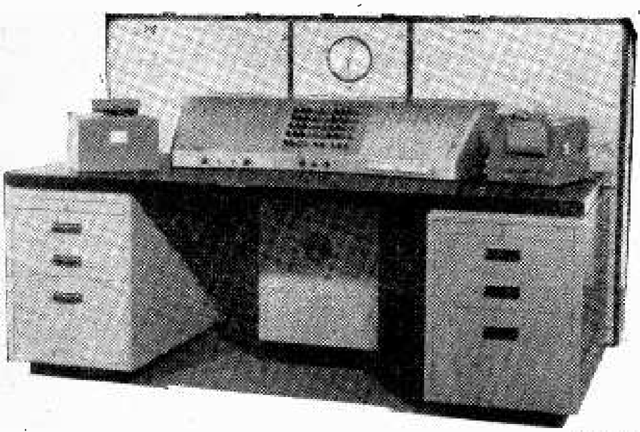
Mobile Power Supplies.—The difficulties of obtaining high, direct or alternating voltage from the low-voltage d.c. supplies available in cars or aeroplanes are only too well known. The transistor, however, can be used as a repetitive switch which has very good performance compared with mechanical interruptors and, in such a mode, it dissipates but little power within itself. Most convertors follow the same general outline—oscillating transistors feed "chopped" d.c. into a transformer where it is stepped up to the required potential and, then, for a d.c. output, rectified and smoothed.

An example of one typical approach was the Ultra UA1701 convertor which is designed as a direct replacement for a rotary machine in some of this company's airborne equipment. Four transistors in a bridge oscillator circuit interrupt the 28-V d.c. supply, feeding it to a square-(hysteresis)-loop transformer, whose output is rectified by junction devices to provide 250V at 250mA d.c. Efficiencies, on the whole, are good: for a d.c. output the use of a square-loop transformer helps considerably as this enables the transistors to be operated with the minimum of internal power loss. However, for an a.c. output the preferred practice seems to be to use either a separate sine-wave oscillator driving a fairly-efficient output stage, or to use the power transistors as sine-wave oscillators, so avoiding the use of filters.

D.C.-to-a.c. convertors have been made in sizes handling hundreds of watts, but one which caught our eye was on the Elliott stand. This was rated at 20W (Type B.725) and gives a 400c/s output which was displayed together with 400c/s from an a.f generator on a double-beam oscilloscope. There was a barely discernable difference between the waveforms. The use of these convertors seems worthwhile even for purposes such as fluorescent lighting in aircraft, cars and railway carriages. Many oscillators designed expressly for this purpose were shown in a variety of sizes from 6 up to about 150W. A side issue of this is that G.E.C. have been able to reduce appreciably the magneto-strictive noise from the transformers by coating them with a ¼-in-layer of solid polyurethane.

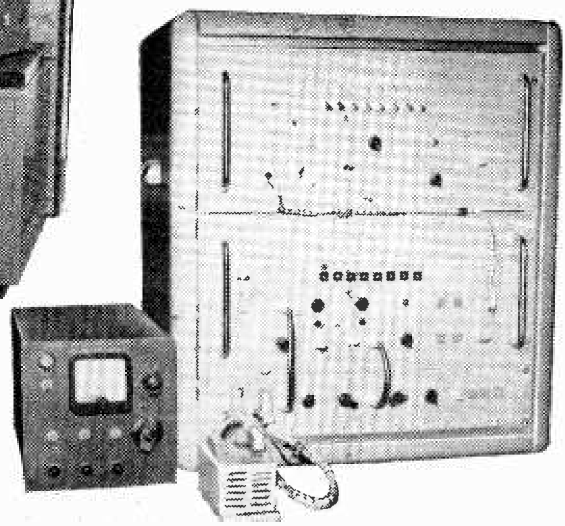
Transistor H.T. Smoothing.—Where there are severe limitations on space or weight a transistor may be used in place of the normal L-C h.t.-smoothing arrangement. This was illustrated by a unit from the "Sea Slug" guided missile in which a small power transistor is used to smooth an h.t. supply. Again the circuit used is an emitter follower, the base being connected to a supply smoothed by a simple, small R-C filter.

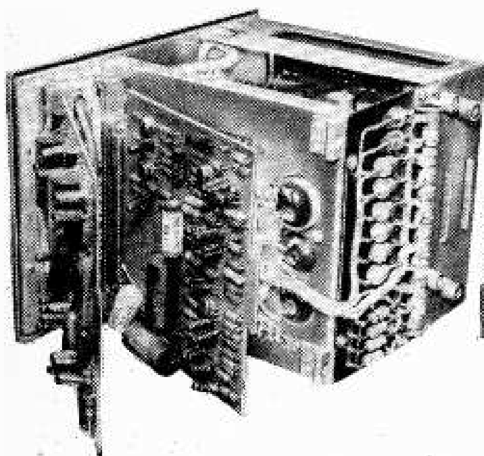
Data Processing.—The Ferranti "Sirius" is a new, general-purpose digital computer designed mainly for the user who needs a computer but who does not have sufficient work to keep a large machine economically occupied. The computing elements are transistor-transformer units employing "ballot-box logic" and the 1,000-word store

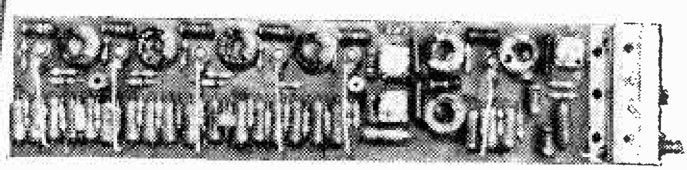


Ferranti "Sirius" general-purpose digital computer.

Armstrong-Whitworth analogue-to-digital and digital-to-analogue convertors (upper and middle decks of large cabinet) wired together for demonstration.







6.6Mc/s i.f. strip (using toroidal coils) from S.T.C. i.l.s. receiver.

Rear view of Ferguson "Digitizer" 5-bit analogue-to-digital convertor using "book-leaf" construction.

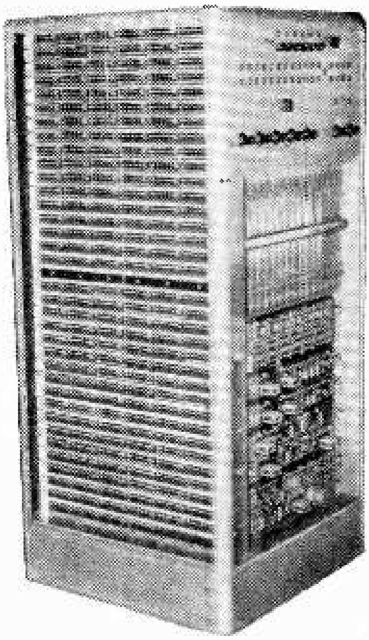
is made up from 20 torsional nickel-wire delay lines using magneto-strictive input and output. The logic circuits are made up on colour-coded plug-in boards. No cooling system is necessary. Notable features of this computer are its small size, 7ft × 3ft 6in × 4ft; low weight, 5 cwt; power consumption, 600W; and price, £15,000 complete with input and output apparatus (5-hole paper-tape equipment).

The Ferguson "digitizer" is a comparatively simple medium-speed analogue-to-binary code convertor giving a straight 5-bit output. Housed in a cubic box of side 6-in, it is mains powered and is built on the book-leaf pattern. The Armstrong-Whitworth analogue-to-digital convertor is rather more sophisticated—this gives an 8-bit output in both serial and parallel form and a 500-kc/s digit-pulse rate is achieved by the use of surface-barrier transistors. It has a companion digital-to-analogue convertor which accepts an 8-bit number, stores it and then uses it to control transistor switches feeding a resistor network, from which the output voltage is produced.

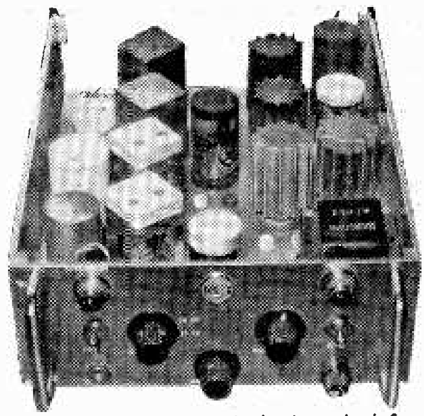
Experimental use of the automatic letter-sorting machine has shown the G.P.O. that a serious barrier to the extension of its use is the difficulty of teaching quickly the special code fed in by the operator. To overcome this difficulty a translator has been developed at the Post Office Research Station which feeds to the sorting machine the required two-letter code. This code is derived from the three initial and two final letters of the name of the "post town" (this large number is necessary to avoid ambiguities) which are fed in by the operator from an ordinary typewriter keyboard. The translator unit uses a 5 × 26 matrix of square-loop cores, whose output is amplified by transistors and used to strike cold-cathode tubes feeding the sorter.

A device which could replace square-loop cores in computing applications is the p-n-p-n junction. On the stand of the A.E.I. Research Laboratories these devices, which exhibit similar characteristics to those of a gas-discharge tube, were shown operating in a 5 × 5 matrix, a saw-tooth generator, a bi-stable circuit and two forms of ring-counter (see circuit diagram). Their chief advantage in a matrix is that they are individually replaceable, whereas in a core matrix a failure of one core usually means that the whole matrix has to be replaced.

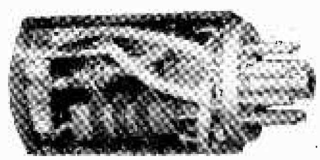
Communications: — R.C.A. were showing a single-channel transistor v.h.f. receiver (the AR108) for the 108- to 156-Mc/s band with a performance of a surprisingly high order—50mW output is obtained for a 2-μV input, with a signal/noise ratio of 10dB at 30% modulation. The large amount of power wasted in valve receivers is brought home with a vengeance by the power consumption of this set —8 to 10W maximum at 12Vd.c. for a 2-W a.f. output. The underside of the chassis of the AR108 is a little disappointing—all that can be seen is wiring between octal valve sockets! Into these sockets plug resin-encapsulated units each con-



Code translator for G.P.O. letter-sorting machine.



R.C.A.'s all-transistor single-channel v.h.f. receiver using potted plug-in component assemblies and (below) potted plug-in unit from R.C.A. AR108 receiver.



taining all the components for a particular stage. The units are coded by colour and shape and the overall size of the receiver is such that two can be mounted side-by-side in a 19-in rack (height 3in). It is also available in a 117/234-V, 50 to 60c/s version.

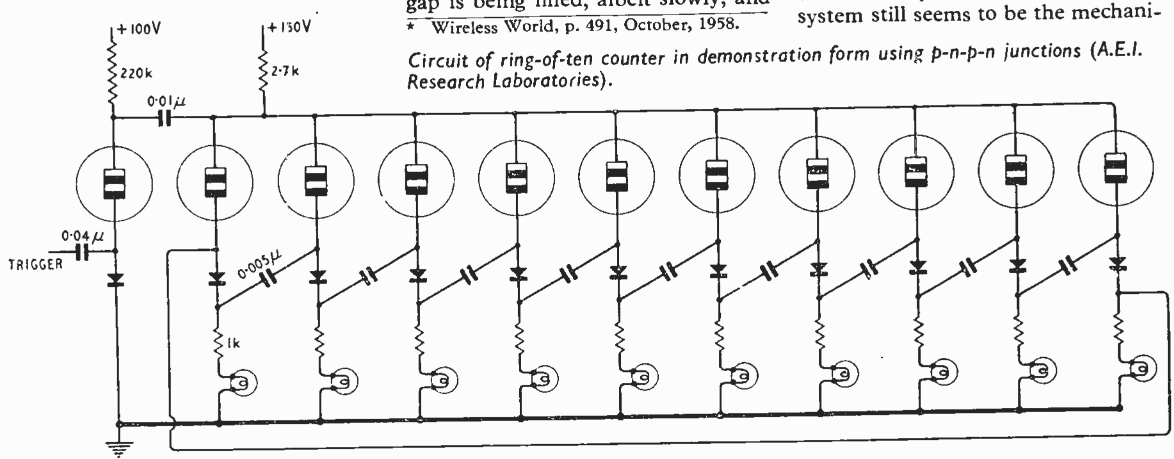
Another striking example of miniaturization by the use of transistors was shown on the Ministry of Supply stand. This was a "Forward-area Time-division Multiplex Equipment" which is contained in one box, weighs only 30lb. and consumes 5W of power at 12Vd.c. This provides four, good two-way telephone channels over a radio link or land line of very poor quality. Contrasted with its 8-year-old "valved" equivalent which consisted of sixteen boxes each weighing 50 to 80 lb. and consuming 1.5kW the new equipment can be considered truly portable and suitable for "forward-area" use.

The growing use of transistors in airborne equipment was noted at last year's S.B.A.C. show*. The general trend seems to be to allow a reasonable amount of "spare" space in the layout so that servicing is rather easier than with valved equipment. One example of this was an i.f. strip from the S.T.C. i.l.s. glide-slope receiver. Operating at 6.6Mc/s this uses six stages of grounded-emitter amplification to provide 100dB ± 6dB gain over a bandwidth of 200kc/s. Transmitters are at present limited by the lack of suitable transistors: however this gap is being filled, albeit slowly, and

* Wireless World, p. 491, October, 1958.

Mullard were showing an "S.O.S." transmitter with a 4-W output at 500kc/s. This used a pair of OC24s in Class-B push-pull, driven from a crystal oscillator using an OC45. The efficiency realised was about 50%.

Circuitry.—D.C. amplifier design, is at the best of times, a difficult business and it is not eased by the additional drifts present in transistors, but these disadvantages are being overcome. One item on the Mullard stand featured a display of 8 types of d.c. amplifiers, together with some performance data. The first type was a direct-coupled amplifier having a current gain of 500 and which used germanium devices. The drift exhibited by this was about 5μA/°C, referred to the 2-mA input. The use of silicon transistors and base stabilization by Zener diodes in the second example raised the input impedance from about 100Ω to 300kΩ and cut the drift to 0.1μA/°C referred to the input. The third example was a set of germanium long-tailed pairs with a drift of 1.5mV, relative to the maximum input of 10mV, from 20 to 35°C. and again replacing the germanium devices by silicon reduces drift and increases input impedance. No. 5 illustrated the use of temperature stabilization of the input stage by means of a subsidiary amplifier controlling a small heating coil round the transistor. This reduced drift by a factor of 20 and temperature was sensed by a second transistor inside the coil. The sixth example used chopper techniques and the chopping was done by a silicon-diode bridge —a drift of about 2.5mμA/°C was achieved relative to 1-μA input, with a gain of 1000. Another chopped design used a transistor as a parallel switch across the input. This had a drift of only 0.5mμA but the best system still seems to be the mechani-

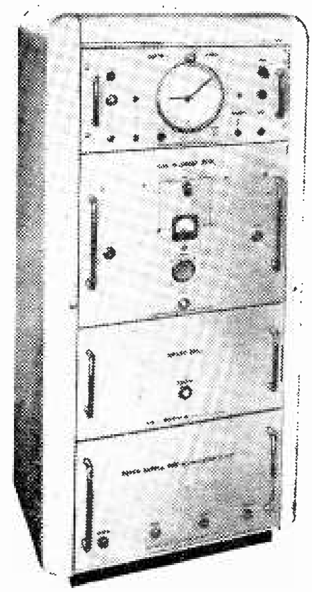


Circuit of ring-of-ten counter in demonstration form using p-n-p-n junctions (A.E.I. Research Laboratories).

cally-chopped amplifier. The last example, using a Carpenter relay, exhibited a gain of 50,000 with a very small drift, which is time-dependant. The temperature control method mentioned above was used in an amplifier panel offered by the G.E.C. as a basic "brick" for instrumentation purposes. This amplifier has a guaranteed minimum gain of 200,000, a drift of $\pm$ 2.5μV and a noise level of 5μV peak to peak referred to the input. The output is $\pm$ 10V and synchronous-chopper techniques are also used. All the transistors are germanium types arranged in feedback pairs and the low-noise GET106 is used for the first stage.

Work at the Royal Radar Establishment on the use of transistors in radar has resulted in the development of a very-linear timebase for a magnetically-deflected c.r.t. This uses an r.f. transistor as a switch (not specifically for its high cut-off frequency; but for its low leakage current) across the scan-determining capacitor, one plate of which is connected the input of an amplifier whose output is developed across a low value resistor in the emitter circuit. The output voltage is fed back to the other plate of the capacitor. Thus something very similar to the single-pentode Miller circuit is achieved. To neutralize the leakage current of the switching transistor a similar transistor is connected, in the reverse sense, to the capacitor. The Miller voltage waveform developed across the emitter resistor in the output stage causes a linear current sawtooth to flow through the deflector coils, which are placed in the collector circuit. The waveform has a peak current of 1A, is 120-μsec long, its linearity is better 1% and the leakage-current compensating circuit ensures that the velocity changes by less than 1% for a change in temperature from 15°C to 50°C.

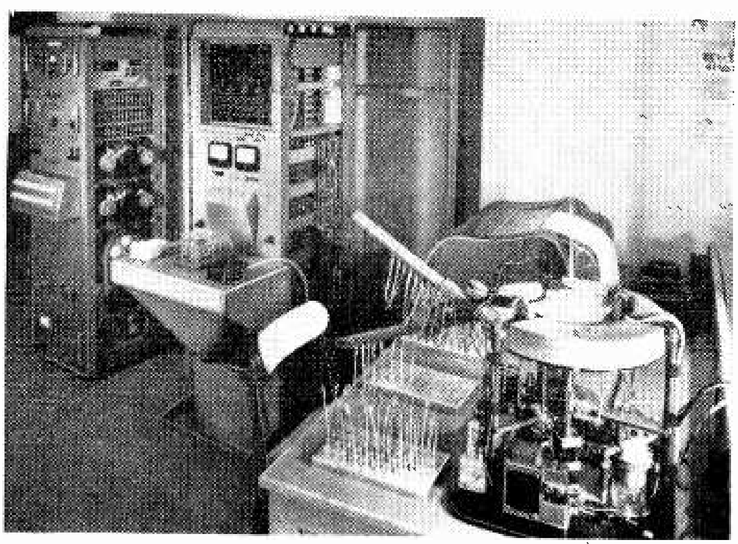
Medical Electronics:—A miniature, transistor heartbeat detector developed at R.A.E. Farnborough for use in physiological tests was shown on the Ministry of Supply stand. Skin potentials are developed which depend on heartbeat action; but normally, in an active subject, these are masked by the noise made by the working of the muscles. To overcome this, skin potentials are monitored at two places approximately equidistant from the heart, preferably on antagonistic groups of muscles so that the noise of one muscle contracting does not coincide with that of the other, which is then relaxing. A common electrode is placed near the heart and the two pick-up voltages, after amplification, are applied to a coincidence detector, which produces a 2-V pulse at each heartbeat only.



FORTY-NINE POLE TIME SWITCH

AS MANY as forty-nine processes can be switched on over a total period of up to 2½ hours by the Venner programme record/playback console Type TSA 50 shown in the photograph. The command pulses are stored on standard magnetic recording tape. This instrument is made by Venner Electronics Ltd., Kingston By-Pass, New Malden, Surrey.

Automatic Component Testing



Automatic: est machine and equipment in a laboratory at Sylvania-Thorn.

AN AUTOMATIC machine for the testing of components and the individual recording of their characteristics has been developed by Sylvania-Thorn Colour-Television Laboratories, Ltd. The machine applies up to 10 tests sequentially at the rate of 10,000 per hour, recording the results simultaneously on punched paper tape and on a paper roll, printing out through a teleprinter receiver.

If a component fails one test, other tests can be inhibited and another valuable feature of the machine is that it can retest components after an environmental stress has been applied, giving a read-out interlaced with the original figures on the teleprinter. This second readout appears only when a change has occurred during the stress period. Test results, in the form of analogues, are converted by a transistor digitizer to a 5-bit code, which is then converted to telegraph code to operate the teleprinter. The machine can also test other components such as transistors.

PARAMAGNETISM

By "CATHODE RAY"

An Apparently Insignificant Phenomenon Comes to Life

TWO months ago I objected to the term "parametric amplifier" because (among other reasons) some but not all of such amplifiers make use of paramagnetic materials, and the two words occurring in the same context are bound to be confused. To make matters worse, some but not all "masers" are paramagnetic, though they are not parametric in the currently accepted sense.

We are likely to hear more about paramagnetic materials and paramagnetism. Most of us know something about magnetism, which we usually associate with permanent magnets and with currents flowing through coils. These are considered officially under the respective headings *ferromagnetism* and *electromagnetism*. We may even remember vaguely that there were two other things, called *diamagnetism* and *paramagnetism*, but it was difficult to remember which was which, and anyway they seemed insignificant. Now that paramagnetism is in the news perhaps we have been hastily looking it up in our textbooks, and (unless you were luckier than I was) finding it highly confusing.

Early Theories

About 130 years ago the great electrical pioneer Ampère, meditating on the discovery that a current flowing round a coil makes it a magnet, surmized that magnetism in iron, etc., was caused by small circulating currents in each atom. The idea was expressed more definitely by Weber, not so very long after. This, remember, was when very little was known about atoms, and, of course, nothing at all about electrons. Modern science, though it has upset so many old ideas, has confirmed this one, which was a remarkable flash of prophetic genius.

We now know that atoms are constructed largely of electrically charged particles – protons and electrons – which revolve in orbits and also spin on their own axes. Both these movements are essentially tiny electric currents flowing round tiny one-turn coils, and have the same result as we find on a vastly larger scale in magnet coils.

The fact that with very few exceptions materials as a whole are not magnets can easily be explained on the very natural assumption that the magnetic fields of the individual atoms cancel one another out by their random arrangement. The problem then is to explain the exceptions.

These exceptions, notably iron and its alloys, have an enormous multiplying effect (called permeability) on any magnetic field in which they are placed; and some of their magnetism remains after the field is switched off. Such effects, called ferromagnetism, were plausibly explained by Ewing as being due to the atomic (or rather molecular) magnets being forced gradually into alignment until forced back by a field in the opposite direction. This was the theory I was brought up on (in an establishment presided over by the said Ewing), and when later it was thrown out in favour of what was called the domain theory, it seemed to me that this new theory was essentially the same as the old, except for the name and the larger size of the elementary magnets. However, when one goes into the thing in detail the differences are considerable, and if you want to know more about them you had better refer again to the series by Dr. D. H. Martin in the January to April issues of last year. Since our present subject is paramagnetism I will just mention in passing that ferromagnetic materials are those in which large groups ("domains") of atoms all face the same way magnetically, held so by internal forces many thousands or even millions of times stronger than magnetic fields sufficient to saturate iron. The reason why so few materials are ferromagnetic is that the particular atomic structure needed for it is quite exceptional.

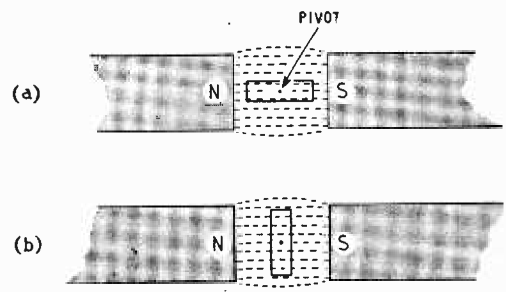


Fig. 1. All substances, suspended between the poles of a magnet, tend to take up one of these positions. Ferromagnetic and paramagnetic adopt position (a); diamagnetic, (b)

It's easy enough, of course, to tell which materials are ferromagnetic, by seeing if they are attracted by a permanent magnet. If we made the test more scientifically we would suspend a short rod of the stuff between the poles of a magnet, as in Fig. 1, so that it is free to turn round but not move in any other way. We all know that a piece of iron takes up the position shown at (a) with considerable alacrity, rather than lying across the field as at (b). Why?

We might say that the magnet attracts the piece of iron, and position (a) is the one that brings it nearest. To be more specific; iron being what it is, the field magnetizes it, making the end nearest N an opposite pole (S), and the same in reverse at the other end. Unlike poles attract, so energy would have to be supplied from outside to turn the iron from position (a) to (b). It is a general rule that the energy of a system tends to change from available to unavailable forms (heat), as when a metal object in water sinks. So the iron tends to move from position (b) to (a).

If we tried the same experiment with a bar of aluminium or frozen oxygen we would probably fail, unless we were as careful experimenters as Faraday. He found that some "non-magnetic" substances tended to take up position (a), though with considerably less alacrity than iron (of the order of a hundred million times less) while others such as copper and

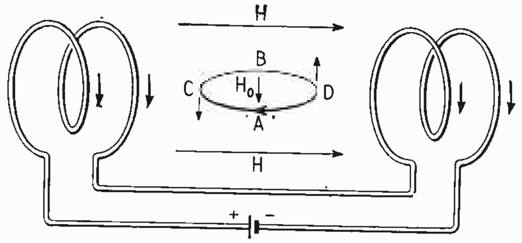


Fig. 2. The effect of a magnetic field (H) on a revolving electron (or proton) is to make its orbit slowly rotate around an axis parallel to H.

bismuth preferred position (b), though with possibly even less enthusiasm. If the former were like heavier-than-water bodies sinking, these could be likened to lighter-than-water bodies floating. He came to the conclusion that all substances other than the few ferromagnetic kinds fell into one or other class. Those that follow the example of iron, but so very much more feebly, are called paramagnetic, and the opposite kind are diamagnetic.

This exceedingly lukewarm reaction either for or against a magnetic field suggests no very obvious use. Certainly the materials wouldn't justify even a moderate cost as magnetic cores, or even anti-magnetic ones! The whole thing seems to have only academic interest. Hence, no doubt, our haste to forget all we ever learnt about it. The reason for a recent change in attitude is that paramagnetic effects involve energy changes in atoms, and these (in accordance with the quantum principle) are directly related to frequency.

Magnetics in Molecules

But before tackling paramagnetism we must know that basically everything is diamagnetic, and that the paramagnetic substances (and, of course, still more the ferromagnetic) are those in which the diamagnetism is more than cancelled out by the opposite effect.

The first thing to get hold of is that nearly all molecules are constructed in such a way that the magnetic effects of their individual electrons exactly cancel out. So the molecules are not permanent magnets. Still less can any objects made of the molecules be permanent magnets. It would be possible and, in fact, natural for the molecules, even if they were magnetic, to be so jumbled up that their magnetic effects would cancel out in any piece of material. But that is not to say that the molecules (and material made of them) cannot be magnetized, by putting them in a magnetic field.

This is one of the places where the books became hard to follow. They plunge into a highly mathematical treatment of such matters as Larmor precession and Coriolis forces, finally emerging with the conclusion that when the magnetic field is applied the response is in the contrary direction; in other words, the permeability of the material is (very) slightly less than 1. This is rather surprising to simple minds, because if, say, the single electron in a hydrogen atom was flying round an orbit which caused it to generate a tiny magnetic field, one would expect that putting it in a magnetic field would make it turn, like a compass needle, into such a position that its own field would add its modest quota to the whole. And that molecules, in which there are usually equal numbers of electrons with opposite rotation, would experience equal and opposite forces, so as wholes would be unaffected. But that is too simple to be true.

Fig. 2 shows a pair of coils with current flowing through them, and as the direction of current viewed from the left-hand end is clockwise, by the corkscrew rule the magnetic field must be in the direction marked H. In this horizontal field an electron is spinning around in a horizontal circle, clockwise when viewed from below, so the current is clockwise viewed from above, and its own magnetic field (H_0) is downward. When the electron is at positions A and B it (and the current) is moving parallel to the main field H, so is not affected thereby. But in positions C and D it is moving across the field, and the left-hand rule tells us that it is forced in the directions of the arrows.

This still looks as if it would tilt the whole orbit so that its field would come into line with the main field, just as our simple minds predicted. But we have forgotten that an electron has mass as well as electric charge.

Fig. 3 shows a top spinning at an angle to the vertical, so that gravity acting on its mass creates a downward force through its centre of gravity C, and of course the table on which it is spinning exerts an equal upward force at the point. This pair of forces might be expected to make the top fall over towards the right, and if it were not spinning it would certainly do so. But the spin momentum of the top carries it around, and the combination of this with the force of gravity makes the leaning angle move comparatively slowly round in the direction of spin. The faster the top is spinning and the less it leans, the slower this motion, which is called *precession*. If the top could lean over horizontally, still spinning on its point, the top as a whole would rotate in a horizontal plane about its point.

If you have ever handled a gyroscope, you will know the rather uncanny feeling of trying to tilt it as in Fig. 2 and finding that the result is to make its plane of rotation turn over in an unexpected manner. Suppose the electron is at C. Then its orbital motion would be bringing it round to the front (opposite to the direction of the arrow, which refers to the conventional positive current); but the addition of the downward force actually brings it rather lower than A. In other words, the orbit as a whole begins to rotate around the lines of force H in a clockwise direction viewed from the left. This means a clockwise movement of the electron, or anti-clockwise movement of the current, which causes a component of magnetic field opposing H. The total field is slightly reduced.

Now suppose that the same molecule has another electron rotating in the opposite direction. If you work it out you will find that it too reduces the total

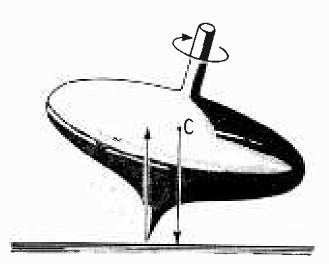


Fig. 3. The effect shown in Fig. 2 is something like the familiar slow motion of a spinning top.

field. So the permeability of material made of the molecules is less than 1. In other words, the stuff is diamagnetic, whether magnetically its electrons are all oppositely balanced or not.

Those that aren't exhibit paramagnetism as well, and if (as is normally so) the paramagnetism is greater than the diamagnetism, they will as a whole be paramagnetic. Since the molecules are not magnetically balanced, each one is a tiny magnet. Nevertheless the material as a whole is not a magnet, because heat energy is pushing all the molecules around in a completely random fashion; and with the stupendous number of molecules in even a small piece, the chances of there being any appreciable excess pointing in any one direction for an appreciable length of time is negligible.

But it is different when an external magnetic field is applied. If one could switch off all fields, including the earth's, a collection of thousands of vigorously shaken compass needles would point in random directions. Restoring the earth's field would swing them all round in one direction, making a sizeable magnet. Similarly with the paramagnetic material. The total magnetic flux is increased, so the permeability is greater than 1.

Actually the response at any temperature much above the absolute zero is very small indeed, for practical magnetic fields can do very little to counteract the disordering influence of heat. It is as if the compass needles were situated in a beehive, with the insects pushing them about in all directions so that only a slight trend towards magnetic north could be discerned. Obviously, then, paramagnetism (unlike diamagnetism) depends largely on temperature, being considerable near absolute zero and falling off as the temperature rises.

But there is more to paramagnetism than this. Very much more! After having struggled with a number of books on the subject I have arrived at the considered opinion that this must be an exception to the rule that there is nothing that can't be explained simply and concisely. It involves all the atomic matters we have discussed during the past year or two, in far greater detail and with very much added. And since the task of creating Honours Physicists in One Short Easy Lesson is not one that I propose to attempt, we shall have to make do with something less. To real physicists it will appear hopelessly over-simplified.

Energy Content

When an atomic magnet formed as just described, is placed in a magnetic field, it is thereby given an amount of energy which depends on the angle between its own magnetic axis and the field. If the two already coincide, like a compass needle that was already pointing north before it was put in the earth's field, it won't feel any inclination to move. But one lying across the field has potential energy, which is lost when it swings into alignment. One would expect the amount of energy to vary smoothly between one position and the other.

But you may remember* that one of the elementary facts about electron orbits around atomic nuclei is that the energy of an electron cannot change gradually by gradually enlarging or closing up its orbit; it can change only in certain fixed jumps, according to quantum rules. The same applies to magnetic energy levels.

Obviously, too, the energy varies in proportion to the strength of applied field. And so we get the kind of energy diagram we saw two months ago—Fig. 4. The direct proportion between energy jump and frequency ($E=hf$) holds, of course; so if a paramagnetic material is stimulated by power at a frequency corresponding to one of the energy gaps, atoms (or rather molecules) tend to be lifted up or "excited" across that gap. We saw how this was applied in paramagnetic masers, which can be made to amplify or oscillate. For electron-orbit magnets, the frequencies are usually in the microwave region. A useful feature, not possessed by the much larger energy gaps between orbits, is that the frequencies can be varied by controlling the applied field strength.

Another thing that happens in paramagnetic substances, as in diamagnetic, is precession. Now there is a difference in the energy of the spinning electron (or whatever particle it is that is precessing) depending on whether its magnetic axis is with or opposing that of the applied field. It is as if a top could spin either right way up or upside down; the latter having the

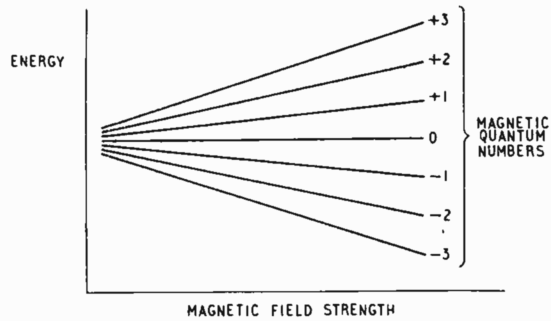


Fig. 4. The energy levels of a paramagnetic molecule vary in proportion to an applied magnetic field, but at any one field strength they occur at fixed intervals.

greater energy, so that some outside boost is needed to effect the change-over.

One way of imparting such a boost is to apply a magnetic field at right angles to the first applied field, rotating at the precession frequency. Suppose the top in Fig. 3 is the electron, precessing under the influence of a steady vertical field (represented by gravity). If now one were to move the table with a horizontal circular motion, so as to give the top a rotating sideways pull in time with the rate of precession, it would tend to turn upside down.

The required frequency for upsetting spinning electrons is of the order of 10,000 Mc/s. A rotating magnetic field exists in a waveguide or cavity into which power at the appropriate frequency is fed. The only thing is to make sure that the paramagnetic sample is placed in the right position, and that the steady field is applied at right angles to the plane of rotation. When the frequency of the microwave power comes into tune with the frequency of the spin energy difference (or when the latter is brought into tune with the former by varying the steady field) the accepting of energy from the microwave power can be detected as a sudden increase in loss of the system. It is just as if a loosely coupled circuit had been brought into resonance.

The protons in the nucleus of an atom also spin,

* E.g., March, 1958 issue, p. 115

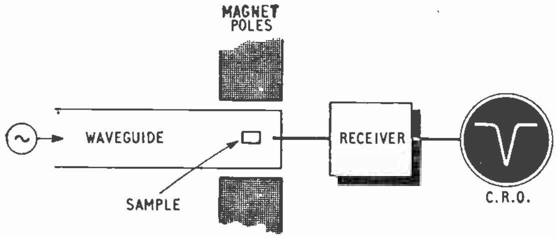


Fig. 5. Outline of apparatus for detecting atomic resonances and measuring their frequency and hence the energy jumps represented.

and if they are unpaired they cause paramagnetism; but because protons are so much heavier for the same charge as an electron they spin much more slowly and the energy differences are small, corresponding to frequencies of only a few Mc/s.

All these effects are very much influenced by interactions between all the particles concerned. In solids these interactions are greater than in liquids and have the effect of broadening the resonance peaks.

Fig. 5 is a diagram of the sort of set-up used for tracing the resonance patterns of paramagnetic materials. By such means a vast amount of information has been accumulated on the complicated goings-on inside atoms. It is a research tool of first-rate importance.

Another application of paramagnetism we did just touch on in the July 1957 issue, is superconductivity. Has it ever puzzled you how things can be cooled down to within a small fraction of one degree of absolute zero (0.000015°K was claimed some time ago)? One can get down to somewhere around 1°K by successive use of liquid gases, finishing up with helium. Then a paramagnetic material, such as iron ammonium alum, which is inside the apparatus and has been reduced to this low temperature, is magnetized by a strong externally-applied magnetic field. The effect is to cause the material to give out heat, which is carried away by the helium. Switching off the field has the reverse effect—heat has to be taken in by the material, and if it is thermally insulated the only way it can do so is to reduce its own temperature, like a starved man living on his own fat.

You might think that at those low temperatures the tendency for heat to leak in from the surroundings would make such a drop in temperature a very temporary—almost momentary—affair. So it is a convenient as well as astonishing fact that 1 cubic centimetre of the paramagnetic alum mentioned has, at 0.05°K, a thermal capacity equal to that of 16 tons of lead at the same temperature!

One way and another then, paramagnetism is acquiring practical as well as theoretical interest. And if some of the applications still seem a little highbrow to us radio engineers, perhaps at one time so did the physical researches that have now brought transistors on to the market in their millions.

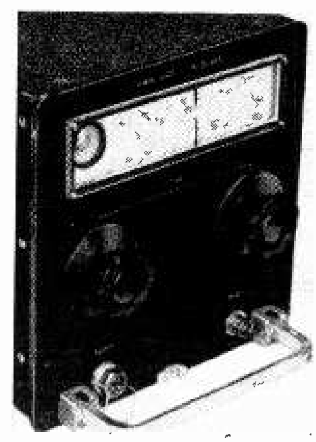
Addendum—"Hall and Holes"

ON p. 605 of the December 1958 issue I complained that nobody, repeat nobody, known to me had explained clearly how the Hall effect managed to distinguish between electron and hole currents seeing that both were in fact movments of electrons, and I appealed to any authors unknown to lodge claims. It has been necessary to go as far as Australia for one. Dr. J. L. Salpeter has called attention to his 16-page paper, "The Concept of the Hole in Semiconductors", in *Proc.I.R.E.Aus.* for December 1955, which I have found extremely interesting. One has to travel rather a long way with Dr. Salpeter to get to the point in question, but at least one would realize by then that the hole is not *quite* so simple as it is sometimes made out to be.

In a letter, Dr. Salpeter points out that my Fig. 6, showing two atoms before and after an electron movement has brought about a shift of positive charge, leads to difficulty if one considers what is happening *during* the movement. There certainly seems to be, as he claims, no escape from going into the wave mechanics of electrons in a crystal lattice if one is to understand holes correctly. Some writers use the concept of negative mass, but I felt some reluctance about putting that forward!

Low-noise U.H.F. Receiver

THIS receiver, primarily designed for ground-station missile-telemetry applications, features continuous tuning over the 420 to 500Mc/s band. Two tuning controls are provided, one for the r.f. circuits and one for the local oscillator; this, and the use of a low-noise grounded-grid r.f. stage (A2421), enables an overall noise factor of better than 10dB to be realized. The grounded-grid mixer (CV408) feeds a cascode first, i.f. stage (E88CC), which is followed by three high-gain pentodes (E180Fs). The i.f. is 45Mc/s and the overall bandwidth of the standard receivers is ±2.25Mc/s for a response at −3dB (compared with the central frequency): this bandwidth is achieved by stagger tuning the i.f. stages and the manufacturers state that it can be increased to ±3Mc/s without extra cost. Amplified a.g.c. is provided for the first i.f. stage and for operating the "magic-eye" tuning indicator; this bias is produced by a rectifier fed from an additional i.f. amplifier (E180F). The signal detector (semiconductor diode) feeds a cathode follower to provide a low-impedance output. The local oscillator (CV408) is run in the "oscillator high" condition and drift is given as 0.2Mc/s after 12 hours continuous operation (provisional figure only). The aerial input (unbalanced) impedance is 70Ω at 450Mc/s.



Armstrong-Whitworth low-noise u.h.f. receiver, "boxed" version.

The receiver is available in two forms: one for 19-in rack mounting, the other as a 8in×8in×15½in boxed unit to fit aircraft racking. The 19-in type (weight 42lb) includes a 200-250V 50c/s power supply; but the airborne version (weight 12 lb) requires an external supply of 190V at 110mA d.c. (stabilized) and 6.3V at 3.5A for the valve heaters. Manufacturers: Sir W. G. Armstrong Whitworth Aircraft, Ltd., Baginton, Coventry.

CONFERENCES AND EXHIBITIONS

Latest information on events from September to next March both in the U.K. and abroad is given below. Further details are obtainable from the addresses in parenthesis.

UNITED KINGDOM

National Radio and Television Show, Earls Court, London, S.W.5 Aug. 26-Sept. 5
(British Radio Exhibitions Ltd., 49 Russell Square, London, W.C.1.)

British Association Annual Meeting, York .... Sept. 2-9
(British Association for the Advancement of Science, 18 Adam Street, London, W.C.2.)

Scottish Industries Exhibition, Kelvin Hall, Glasgow .... Sept. 3-19
(Matthew H. Donaldson, 2 Woodside Terrace, Glasgow, C.3.)

Farnborough Air Show .... Sept. 8-14
(Society of British Aircraft Constructors, 29 King Street, London, S.W.1.)

Dielectric Devices (Conference), University of Birmingham ...... Sept. 14-17
(Electrical Engineering Department, The University, Birmingham, 15.)

Modern Network Theory (Conference), University of Birmingham, Sept. 21-24
(Electrical Engineering Department, The University, Birmingham, 15.)

Some Aspects of Magnetism (Conference), Sheffield University .. Sept. 22-24
(Institute of Physics, 47 Belgrave Square, London, S.W.1.)

Cabinet Styling Exhibition, Victoria Halls, Bloomsbury Square, London, W.C.1. Oct. 6-8
(B.R.E.M.A., 49 Russell Square, London, W.C.1.)

Scientific Instrument Manufacturers' Association Convention, Hotel Metropole, Brighton .... Oct. 22-24
(S.I.M.A., 20 Queen Anne Street, London, W.1.)

Radio Hobbies Exhibition, Royal Horticultural Hall, London, S.W.1..Nov. 25-28
(P. A. Thorogood, 35 Gibbs Green, Edgware, Middx.)

Physical Society's Exhibition, Royal Horticultural Halls, London, S.W.1 Jan. 18-22
(Physical Society, 1 Lowther Gardens, London, S.W.7.)

Engineering Materials and Design Exhibition, Earls Court, London, S.W.5 Feb. 22-26
(Industrial and Trade Fairs Ltd., Drury House, Russell Street, London, W.C.2.)

OVERSEAS

Acoustics Congress, Stuttgart .... Sept. 1-8
(Dr. Ing. E. Zwicker, Breitscheidstr. 3, Stuttgart.)

Firato 1959; International Electronics Exhibition, Amsterdam .... Sept. 1-8
(Firato Secretariat, Emmalaan 20, Amsterdam, Z.)

International Trade Fair, Salonika .... Sept. 6-27
(Fair Committee Office, Salonika, Greece.)

French National Radio & Television Show, Paris .... Sept. 10-21
(Fédération Nationale des Industries Electroniques, 23 rue de Lubeck, Paris.)

Salon Belge de l'Electronique, Brussels .... Sept. 19-24
(Comité des Expositions de la Radio-Electricité, de la Télévision et des Industries Connexes, 7 rue de Florence, Brussels, Belgium.)

Telemetring Symposium, San Francisco .... Sept. 28-30
(Robert A. Grimm, Dymec Inc., 395 Page Mill Road, Palo Alto, Calif., U.S.A.)

Irish Radio and Television Show, Mansion House, Dublin .... Sept. 28-Oct. 3
(Castle Publications, 38 Merrion Square, Dublin, Eire.)

Communications Symposium, Utica .... Oct. 5-7
(E. William Morris, 224 Fairway Drive, New Hartford, N.Y., U.S.A.)

High Fidelity Music Show, New York .... Oct. 5-10
(Institute of High Fidelity Manufacturers Inc., 125 East 23rd Street, New York 10, U.S.A.)

Radio-Interference Reduction, Chicago .... Oct. 6-8
(H. M. Sachs, Armour Research Foundation of Illinois Institute of Technology, Chicago.)

I.R.E. Canadian Convention, Toronto .... Oct. 7-9
(Convention Office, 1819 Yonge Street, Toronto, 7.)

National Electronics Conference, Chicago .... Oct. 12-14
(N.E.C., 228 N. La Salle Street, Chicago, Ill., U.S.A.)

Electrical Techniques in Medicine and Biology, Philadelphia .... Nov. 10-12
(Dr. L. E. Flory, RCA Laboratories, Princeton, N.J., U.S.A.)

Magnetism and Magnetic Materials, Detroit .... Nov. 16-19
(D. M. Grimes, University of Michigan, U.S.A.)

Computer Conference, Boston .... Dec. 1-3
(J. H. Felker, Bell Telephone Laboratories, Murray Hill, N.J., U.S.A.)

Reliability and Quality Control Symposium, Washington ...... Jan. 11-13
(R. Brewer, G.E.C. Research Laboratories, Wembley, Middx.)

Solid-State Circuits Conference, Philadelphia .... Feb. 10-12
(Tudor R. Finch, Bell Telephone Laboratories, Murray Hill, N.J., U.S.A.)

I.R.E. National Convention, New York .... Mar. 21-24
(E. K. Gannett, I.R.E., 1 East 79 Street, N.Y. 21.)

RANDOM RADIATIONS

By "DIALLIST"

America via the Moon

AT the moment of writing no fewer than four different attacks are being made on the problems which beset long-distance wireless communications conducted on the direct transmitting - aerial - to - receiving - aerial systems in use today. The plain, blunt fact is that they're not sufficiently reliable: you can't guarantee a twenty-four-hours-a-day service on three hundred and sixty-five days a year. Amongst the chief snags are blackouts, fading and interference—and these are not the only ones. Many readers will remember the demonstration given by Professor A. C. B. Lovell in the B.B.C. Reith lectures last year of the fact that it had proved possible in experimental transmissions to use the moon as a reflector of wireless waves. Recently a joint effort by him and the Pye people succeeded in establishing a link for both morse and the spoken word between Jodrell Bank and the U.S. Air Force centre in Massachusetts. The power used was 1kW at 201 Mc/s, but the e.r.p. with 40dB of aerial gain would be 10,000kW. The large Jodrell Bank radio telescope, 250-ft in diameter and costing a vast sum of money, is hardly a practical proposition as a transmitting aerial. But Pye Telecommunications are getting down to the job of developing a 25-ft radio telescope, fed with radio waves of much higher frequency and with far greater power behind them. They will undoubtedly succeed before very long and it is likely that a very important advance in long-distance wireless communication will result.

Other Approaches, Too

But that's by no means the only way in which the problem is being tackled. The use of artificial satellites as relays was proposed many years ago, and the Press Secretary of the White House said recently that he confidently expects global television to come into being in this way before the end of next year. The most surprising idea of the lot is the child of Westinghouse, of Pittsburgh. They are already producing various types of balloon aerials, some made of fabric incorporating large numbers of fine metallic threads. These aerials are light and easily transportable. One suggestion is that they should be carried aloft in a deflated condition either by aircraft or by rockets and then be filled with suitable gas and launched.

Films Across the Pond

IN the system which it has developed for transmitting news films across the Atlantic, by telephone cable, the B.B.C. seem to have accomplished something akin to pouring a quart into a pint pot. In other words, they've evolved a method of squashing the normal 3Mc/s TV bandwidth down to well within 6.4 kc/s which was the channel width allocated for this purpose on the transatlantic cable. It has been done ingeniously by restricting the horizontal definition so that it corresponds to a 1.75Mc/s bandwidth in a 405-line system, by reducing the number of lines to 200 with sequential scanning and by transmitting only alternate film frames; at the receiving end each frame is recorded simultaneously on two adjacent frames. The effective repetition frequency is thus 12½ frames a second. But that's not the whole answer, for if nothing more were done the bandwidth would still be 450 kc/s and therefore unusable over the cable. It had to be reduced to one hundredth of this figure and that was done by increasing the scanning time. This means that a one-minute news film takes 100 minutes to transmit and record. Slow though the process may seem, it enables news films to be received on either side of the Atlantic a great deal earlier than if they were flown by fast 'plane. The 16-mm film (almost universally used for TV news purposes) is scanned at the transmitting end by a slow-speed flying-spot scanner, the slow-speed video signal being used to modulate a 5 kc/s carrier. At the receiving end the demodulated signal is fed to a flying-spot telerecorder with twin optical systems. For scenes involving rapid movements every frame can be scanned instead of every other one. This means that the transmitting time is doubled, but even so this system is much quicker than any other method of getting pictures across the Herring Pond.

New Giant Labs

WHAT a vast concern the research and development organization of the Bell Telephone System already is! It now employs nearly 11,000 people at 18 stations and soon it will be still bigger, for $20,000,000 is to be spent on the erection of new laboratories at the Holmdel site, famous for the work done there by Jansky on aerials and Southworth on waveguides. Jansky was responsible for the invention of the rhombic aerial and, later, for Musa (multiple unit steerable aerial), an electrically steerable array of rhombic aerials, which was just about the last word in short-wave reception. The Musa principle was developed in the last war into the electrically steerable multi-rod array. At Holmdel, too, the need for shorter and shorter wavelengths led to an immense amount of invaluable work by Southworth and his co-workers on waveguides and to the development of components and specialized valves which are now essential parts of microwave technique. A great deal of priceless work was done in the investigation of the background (sometimes foreground!) noise which can be such a nuisance in short-wave wireless. Jansky was specially interested in the continuous hissing heard when his rotatable aerial was directed towards a particular part of the heavens. He concluded that its origin was an area in the galaxy some 27,000 light-years away. Thus he laid the foundations of radio astronomy, though it was Lovell who gave it practical form after the end of the war. The tropospheric forward-scatter systems had their origin at Holmdel and the work done on waveguides may point the way to a system in which something like 200,000 telephone circuits may eventually be carried by a circular waveguide.

A Worth-while Guarantee

IT'S good to learn that several manufacturers have extended the guarantee period from six months to twelve months on all new cathode-ray tubes. Mazda state that since purchase tax on replacement tubes was knocked off in the Budget there has been a five-fold increase in the demand. Their expectation is that the doubling of the guarantee period will lead to a still greater increase in the sales of new tubes, since people will prefer them to those which have been rebuilt or repaired. They may be right in this, though my own feeling is that so long as there is a biggish difference between the cost of buying a new c.r.t. and a rebuilt one, those firms which have a reputation for doing reliable rebuilding work *and* are prepared to give as long a guarantee period (as C.R.T. Ltd. have announced) won't find themselves idle. The c.r. tube guarantee now lines up with the setmakers' overall guarantee, but there is still a mingy three-months' on valves. And as TV set owners and servicemen know, valve replacements are amongst the most frequently needed repairs.

UNBIASED

By FREE GRID

Caveat Amator

I HAVE previously discussed the question of the growing menace of the tape recorder which seems more and more to threaten the sanctity of our private conversations. To my mind the most irritating thing about it is that from a scientific and commonsense point of view, there is some justification for such recording.

But I cannot see any justification at all for a new use of it which, I read, is coming into fashion among modern girls. We all know that in Queen Victoria's time, girls used to tie up their love letters with pink tape and pack them away with lavender-filled sachets. Modern girls have them microfilmed and filed.

Unfortunately certain girls are equipping themselves with portable tape recorders so that they can have a permanent record of any proposals they receive. With some, the idea is undoubtedly to confront their husbands in later days with what they said long years previously. But I expect that with many of them the idea is to collect a round dozen or so of proposals and then to play them back and pick the man who makes the best oratorical effort.

This will improve the standard of eloquence in proposals as men will naturally buy one of these machines to practise on. Thus instead of the few faltering words which most men manage to stammer out, girls of the future may hear something worthy of Shakespeare.

If I had my time over again, I would make the perfect tape recording and then post it to the girl I wished to marry. I doubt if my blonde of long ago could have resisted me if I had used the magic words with which Cupid wooed Psyche, especially if I had finished off by bursting into the famous song "Lovely Art thou" from the opera "Xerxes." This song is, of course, usually known to the vulgar more by its tune—Handel's Largo—than by its passionate words.

A permanent record of a proposal

However, there is a real and serious danger that tape recordings may one day be accepted as evidence in a breach-of-promise action, and it would not be impossible for an unscrupulous blonde to forge a proposal. She could first obtain several tape recordings of her intended victim's voice in a perfectly normal manner. She could subsequently play these back, and feed the sequels into a sound-on-film recorder so that she could make a *visual* study of the idiosyncracies of the victim's voice.

Then, following the techniques of Rudolf Pfenniger, she could paint on a strip of virgin film totally fictitious utterances in her victim's voice. These could be played back, and fed to a tape recorder and this recording would then be taken to court, and played over to a sympathetic jury. Believe me, it is a very real danger, and no laughing matter.

[Popping the question on tape is not uncommon. The June issue of the *Grundig Gazette*, which circulates among dealers, records that Arthur Rowe, of Coventry, "wooed and won his bride-to-be in the U.S.A. with nothing more romantic than a mailspool."—ED.]

Audio and Photo

THE Photo Fair at Olympia in May had a lot in common with the Audio Fair held elsewhere a month earlier. Both exhibitions were intended to appeal to the same two classes of people, namely those whose chief interest lies in the design of the high-class instruments available at each show, and those who delight chiefly in the end-product, namely a work of art, visual in one case and aural in the other. In both shows were to be found many visitors who were interested in the means as well as the end, and not instead of it.

The Photo Fair was the bigger as it filled the National Hall at Olympia but I could not help thinking what a splendid opportunity there would be of lessening expenses and increasing interest if the Audio and Photo Fairs combined. Together they could easily fill the main hall at Olympia while the smaller National Hall could be fitted with a large number of sound-proof demonstration theatrettes such as are needed by both shows, the photographic people, of course, needing them for amateur talkie demonstrations.

In both the Audio and the Photo Fairs this year stereo was a leading feature, and here the Photo Fair scored heavily for stereoscopy has a hundred years of history behind it and has long since left its childhood days. At the Audio Fair it was only too painfully obvious that stereophony is still in the teeth-cutting stage of infancy, and those of you who are fathers will know what a howling hullaballoo that can mean.

Si-Fi

I OFTEN think that a small but somewhat important point of receiver design which manufacturers neglect is the provision of properly connected sockets for an external loudspeaker. Usually these are just inserted in parallel with the internal loudspeaker.

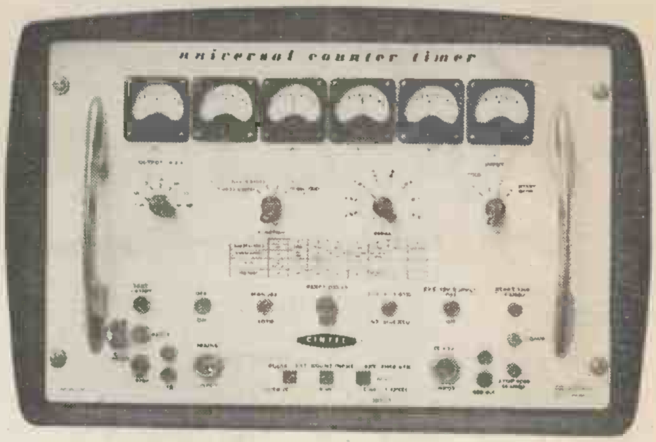
What's wrong with that, you may ask. Nothing at all if you are just going to use an extension loudspeaker a few feet away. Of course, if the set is of the "Hi-Fi" type even this will upset things a bit from the point of view of a musical purist. But I am not discussing things from the point of view of the long-haired fraternity, but from that of ordinary people like you and me who are addicted to the sugary sort of music usually known as "Si-Fi" because of the sighs it produces from its sentimental audience.

Now I may be a bit of an extremist, but I have an extension loudspeaker in every room. They used all to be of the conventional 3-ohm or less type, but I soon had to alter that. When you have only 3 ohms or less to play with, the resistance of long extension leads becomes a serious matter. Also, of course, the use of several 3-ohm loudspeakers in parallel means that the output valve is virtually working into a short circuit. If you want to know what that sounds like, try connecting a couple of 6-volt 36-watt car bulbs ($=\frac{1}{2}$ohm)† in parallel with your loudspeaker.

Now I don't expect all manufacturers to provide me with a separate output valve for each of my extension loudspeakers but they could, I think, provide me with at least one extra secondary winding on the output transformer, such winding being of 15 ohms or so rather than 3 ohms. Naturally my extension loudspeakers would have to be of higher resistance too. If manufacturers can provide me with the extra 15-ohm secondary, I can easily rewind my speech coils. After all, 30 years ago all readers of *Wireless World* wound their own speech coils. If you don't believe me turn up your issues of 1927 and see for yourselves by reading the words of F. H. Haynes who designed and fathered the *Wireless World* moving-coil loudspeaker. It is now, I believe, in the Science Museum; if not, it certainly ought to be, side by side with the "Everyman Four" receiver which certainly is there.

† [Or less if they are not dissipating 72 watts.—ED.]

Transistorized UNIVERSAL COUNTER TIMER



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TIME/UNIT EVENT (1 LINE): For the measurement of the time interval between two occurrences in a continuously varying electrical function in the range 3µsec to 1sec. The time for 1, 10 or 100 such events can be measured.

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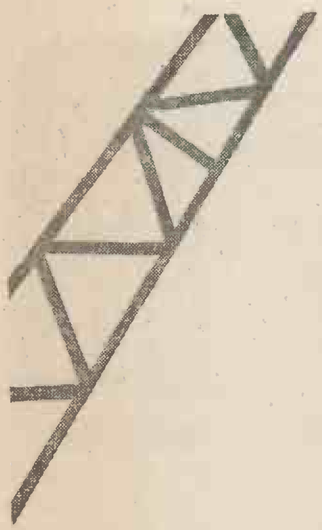

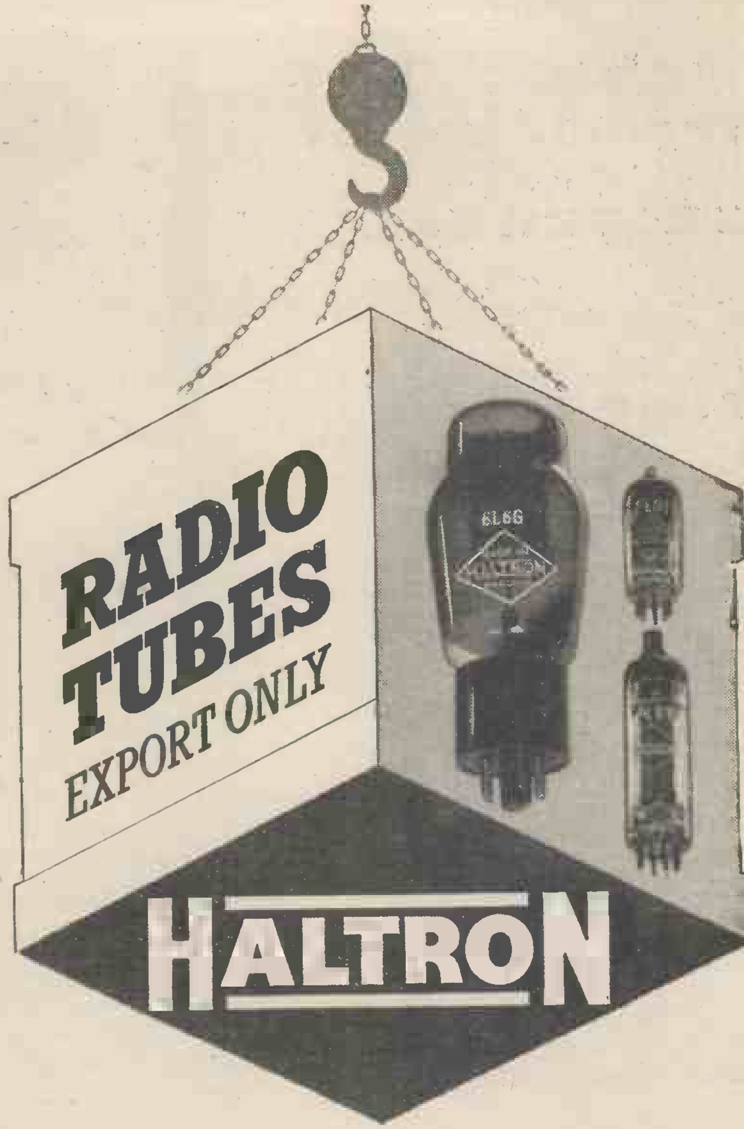

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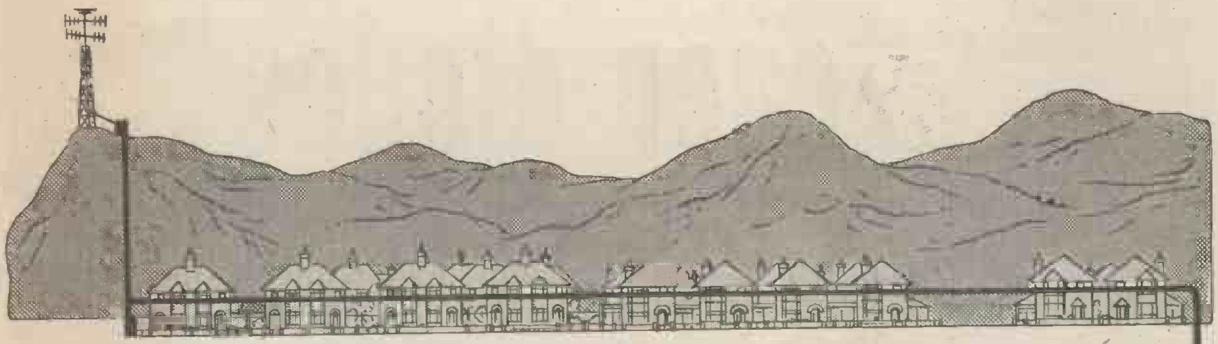

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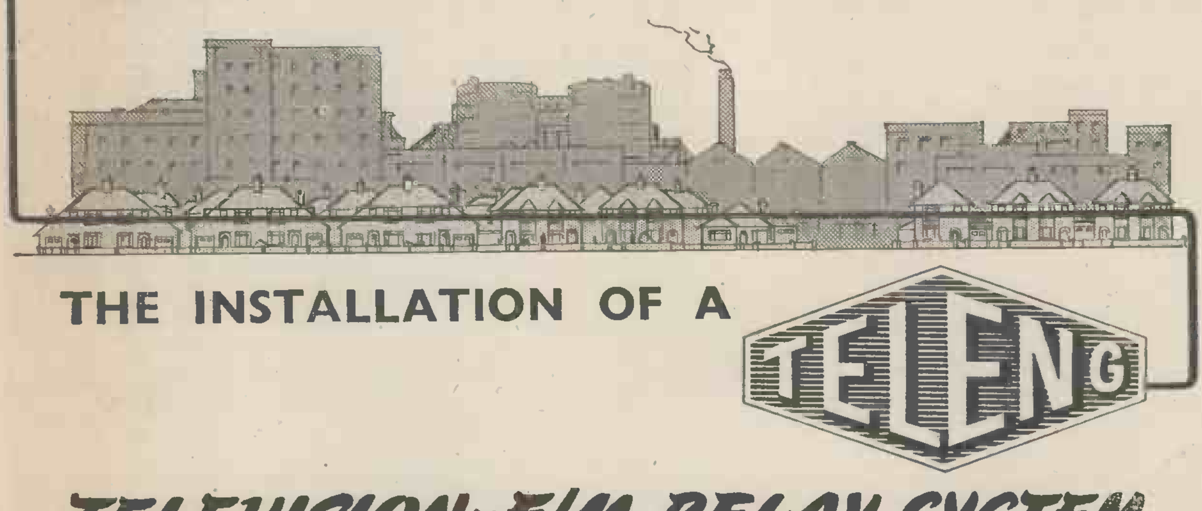

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Output deflection: 6 cm (4 cm at 10 Mc/s).
Sensitivity: calibrated 100 mV/cm to 10 V/cm.
Sensitivity control: in steps 3:1 and 10:1 with continuously variable intermediate control.
Input Attenuator impedance: 1.2 MΩ and 65 pF.

Y2 AMPLIFIER
Identical with Y1 amplifier.

SIGNAL DELAY
200 mμsec approximately. Not more than 10 mμsec differential between channels.

PRE-AMPLIFIER (2)
Gain 10. 5 c/s to 200 kc/s (30% down).
Input Resistance: 3 MΩ.
One for A1 amplifier, the other for A2 or X amplifier.

PROBES (OPTIONAL EXTRA)
Frequency-compensated "L" attenuator.
Input impedance: 6 MΩ and 15 pF.
Insertion loss: 10:1.

TIME-BASE
Triggered.
Range: 0.03 μsec/cm to 15 msec/cm in eleven steps. Triggered from positive or negative signals derived externally or from Y1 amplifier.
Sensitivity: pulse—1 cm. deflection or 2 V external. Sine wave—2 cm deflection or 2 V r.m.s. external at frequencies up to 5 Mc/s.
Expansion amplifier, continuously variable gain up to 5 times. Time-base output available at front panel on slow speed ranges.
Delayed time-base: continuously variable delay 2 μsec to 150 μsec. Delay jitter not greater than 1 part in 1,000. Sensitivity pulse —1 cm deflection or 2 V external.

X AMPLIFIER
10 c/s to 750 kc/s (30% down).
As time-base amplifier: continuously variable expansion up to 5 times.
As independent X amplifier: sensitivity variable from 1 V/cm to 100 V/cm in 5 ranges.

CALIBRATION
Voltage measurement: internal calibrating voltage (square wave) referred through sensitivity control of the amplifiers. Accuracy ±3%.
Time measurement: by directly calibrated X shift control (±5%) and/or by 20 mμsec (±3%) black-out pips (for accurate measurement of rise-time).

POWER SUPPLY
Mains: 100 V to 130 V and 200 V to 250 V.
Frequency: 50 c/s to 100 c/s.
Consumption: 550 W.
Internal supplies are stabilized where necessary.

SIZE AND WEIGHT

Height:	17½ in.	(43.2 cm).
Width:	12 in.	(30.5 cm).
Depth:	24¾ in.	(62.9 cm).
Weight:	80 lb.	(36.3 kg).

ACCESSORY
Camera Model 1428.

COSSOR INSTRUMENTS LTD

The Instrument Company of the Cossor Group

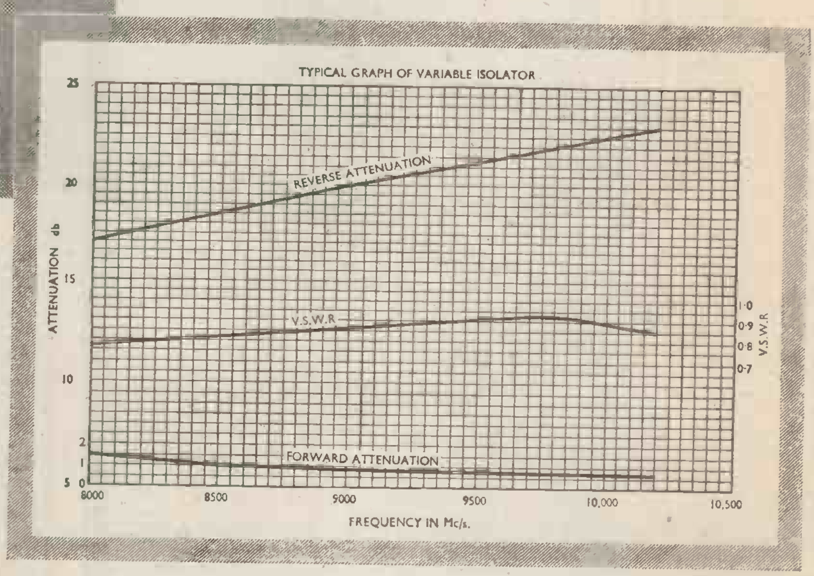
COSSOR HOUSE, P.O. BOX 64, HIGHBURY GROVE, LONDON, N.5.
Telephone: CANonbury 1234 (33 lines) Telegrams: Cossor, Norphone, London Cables: Cossor, London Codes: Bentley's Second

TAS/CI 19

Isolation at Microwaves

L324 X-band isolator

This isolator is a ferrite loaded waveguide component with unidirectional characteristics designed to isolate an X-band microwave source from reflections caused by mismatch. It is a versatile component suitable for incorporation in equipment or for use as a laboratory aid. It is tunable for peak performance over X-band.



For information on other microwave components including circulators, co-axial mixers, switches, folded tees, etc., write to the address below.

ME638a

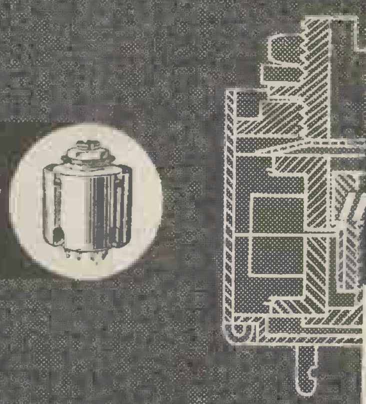
A PRODUCT OF

MULLARD EQUIPMENT LIMITED

A COMPANY OF THE MULLARD GROUP

MULLARD HOUSE · TORRINGTON PLACE
LONDON · W.C.1 · TELEPHONE: LANgham 6633

A NEW CONCEPT IN POT CORE DESIGN



Mullard VINKOR range of adjustable pot cores gives you *outstanding* advantages

- Wide range of sizes
- Easily assembled
- Close tolerance permeability
- Precise and easy inductance adjustment
- Stability
- Single hole chassis mounting

Mullard Vinkors are the most efficient adjustable pot core assemblies commercially available. In addition to high performance, they have the distinct advantage of close tolerance permeability, thus enabling designers to precalculate to within ±3% the inductance of the core when wound. Final adjustment, taking into account normal capacitor tolerance, can be easily effected to an accuracy of better than 0.02%, by means of a simple self-locking device built into the core.

Write today for full details of the wide range of Vinkors currently available.

Mullard

VINKOR POT CORES

MULLARD LTD · COMPONENT DIVISION · MULLARD HOUSE · TORRINGTON PLACE · LONDON W.C.1

MC 280A

NATIONAL RADIO SHOW · 1959

AUDIO HALL

CELESTION

Trade *and* Public Demonstration Rm. 305

GROUND FLOOR

Rola Celestion Ltd.

MANUFACTURERS ENQUIRIES ONLY

Stand No 212

LOUDSPEAKERS FOR ALL PURPOSES

Rola Celestion Ltd. THAMES DITTON, SURREY, ENGLAND. Telephone: Emberbrook 3402/6


Hivac filamentary indicator lamps
In addition to the well-known Hivac ranges of subminiature valves, cold cathode tubes and neon indicator lamps, there is an extensive and growing range of small filamentary indicator lamps.
The range includes wire ended types and lamps on MBC, MES, LES or BA7/S caps as well as telephone switchboard lamps conforming to British, Continental and American practice.
Both metal and carbon filaments are available and all voltages up to 60V can be supplied.
May we provide details of current types or discuss your special requirements?
Hivac Limited
STONEFIELD WAY, SOUTH RUISLIP, MIDDLESEX
A member of the Automatic Telephone & Electric Group.
Ruislip 3366

P 13

RCA

SSB-L1 Fixed Station. 60 watt (500 watt double sideband equivalent) eight channels 3-15 mc/s.

SINGLE SIDEBAND

Communications system

Over 4000 RCA single sideband equipments are in use the world over as fixed and mobile stations.

- **Eight Channels.**
- **Instant Selection of Upper or Lower sideband.**
- **Compatibility with double sideband systems.**
- **Remote aerial tuning facility for SSB-L1.**
- **Mechanical Filter giving outstandingly High Selectivity.**
- **Exceptionally Stable and Reliable Operation.**
- **Rugged construction for naval and military use.**

SSB-L30M Mobile Station. 30 watt (250 watt double sideband equivalent) eight channels 3-15 mc/s.

Automatic remote antenna tuner AAT-L100

Noise limiter–clipper–filter for heavy interference conditions.

RCA GREAT BRITAIN LTD. LINCOLN WAY, SUNBURY-ON-THAMES, MIDDX. *Tel: Sunbury-on-Thames 3101*

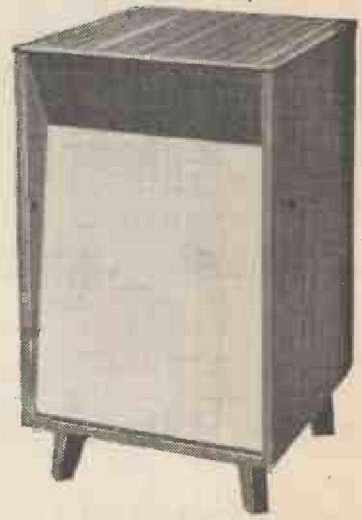
An Associate Company of Radio Corporation of America.

BIG-SELLERS

FROM THE WHITELEY CABINET WORKS

W.B. cabinets and tables have acquired a high reputation for quality and those shown here reflect the traditionally high standards of materials and craftsmanship that distinguishes all W.B. products. Yet—they are offered at prices that will make for ready sales at all seasons. Your usual factor can supply from stock, and we shall be pleased to send supplies of illustrated leaflets on the W.B. products on request.

'PRELUDE' BASS REFLEX CONSOLE CABINET



This is one of our new series of contemporary style cabinets in satin-striped sapele veneers. It is supplied in ready-to-assemble form and put together in a few minutes with a screwdriver. It will provide absolute realism in reproduction when used in conjunction with Stentorian 8in or 10in. units, and has provision for Tweeter unit.

Size: 33 x 19 x 19½in. **Price £11/11/-**

'WELBECK' T.V. TABLE

This contemporary styled table is finished in highly polished walnut veneer and fitted with self-adjusting 'gliders.' It is supplied packed flat ready for instant assembly, simply by inserting concealed bolts.

DIMENSIONS: 20 x 20 x 20in.

Price £3/15/-

JUNIOR TABLE

'Junior' Table Price £4/10/-
Measures 20 x 20 x 21in. high.

★ See our two new tables for "Slimline" T.V. receivers at the Radio Show on Stand number 63

'Forest' Table
Measures 20 x 20 x 20in. high. **Price £3/10/-**

'Senior' Table
Measures 18 x 24 x 25in. high. **Price £4/18/9**

'Sherwood' Table
Measures 23 x 25 x 22in. high. **Price £5/5/-**

ALL PRICES INCLUDE PURCHASE TAX

The complete range of W.B. products includes Stentorian Hi-Fi speakers in a range of sizes, cabinets in contemporary and traditional finishes, amplifiers and VHF tuners, tables and record storage cabinets.

W B

WHITELEY ELECTRICAL RADIO CO. LTD · MANSFIELD · NOTTS. W.B.114

everybody's enthusiastic!

Angus McKenzie in TAPE RECORDING & HI-FI MAGAZINE

'Sometimes, all too rarely, a product received for review has a quite outstanding performance and is reliable and robust. Such a product is the Simon SP4 . . . It has a superb performance in every way, with not one snag in the way of it . . . Staggering Performance . . Any owner of an SP4 can be very proud of it. *I feel sure that this machine will go far to establishing a new standard of quality by which other machines will be judged.*'

Percy Wilson M.A. in THE GRAMOPHONE

'First-class marks for its comprehensive design, for its cleanness and thoroughness of construction, and for its excellent performance . . . *This is a tape recorder that is outstanding by any standards the world over.*'

J. Moir in THE TAPE RECORDER

'The novel features incorporated in the SP4 are generally of great value to the user, and are not gimmicks . . . The Simon machine is not cheap but it has exceptional facilities, a good performance, is undoubtedly good value for money.'

J. C. G. Gilbert F.R.S.A., Assoc. I.E.E., M.Brit. I.R.E., F.T.S. in MUSIC TRADES REVIEW

'At last with the Simon SP4, I have found a machine that is not only simple to use, but is capable of producing professional results . . . Has facilities only found in truly professional machines costing £350 and upwards . . . This machine, both in performance and appearance, is unlikely to be superseded for many years.'

you must hear it!

The Simon SP4 is the machine you've been looking for! Its combination of high performance and range of exclusive features has set off a chain reaction of enthusiasm throughout the hi-fi world.

Look at this list of star features—never have so many been brought together in a portable recorder.

Read what the press says, then come and see it for yourself at your nearest dealer—try it, test it and you too will join the crowds of Simon enthusiasts.

*Automatic, in the Simon sense, is meant to be taken literally: it means continuous replay—the machine stops, reverses and changes to the other track with only a two-second pause, and *with no necessity to touch any control*. Similarly, up to three hours, continuous recording can be made without attention, the machine automatically stopping at the end of the second track.

- SIMON AUTOMATIC DECK* fully 'push-button-controlled'
- AUTOMATIC TAPE REVERSAL without touching controls
- 3-WAY MIXING FACILITIES on both record and playback
- BASS AND TREBLE LIFT AND CUT with independent controls
- REMOTE CONTROL FACILITIES on both record and playback
- HIGH QUALITY MONITORING Paired bass and treble loudspeaker units
- 10 WATTS OUTPUT from ultra-linear push-pull amplifier
- PUSH-PULL OSCILLATOR for noise and hum suppression
- ACCIDENTAL ERASURE PREVENTION by special record 'safety button'
- ACCURATE TAPE POSITION INDICATOR based on linear tape scale
- 'PIN-POINT' MODULATION with cathode ray magic eye

simon SP. 4

Two accessories to do justice to the SP4

THE CADENZA RIBBON MICROPHONE

Dual impedance head for flexibility in use: output sensibly flat between 50-12000 c.p.s. In handsome presentation case: head only 8½ gns. With tripod desk stand 10 gns.

THE SIMON REMOTE CONTROL UNIT

Electrically operated, gives push-button control at any practical distance. (Stop/Start and track change on either Record or Playback). Size 1¾"x 2¾" x 3¾" with 25 ft. of cable 3 gns.

Incorporating the new Simon fully automatic tape deck

Your Simon Dealer would be pleased to arrange H.P. terms **95** GNS.

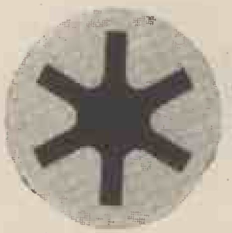
Choose Simon for Sound

Write for leaflet (F 7) to:

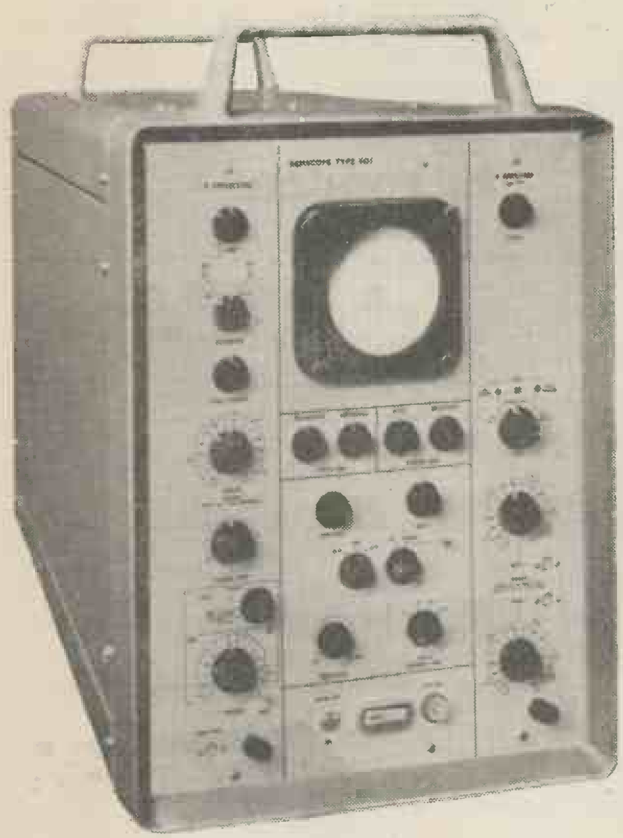
SIMON SOUND SERVICE LTD

46-50 George Street, Portman Square, London W.1

TA 2240



WHAT *is* the REMSCOPE?



THE REMSCOPE is the latest storage oscilloscope designed and manufactured by Cawkell's. It can store a single transient signal for a week and display it for up to two hours during that week. A new image storage tube has been used and faster writing speeds than ever before can be achieved. An exceptionally wide range of sweep speeds and input attenuator ratios makes the "Remscope" suitable for a very large number of applications and every effort has been made to ensure optimum performance and, in particular, reliable triggering. Accurate time and voltage calibration signals are provided.

BRIEF SPECIFICATION

Dimensions:	23½″ x 14½″ x 24″
Screen diameter:	10cm
Resolution:	20-30 lines/cm
Storage time:	1 week
Display time:	15 mins—2 hrs
Erase time:	Less than 1 second
Writing speed:	2-4cm/microsec
Max. Sensitivity:	5mV/cm
Max. Bandwidth:	0-3Mc/s
Sweep velocity:	3cm/microsec—0.1cm/S
Voltage accuracy:	±1%
Power supplies:	100-110, 200-250V 50-60c/s

CAWKELL SOUTHALL ENGLAND

CAWKELL RESEARCH & ELECTRONICS LTD.
SCOTTS ROAD · SOUTHALL · MIDDLESEX
Telephone: SOUthall 3702/5881

PYE PANORAMA

FEATURING PYE TELECOMMUNICATIONS EQUIPMENT

BY APPOINTMENT
TO H.R.H. DUKE OF EDINBURGH
SUPPLIERS OF
RADIO TELEPHONE EQUIPMENT
PYE TELECOMMUNICATIONS LTD.

60 watt H.F. Fixed Station

The Pye 60 watt H.F. Fixed Station PTC931/941 is designed for continuous unattended operation under all climatic conditions. It is ideally suited for ground-to-air or point-to-point operation in those areas where local conditions restrict the use of v.h.f. An unusual feature in a station of this size is push-button selection of any one of four channels either locally or, remotely, up to 15 miles. Extension and remote control units for channel selection or for the control of the entire station are available.

Brief specification:

Service: A1, A2, A3 Telephony, M.C.W. Telegraphy.

Frequency Range: A. 1.6—2.3 Mc/s. B. 2.0—3.9 Mc/s. C. 3.9—7.4 Mc/s. D. 7.4—14.0 Mc/s.

Modulation Capability: 100%.

Receiver Sensitivity: 1μV. for 1 watt output (modulation: 30% at 1 kc/s.).

Signal-to-Noise Ratio: Better than 12dB (conditions as above).

PYE TELECOMMUNICATIONS LIMITED

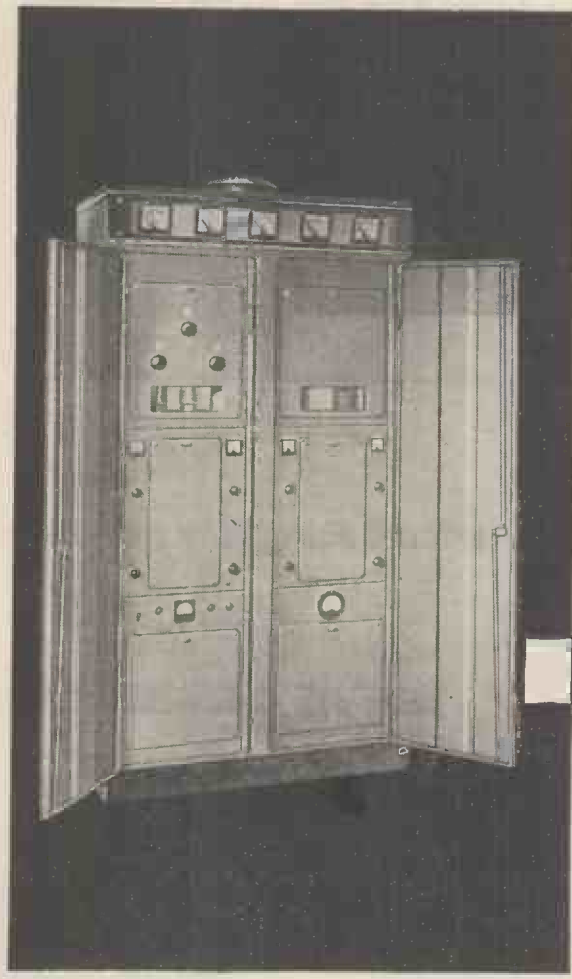
NEWMARKET ROAD • CAMBRIDGE

Telephone: Teversham 3131. Telegrams: Pyetelecom Cambridge.

PANORAMA

FEATURING PYE TELECOMMUNICATIONS' EQUIPMENT

BY APPOINTMENT TO H.R.H. DUKE OF EDINBURGH SUPPLIERS OF RADIO TELEPHONE EQUIPMENT PYE TELECOMMUNICATIONS LTD.



1 kW V.H.F. Transmitter

The Pye PTC 3600 1 kW V.H.F. Transmitter is a medium power communications equipment. It is very suitable for long range en-route ground-to-air operation and also for airport ground-to-air control, teleprinter and V.F. point-to-point links. Comprehensive metering facilities are included.

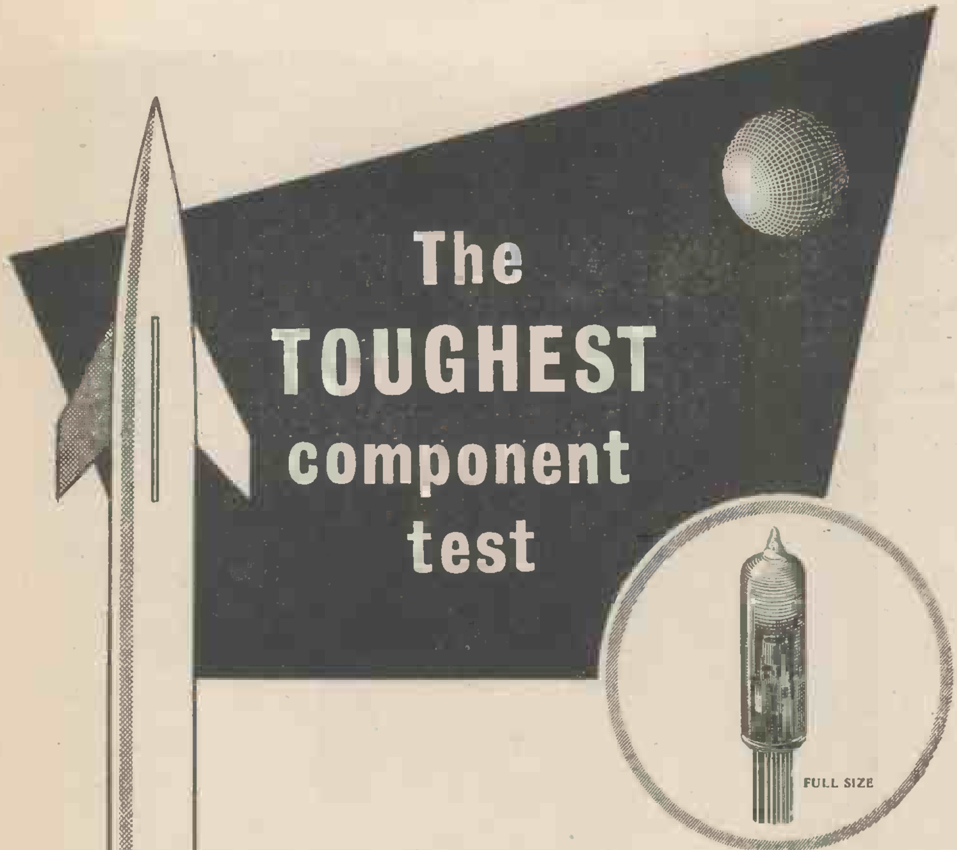
Brief Specification

Service	A3 Radiotelephony—Amplitude modulation.
Frequency Range	118—138 Mc/s. Continuously covered in one band.
Modulation Capability	100%

PYE TELECOMMUNICATIONS LIMITED

NEWMARKET ROAD • CAMBRIDGE

Telephone: Teversham 3131 Telegrams: Pyetelecom Cambridge



will not change the characteristics of the

GD 85 WR

C.V. (4516)

MINIATURE RUGGEDIZED REFERENCE TUBE

Specially constructed for military and commercial service where tubes are to be subjected to severe shock and thermal extremes, this new tube will continue to operate satisfactorily beyond the point which is customarily associated with conventional tube structures.

BRIEF DATA

Nom. stabilized voltage	85V	Shock:	5 g continuously
Striking voltage (total darkness or light)	125V max.		20 g short durations
Current range	500μA to 5·0mA		750 g impact
Max. Incremental resistance	< 1000Ω	Temperature Range:	–60°c to +90°c

For full information write to: Technical Services Dept.

ERICSSON

TUBE DIVISION

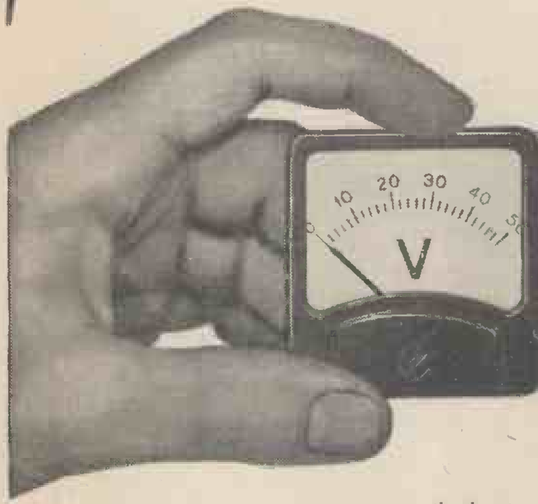
BEESTON, NOTTINGHAM.

ERICSSON TELEPHONES LTD., HEAD OFFICE, 22 LINCOLN'S INN FIELDS, LONDON, W.C.2.

Originators and Sole Manufacturers of the Dekatron Cold-Cathode Scaling Tube.

E82R—632

A COMPREHENSIVE RANGE OF
"Miniature" Instruments



★ **DESIGNED TO HARMONISE WITH ALL MODERN ELECTRONIC EQUIPMENT**

★ **FIXINGS CONFORM TO ACCEPTED PRACTICE**

★ **PRICES ARE HIGHLY COMPETITIVE**

For utmost reliability all 'ENGLISH ELECTRIC' miniature instruments have been designed with a higher-than-normal torque/weight ratio in combination with lower power consumption. All types have been successfully subjected to the following tests:

RESISTANCE TO IMPACT SHOCK OF 200g in any plane.

VIBRATION FATIGUE TEST—two million cycles at peak resonant frequency.

OSCILLATORY TEST—up to one million operations.

Above: 2″ square moving coil voltmeter

SPECIFICATIONS B.S. 89–1954 and other International Specifications.

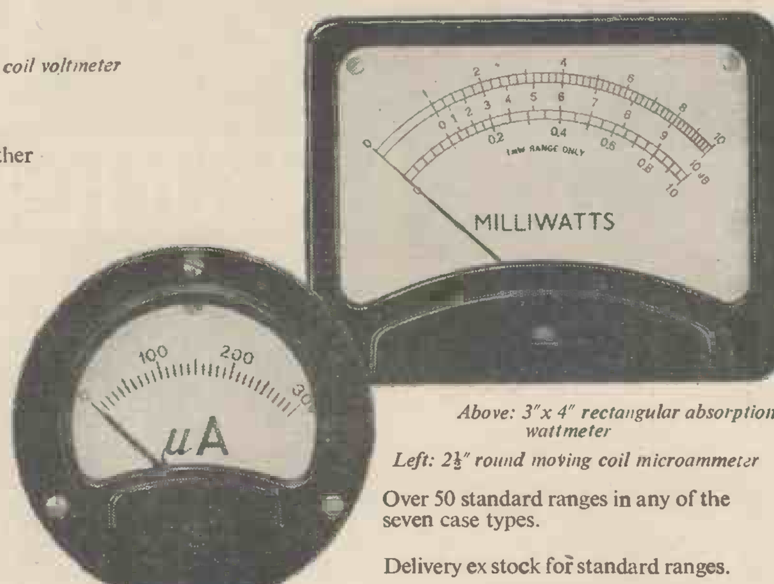
TYPES

Moving coil for D.C. applications.
Rectifier moving coil for A.F. applications.
Thermo-couple operated moving coil for R.F. applications.

SIZES

Square: 2″, 2½″ and 3½″ nominal scale length.
Round: 2½″ and 3½″ nominal scale length.
Rectangular: 5″ x 6″ or 3″ x 4″ nominal case size.

Design registrations pending.



Above: 3″ x 4″ rectangular absorption wattmeter

Left: 2½″ round moving coil microammeter

Over 50 standard ranges in any of the seven case types.

Delivery ex stock for standard ranges.

Non-standard ranges to customer's specification within 21 days.

Literature available on request to The ENGLISH ELECTRIC Co. Ltd., Instrument Department, Stafford.

'ENGLISH ELECTRIC'

THE ENGLISH ELECTRIC COMPANY LIMITED, MARCONI HOUSE, STRAND, LONDON, W.C.2

Meter, Relay and Instrument Division, Stafford

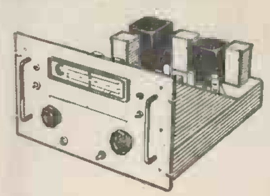
WORKS STAFFORD PRESTON RUGBY BRADFORD LIVERPOOL ACCRINGTON

NS.4 A.

A.W.A ELECTRONICS

New concepts in electronics have been developed at AWA, as a result of experience with missile systems. Now they have a wider application. Here are some of the new AWA devices now available to industry.

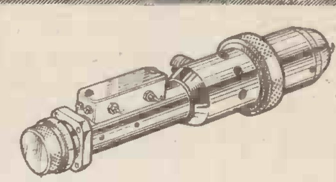
U.H.F. RECEIVER



Designed as a Wide Band Low Noise Receiver for the 420/470 Mc/s Frequency Band. Available as either a 19″ rack mounted unit c/w Stabilised Power Unit, or in an 8″ Case with separate Power Unit. Basic arrangement consists of R.F. Amplifier, Mixer, Local Oscillator, I.F. Amplifier (A.G.C. Controlled) Cathode Follower Output Stage. Wide variations of this Receiver can be supplied to customers' own requirements.

Standard Specification: Frequency Range: 420/470 Mc/s; Bandwidth: 4.5 Mc/s; Noise Factor: 10db (approx.); Intermediate Frequency: 45 Mc/s; Sensitivity: 25 MicroV. for a 12 db signal to noise ratio; R.F. Gain: 12 db; I.F. Gain: 80 db; Image Rejection: 40 db; Input Impedance: 75 ohms (approx.) Unbalanced; Output Impedance: 80 ohms (approx.); Outputs: (a) 0.5v from Crystal Detector, (b) 300 mV at 45 Mc/s.

PRECISION OSCILLATOR

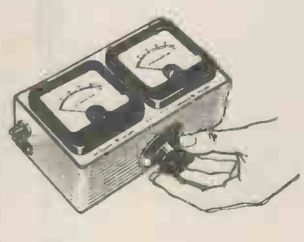


The Oscillator has been designed round a disc sealed triode and particular attention has been paid to ensure good frequency stability. This has been achieved by the use of selected materials and concentric sleeve tuning. The latter in conjunction with Micrometer head tuning giving very good resolution. In order to reduce R.F. losses all cavities and lines are silver plated, polished, and rhodium flashed.

The Oscillator can be supplied in the form illustrated for installation in the customers' own equipment, or as a unit complete with its own stabilised power supply mounted on a 19″ panel.

Standard Specification: Frequency: Adjustable to operate in the 450/550 Mc/s band. Actual Tuning Range in this band is approx. 30 Mc/s; Frequency Stability: Better than 1 part in 10^4 (long term); Input: 300v at 30 mA, 6.3v at 0.4A; Power Output: Max. output 1.25w at 470 Mc/s.

DIRECTIONAL COUPLER



Of the "Loop" type, suitable for measurements of R.F. power and Standing Wave Ratio in coaxial cables. Directional properties are largely unaffected by frequency changes, so coupler may be used to help obtain optimum termination for a 52 ohm coaxial system up to 600 Mc/s.

72 ohm version of this instrument is also available.

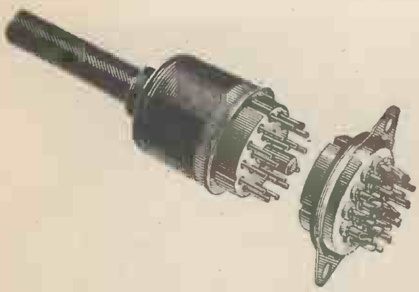
Standard Specification: Case Size: 7″ x 4″ x 2½″; Weight: 4 lbs. 3 ozs.; Power Measurement: low range 1 w cw max., high range 5 w cw max.; Accuracy (at frequency of calibration): low range 0.1 dbs, high range 0.2 dbs; Directivity: 26 dbs (approx.); Coupling Coefficient: 30 dbs (approx.).

All devices are adaptable to suit customer's own requirements. For further information consult:

COMMERCIAL ELECTRONICS DEPT.

SIR W. G. ARMSTRONG, WHITWORTH AIRCRAFT LTD.,
Baginton, Coventry, England.

MEMBER OF THE HAWKER SIDDELEY GROUP

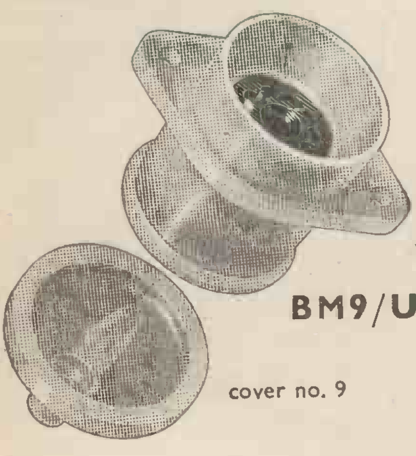


POTTED PAKONECTORS

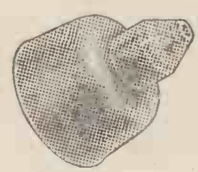
18 WAY

* No cover and cable clamp worries. We connect your cable to plug or socket and put the assembly in polythene. * 18 connections in less than 1 inch diameter. * Standard B9A valveholder mounting. * Nylon loaded PF. mouldings. * Cadmium plated or gold pins and contacts.

McMURDO · ELECTRONIC



TC2



B9A E.H.T. VALVEHOLDERS

BM9/UV

cover no. 9

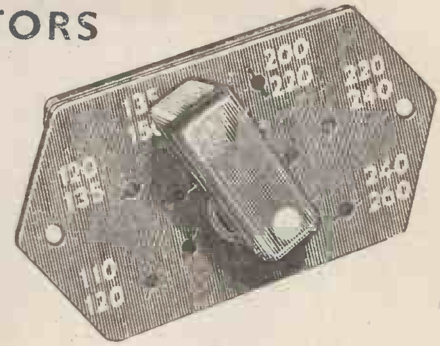
BM9/PS

cover no. 11

Polythene Shrouded B9A. Valveholder for Television E.H.T. Rectifiers.

Send for full details to :— The McMurdo Instrument Co. Ltd.,

VOLTAGE SELECTORS



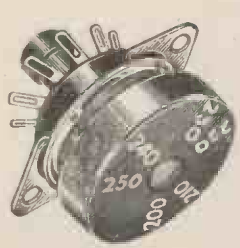
14 WAY B279001

BLACK P.F. MOULDING

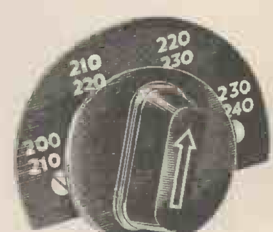
6 WAY XVS/6

NYLON LOADED P.F. MOULDING

COMPONENTS · McMURDO



VOLTAGE SELECTORS



6 WAY MINIATURE BMVS/6

BLACK P.F. MOULDING

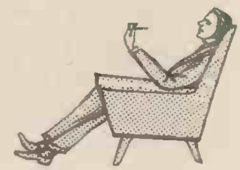
4 WAY BVS/4

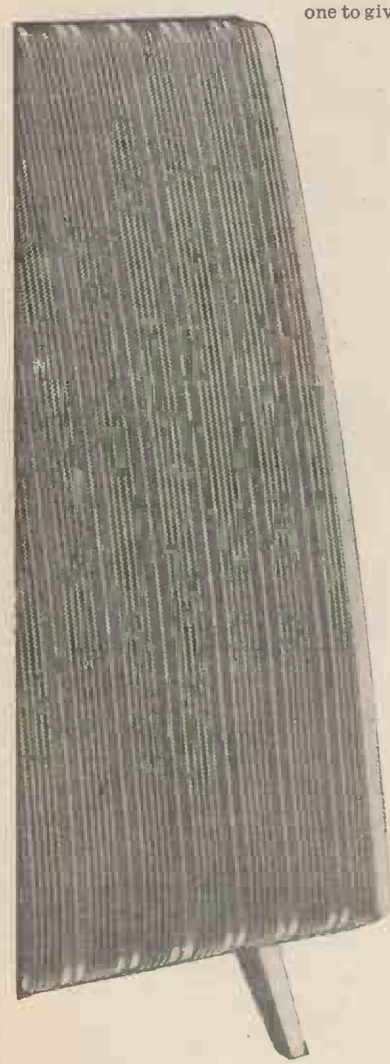
BLACK P.F. MOULDING

Ashtead, Surrey. Tel: Ashtead 3401

CHOOSING YOUR SOUND

Selecting a loudspeaker by audition is the most difficult problem confronting the purchaser of high quality equipment as it is necessary to differentiate the sound heard into two components—that due to the programme and that due to the speaker. The following procedure, whilst being by no means exhaustive, will help to ensure that the choice is the correct one to give the maximum musical pleasure in the years to come.





8 POINTERS FOR YOU TO FOLLOW

Not more than four loudspeakers should be tested at one time in order to avoid confusion and the listener should be symmetrically seated in relation to the loudspeakers.

Ask your dealer to feed a clean programme to one of the loudspeakers with all amplifier controls level. A good local studio VHF transmission is best for this test as very few records can be played on wide range speakers without some degree of filtering.

Adjust the volume level to give the correct perspective for the programme. (i.e., so that the volume is commensurate with the impression of distance in the programme.)

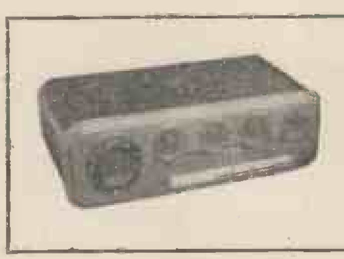
Listen to each loudspeaker in turn. In professional listening tests the greatest care is taken to pre-set the relative power fed to each loudspeaker as it is very important that they all operate at the same apparent loudness. If your dealer is not fitted up with this facility, then he or you will have to adjust the volume by hand—as accurately as possible.

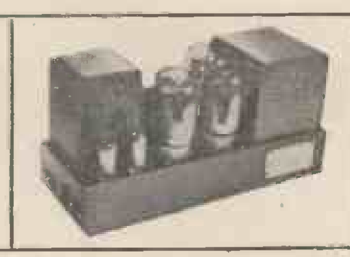
Try to decide which loudspeaker is the most natural. Beware of sensationalism or "gimmick" balances. If the sound is sensational, make sure it is the music that is sensational and not the loudspeaker.

Next take a modern recording or recordings of your choice (as sensational as you like this time). Using the loudspeaker previously selected as the most natural, play the recording and adjust the filters to reproduce the maximum quality inherent in the recording. With these same settings refer back to the other loudspeakers to see that the one selected in the first test remains the best in the second test.

Should there still be doubt, try changing the relative positions of the loudspeakers in the room.

There are of course additional tests which should be made—adequate power output—adequate dispersion, etc. Best of all—but unfortunately seldom possible—is to borrow the speaker of your choice from a friend and try it at home.





The fact that the QUAD electrostatic shows up as first choice under these conditions does not invalidate the test procedure. It may be recommended for loudspeakers of all types, shapes and sizes.

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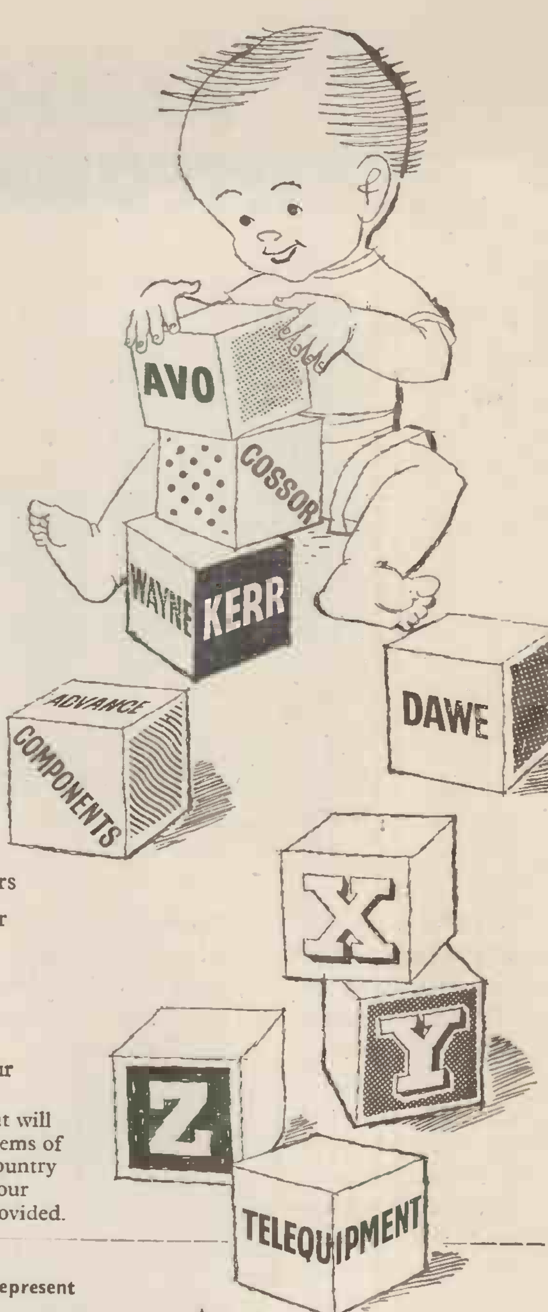

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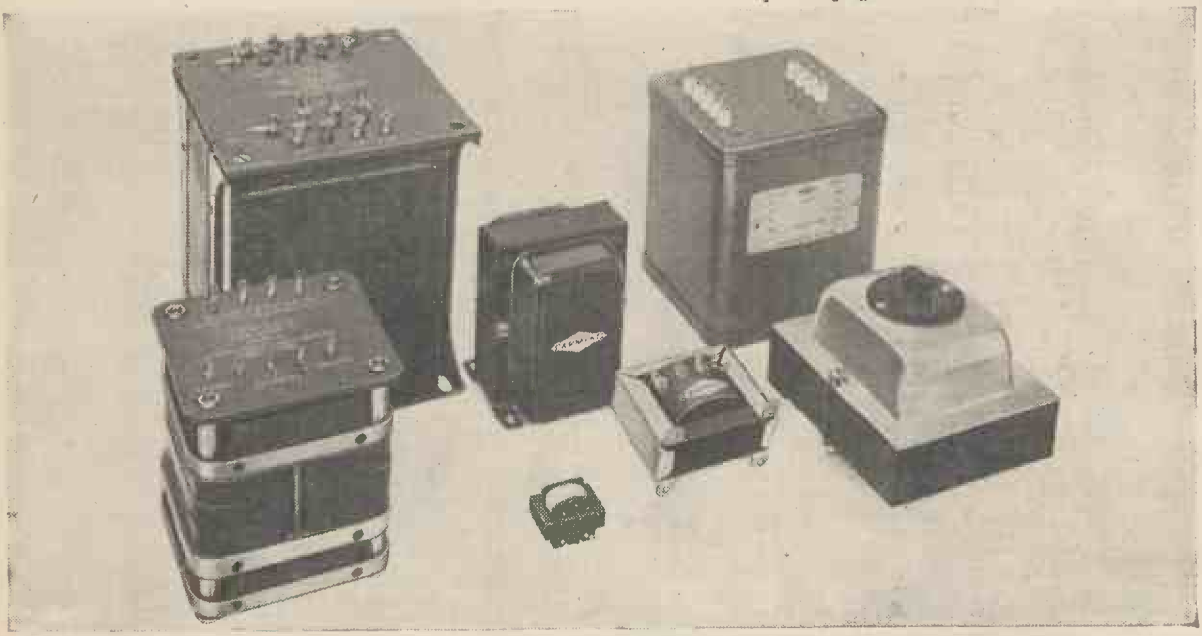

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P2642	EL84 X2	43%	12·5	8000Ω C.T.	55H MIN.	30MH MAX.	3·75 or 15Ω SER/PAR.	5084/12C	Mullard 5-10 or Brimar 2/8P2 8 Watt
P2643	EL84 X2	20%	12·5	6000Ω C.T.	55H MIN.	30MH MAX.	3·75 or 15Ω SER/PAR.	5084/12C	Mullard 5-10
P2641	EL84	No	3	5000Ω	8H MIN. AT 50MADC	60MH MAX.	3·75 or 15Ω SER/PAR.	5084/7C	Mullard 3 Watt Type 'A' Tape Amplifier
P2934	EL34 X2	43%	20	6600Ω C.T.	90H MIN.	30MH MAX.	3·75 or 15Ω SER/PAR.	5084/3C	Mullard 20 Watt
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P2820	UCL82 X2	No	8	6000Ω C.T.	60H MIN.	21MH MAX.	3·75 or 15Ω SER/PAR.	5084/8C	Mullard AC/DC 7 Watt Amplifier
P2928	ECL82	No	2	5600Ω	12H MIN. AT 30MADC	46MH MAX.	15Ω	5089/5E	Mullard 2 Watt Stereo
P2932	ECL82 X2	20%	7	9000Ω C.T.	100H MIN.	50MH MAX.	3·75/8/15Ω	5084/9C	Mullard 7 Watt Stereo
P2632	N709 X2	20%	12	7000Ω C.T.	60H MIN.	100MH MAX.	3·75 or 15Ω SER/PAR.	5080/6	G.E.C. Osram 912
P2649	N709 X2	20%	12	7000Ω C.T.	50H MIN.	40MH MAX.	3·75 or 15Ω SER/PAR.	5084/12D	G.E.C. Osram 912 (Printed Circuit Version)
P2580	6L6 X2	No	40	10000Ω C.T.	100H MIN.	22MH MAX.	1·7Ω (8 sections)	5080/23A	Williamson Amplifier
P2924	EL84	No	4/5	5000Ω	8H MIN. 50MADC	80MH MAX.	4/8/16Ω	5089/5E	4/5 Watt Stereo
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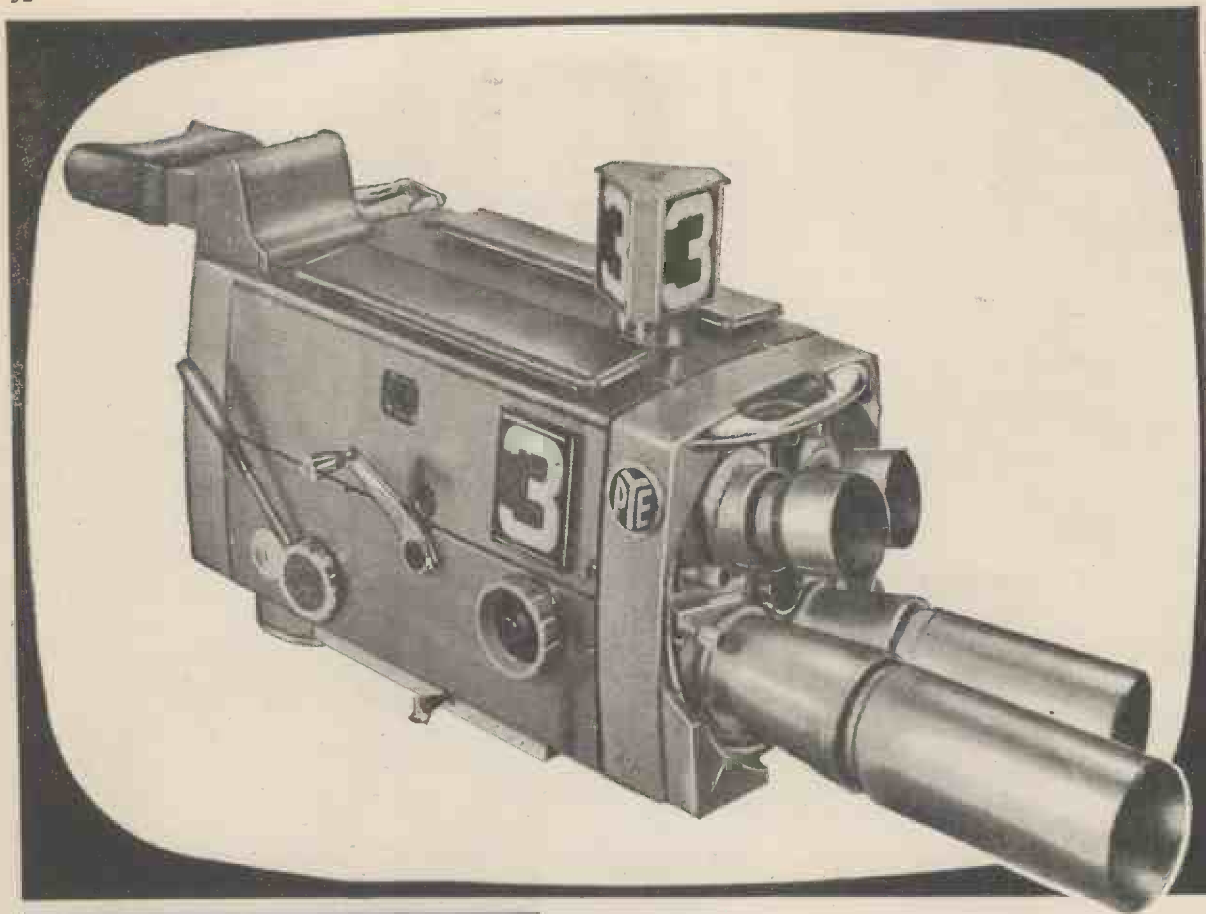

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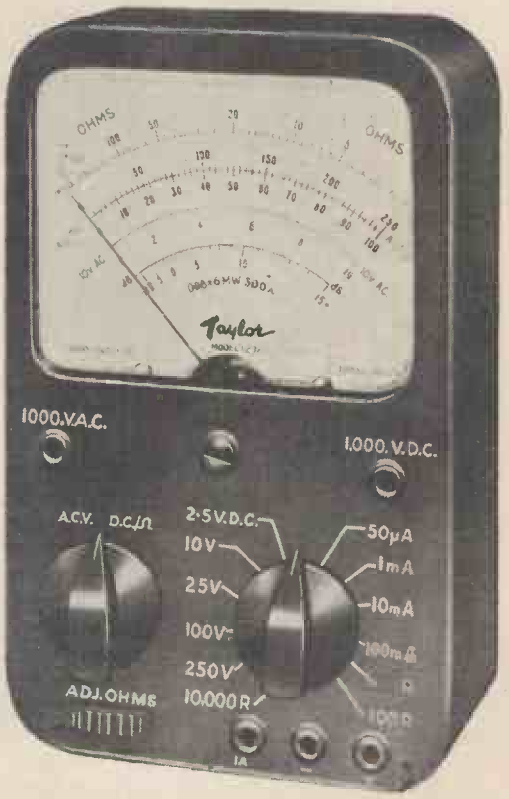

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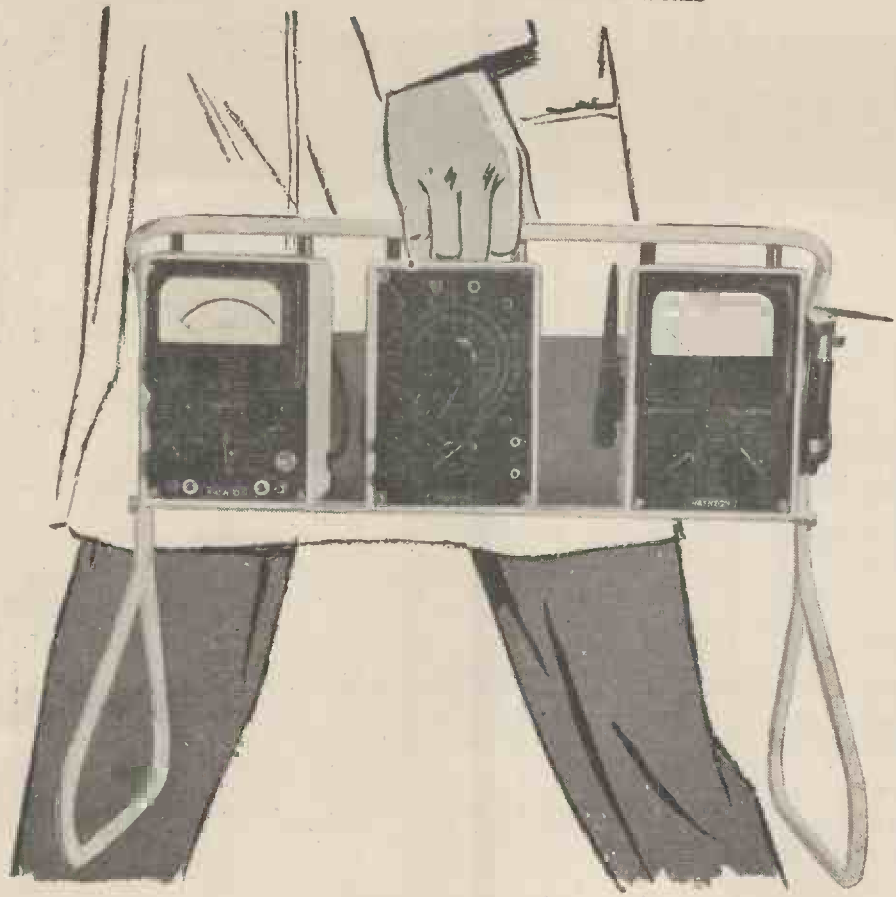

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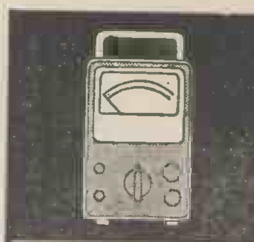

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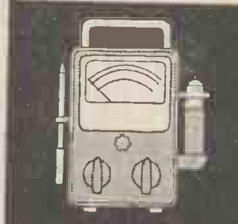

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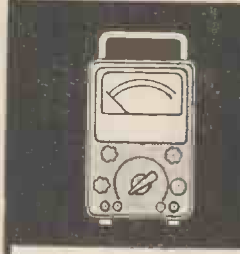

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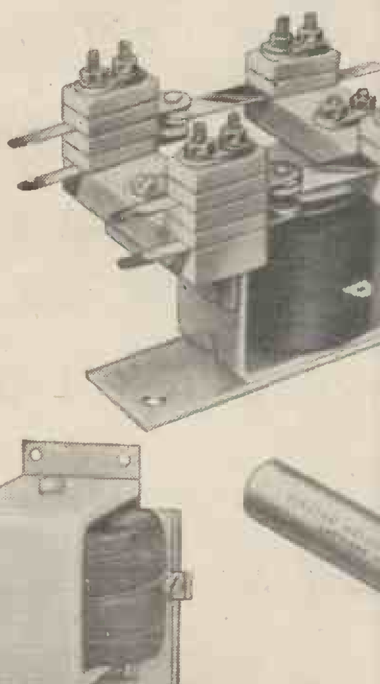

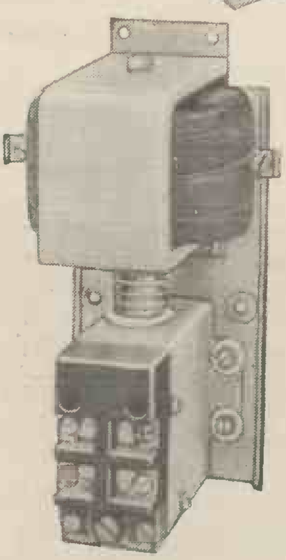

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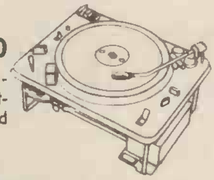

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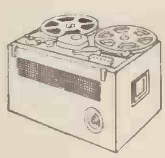

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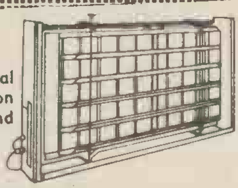

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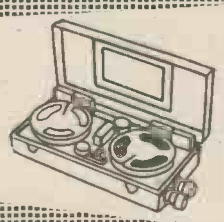

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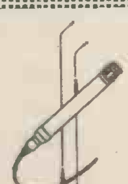

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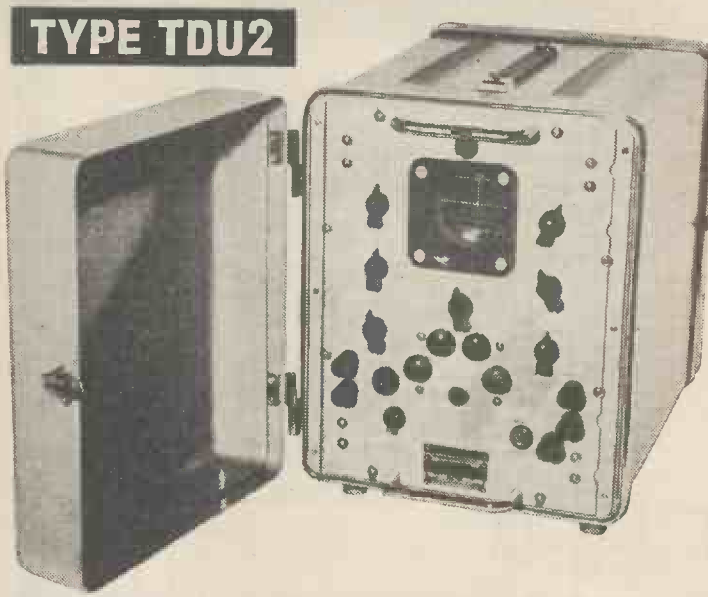

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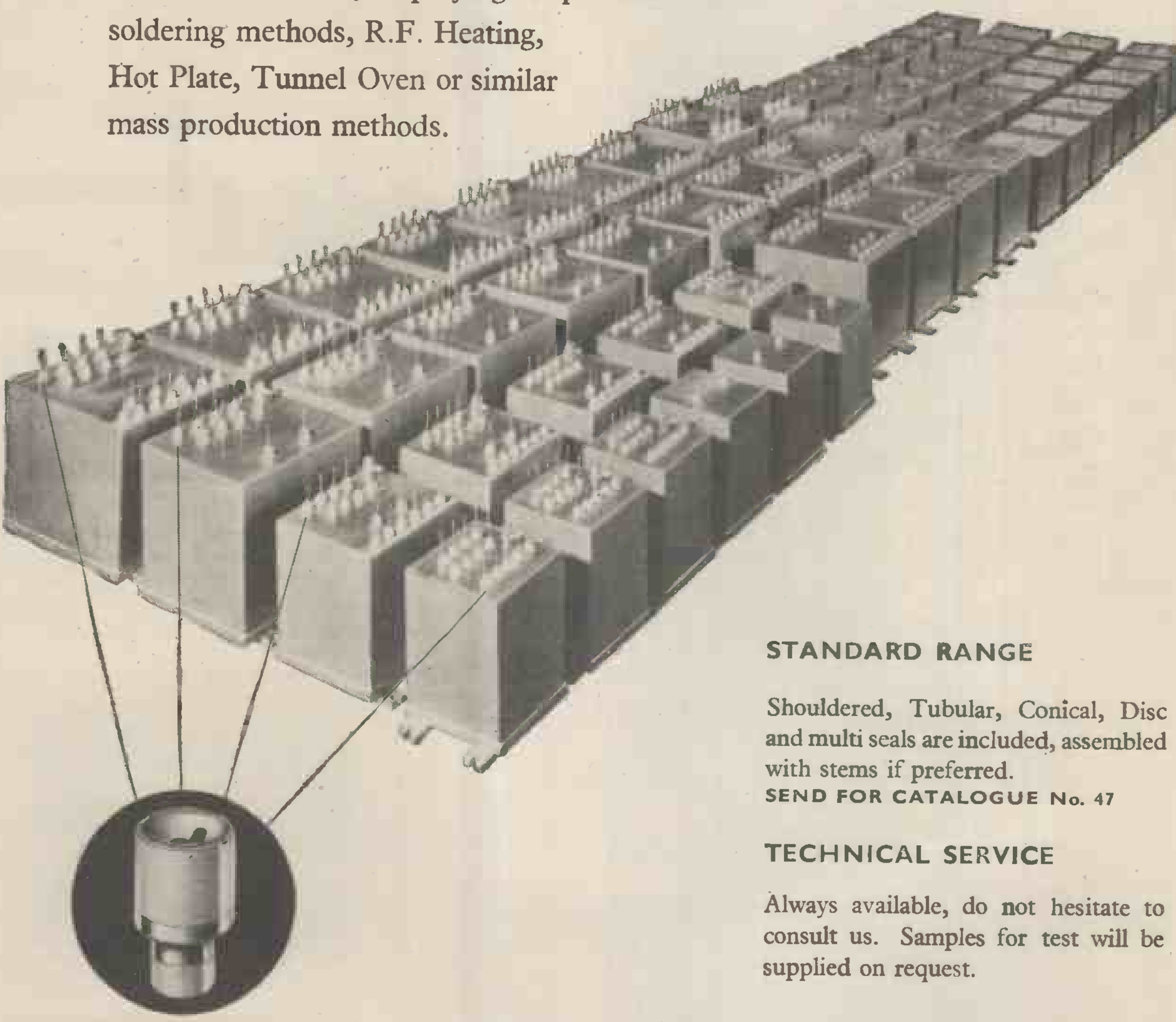

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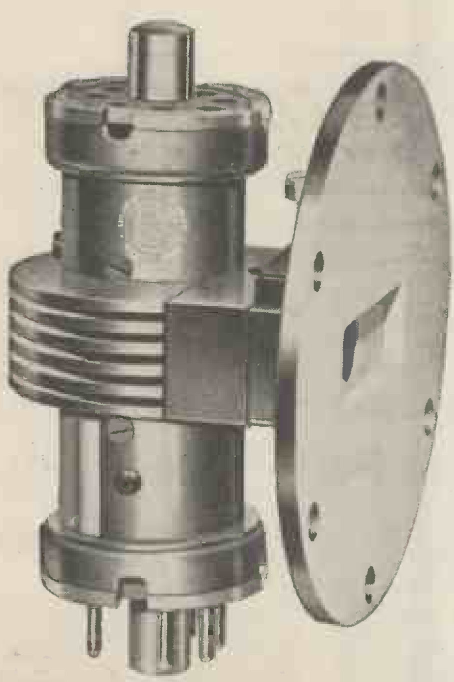

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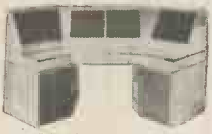

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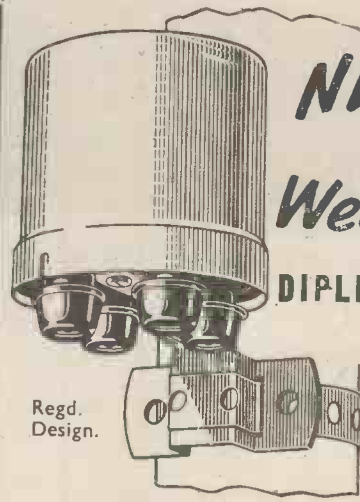

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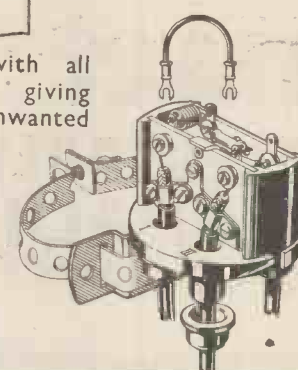

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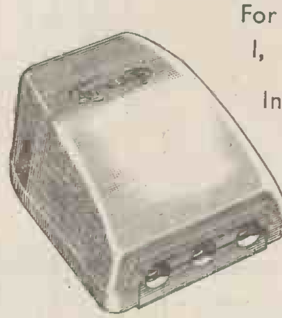

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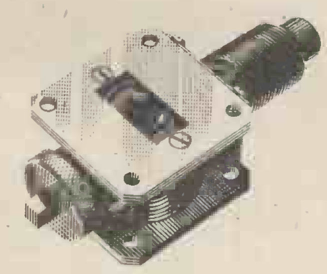

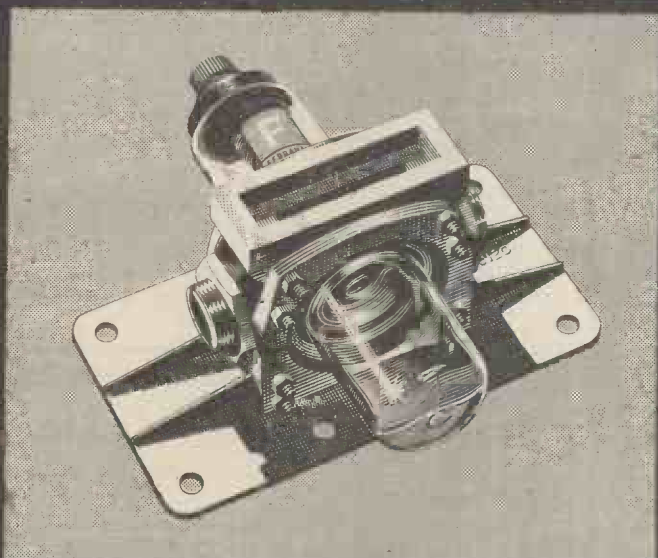

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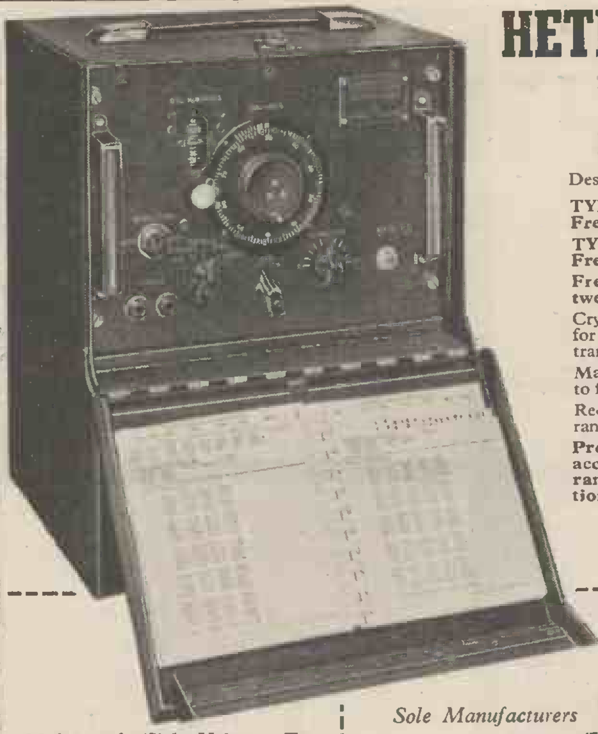

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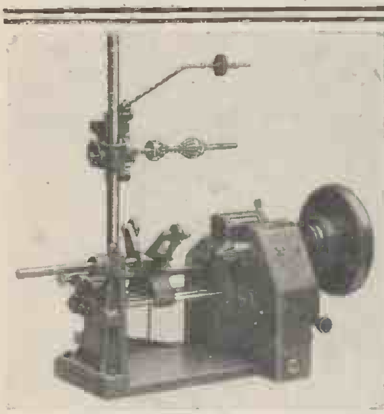

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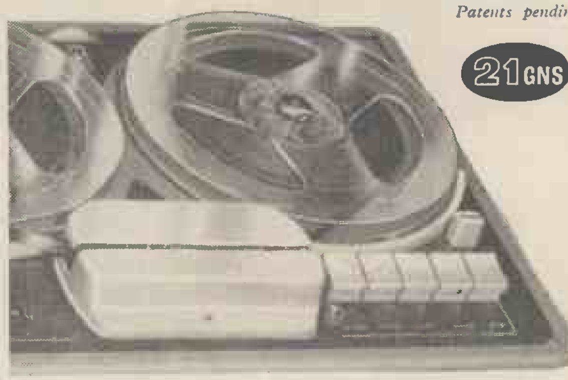

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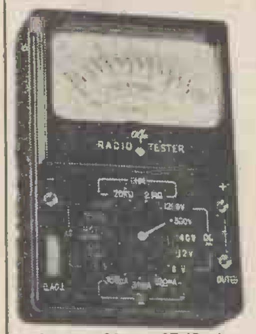

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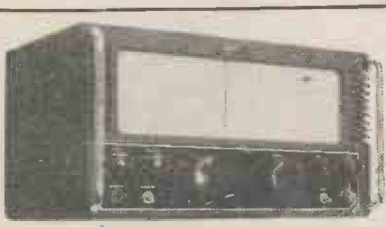

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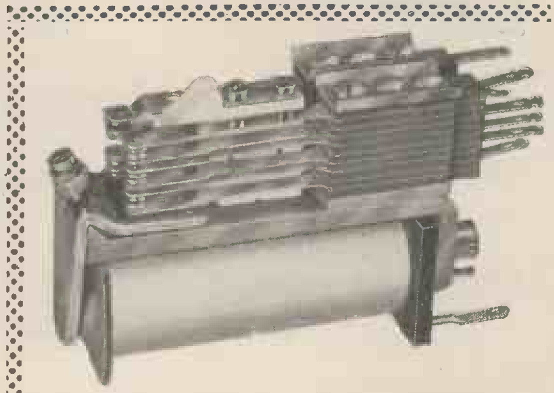

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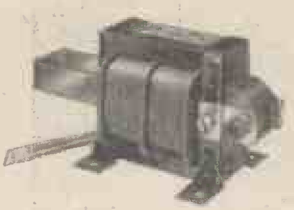

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THE TIMES

REPORT MAY 11 1959

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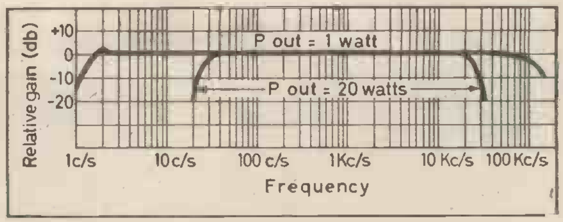

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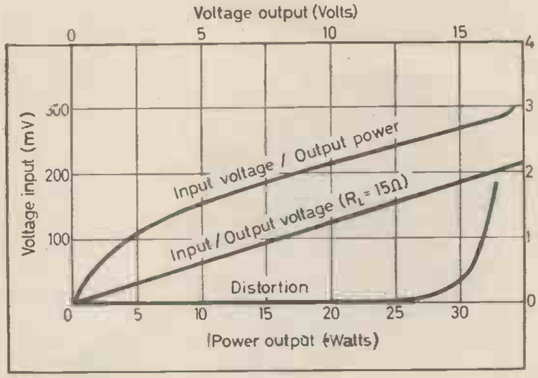

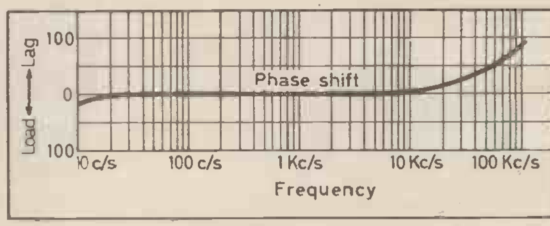

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"BELLING - LEE" NOTES

Parameters of Design

Further notes on Sealing

No. 7 of a series

In the June issue we showed how an apparently solid wire or tube wall could in fact be a bundle of tiny tubes or capillaries and so provide an "open circuit" to an otherwise perfect seal. Now do not let there be any misunderstanding, the extent of such a leak can be very small indeed, and in some cases unmeasurable by ordinary means. To measure the perfection of a seal you must be able to measure the degree of leak. This has become very important with the increased precision of modern science. Theoretically, the perfect seal has never been made, as there could be leakage past the molecules of the material of the container. Many materials thought to be solid are in fact porous; castings in certain metals being notorious in this respect. The unit of leakage is the LUSEC, which is the rate of leak which produces a pressure change of 1 micron of mercury per second in a volume of 1 litre.

This peculiar word LUSEC is a method of writing L (litre) μ (micron) per sec., 10^{-4} lusec = a leak of 4.17 cc per year.

The most practicable method of measuring leaks of that order is with a mass spectrometer, which is an exceedingly expensive tool. There is an infra-red process which is capable of detecting a leak of 10^{-7} which is equal to approximately 1 cc in 250 years.

Perhaps we have started our discussion on sealing at the wrong end. The glass to metal seal is probably the ideal, and the methods of testing are necessarily more scientific as the leaks are so slow and difficult to detect.

We manufacture impedance matching transformers for use in connection with anti-interference aerials. The aerial transformer is always in an exposed position, subjected to sun during the day, and cold at night. There is temperature cycling. As it is an R.F. device, it has to be kept dry and is sealed. Originally, drawn sheet metal cans were used with synthetic rubber glands, and there was no trouble. They were used on ships all over the world. In the interests of economy, we changed to a cast metal container, but it was porous, filled up with water, and apart from impairing the efficiency of the equipment, the water, using the coaxial feeder as a pipe, with a good head of pressure, leaked down into the receiving apparatus. We had to seal the casting with a special varnish. If an electronic equipment has to be sealed, it means that every connection to it must also be sealed, and you must be able to change fuses, plug-in and withdraw plugs, and carry out numerous adjustments all without breaking the seal.

Bear in mind that a length of feeder, coaxial or otherwise, with a connector at each end, must be truly sealed if so specified. The presence of any moisture would unbalance the feeder. To those without the experience of the problem, it may not be easy to appreciate just what it means to design a miniature connector to seal a length of cable with say twenty-four conductors.

We have had some experience of what happens to coaxial feeder from a television transmitter to the aerial. In the exposed situations generally chosen, it is exceedingly difficult to keep out water, and these feeders are like big pipes. When monitors showed us a drop in radiated power, we suspected water first, and on more than one occasion, when we went "off the air," the engineers drilled a hole in the feeder at the lowest elbow, and the water gushed out. In many permanent installations such cables are pressurised with nitrogen to prevent the ingress of moisture. Aircraft equipments are also sometimes pressurised, not only to keep moisture out, but to retard voltage breakdown at high altitudes—low pressures. So sealing is used to keep gases or air in as well as moisture out.

The optical industry is also interested in sealing. There must be no moisture between the lenses of binoculars or telescopes as it would condense on the "inside" of the lenses which is not generally accessible. If air or water vapour can get in, so can micro-organisms, and there is at least one that can ruin lenses. Many industries must give careful consideration to sealing for a variety of reasons.

It does not seem so long ago that the standard method of testing for leaks was similar to looking for a tyre puncture, immerse the article in a bucket of water and look for the bubbles. Hot water with a little tepol was best, as the heat expanded the air inside the container and the tepol broke down the surface tension. It was soon appreciated that atmospheric breathing or temperature/pressure cycling was a far more stringent test, and far more realistic. There was a definite sucking action when outside pressure increased or the temperature inside dropped.

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L.1417/CS.
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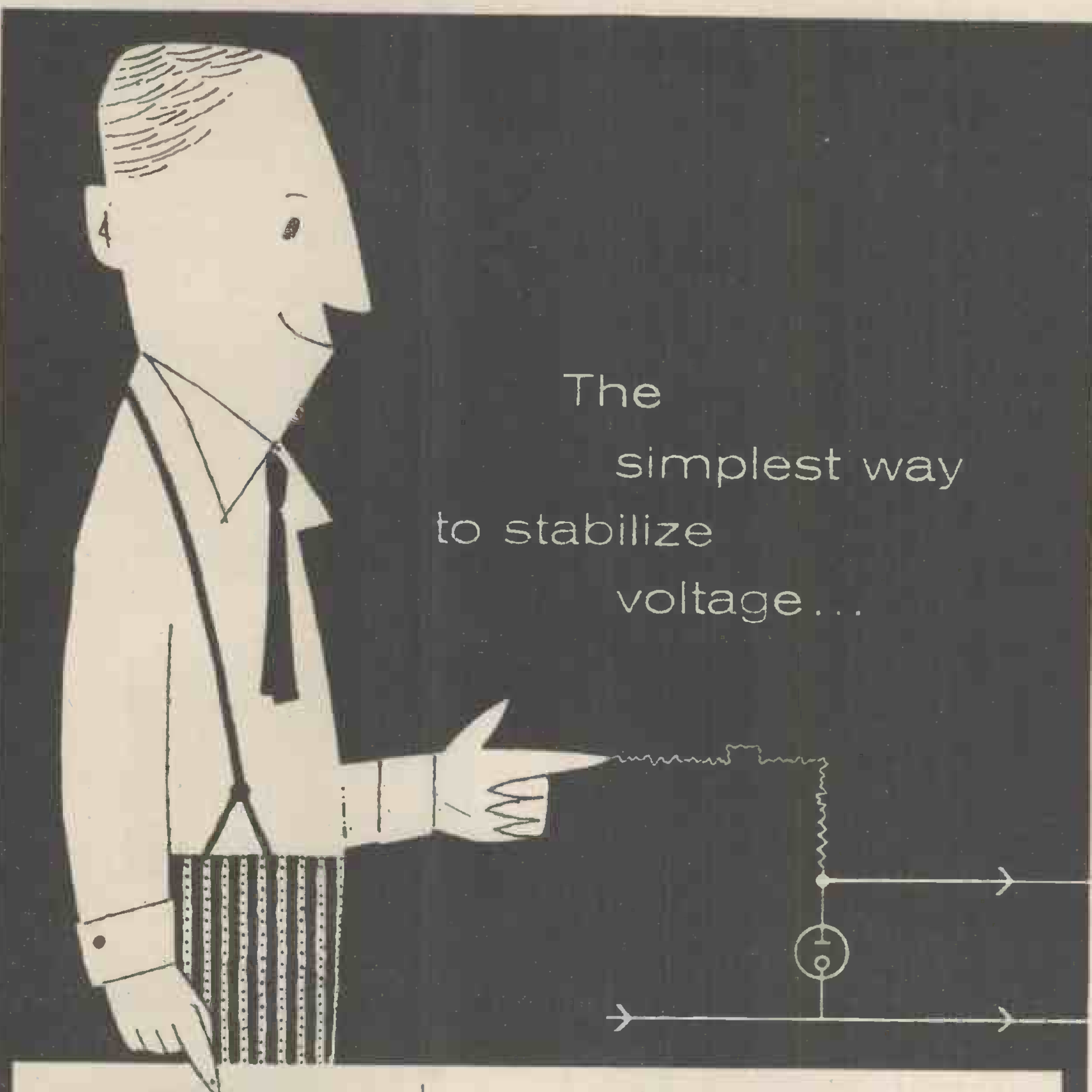

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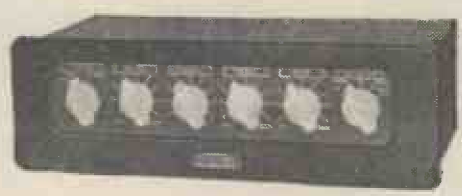

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Aspects of design 13

TELEVISION TUNER MIXER STAGE

This is the Thirteenth of a series of special features dealing with advanced problems in television and radio circuit design to be published by Siemens Edison Swan. The Ediswan Mazda Applications Laboratory will be pleased to deal with any questions arising from this or other articles, the fourteenth of which will appear in the September 1959 issue.

The Mixer Stage of Television Tuners

The circuits employed in the mixer stage of a television front end tuner are nearly always designed around the triode pentode frequency changer in which the pentode performs the operation of mixing and the triode acts as the local oscillator.

Unwanted Features

This type of mixer has two unwanted features which become very evident on Band III namely, a high noise factor of about 40 and a low input resistance which falls to something between 600 to 700 ohms at 200 Mc/s. Fortunately the high noise contribution of the mixer can be rendered almost negligible by the use of an RF amplifier with high gain such as can be provided by the 30L15. But the low input resistance of the mixer on Band III still remains and means have to be found of reducing the effect of this damping on the preceeding band pass transformer.

Improving the Mixer Stage

There are four methods by which the effect of the low input resistance of the mixer can be reduced, the first two deal with circuit arrangements, the third with improvements that can be made in the design of the valve and the fourth with the most suitable pin connections.

1. ***Reducing Valve Input Damping***

First, the influence of the valve input damping and input capacitance can be reduced by inserting a series trimmer capacitance (10 pF min.) in the secondary circuit of the RF transformer. This steps down the valve damping in the ratio of the valve input capacitance to the series trimmer capacitance. On Band III there is a marked reduction in the effective damping. There is a further advantage: as a larger secondary inductance will be required, a better RF transformer can be made for the higher channels on this band.

2. ***Raising Mixer Input Resistance***

Secondly, the input resistance of the mixer stage can be raised by designing the circuit to provide a small amount of regeneration from g_2 into g_1 via the g_2/g_1 inter-electrode capacitance. This can be done by including a small inductance between the g_2 pin and its decoupling capacitor. By this means a negative component is given to the input resistance which tends to prevent its value from falling as the frequency is progressively raised. A small increase in the input capacitance of the mixer also occurs with g_2 regeneration but this is not important as it can be accepted when a series tuned circuit is used. The amount of regeneration must be kept within reasonable limits as its effect can vary to some extent with the spread of valve parameters and with wiring changes. Usually an added screen inductance of 0.02 μH is suitable with the 30C15.

3. ***Reducing Cathode Lead Inductance***

One of the principal causes of low input resistance and one which can be modified by valve design is that due to the cathode lead inductance, part of which is in the valve and part in the external circuit. Because this inductance carries the whole output current and is, at the same time, common to the input circuit, degeneration occurs, giving a positive component of input resistance which causes damping.

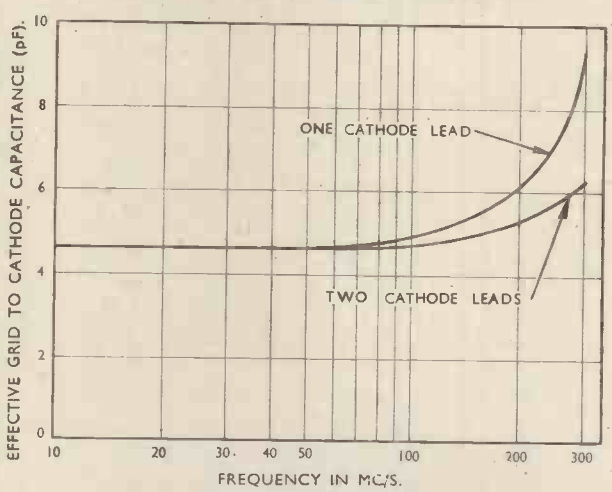
One way of reducing the cathode lead inductance is to bring out the cathode on two pins instead of one. This can be done on the mixer valve without going to a ten pin valve base by making use of the triode cathode pin. If the pentode cathode is strapped internally to the triode cathode with a low inductance connection it will virtually halve the cathode lead inductance of the pentode in the valve base. By following this construction, the contribution of the cathode lead inductance to the total input resistance can be increased from 950 to 1800 ohms at 200 Mc/s.

This feature of using twin cathode leads for the pentode mixer has been incorporated in the 30C15 which is the latest design of frequency changer valve in the Ediswan Mazda range. In developing this valve, it was necessary to experiment with various alternative methods of strapping the two cathodes internally to obtain the lowest value of cathode lead inductance.

The internal lead inductance is the sum of the inductances of the lead-in wires and various short straps of irregular shape; it can be determined by measuring the change of cold input capacitance that occurs as the measuring frequency is increased.

The capacitance that is measured is the g_1 to k capacitance in series with the cathode and grid lead inductances. At frequencies up to about 50 Mc/s the input capacitance remains practically constant but following the normal characteristics of a series circuit the effective input capacitance starts to increase rapidly as series resonance is approached. The valve with the lowest lead inductance shows the smallest change of input capacitance with increase of measuring frequency. The lower inductance obtainable with two cathode leads instead of one can be seen in Fig. 1. The same method of measurement enabled a selection to be made of the best arrangement of valve basing, using two cathode leads, which would provide the lowest cathode lead inductance.

Change of effective g_1 to k capacitance (valve cold)



4. ***Choosing the best pin connections***

The disposition of the pins around the B9A base of the mixer must be chosen to benefit the general design in relation to the external circuit, particularly with printed circuits when there is a greater opportunity of making the best use of the low cathode lead inductance within the valve.

For example for use with a printed circuit board it is an advantage to bring out the pentode grid and cathode on adjacent pins. This enables the grid trimmer to be very close both to the g_1 to k capacitance and the grid coil.

It is also an advantage if the grid and anode of the triode oscillator are located on pins adjoining the pentode grid and cathode in order to provide short connections to the oscillator coil.

The Ediswan Mazda 30C15 is designed to meet the requirements of low cathode lead inductance and suitable basing. In addition it will provide a conversion gain approximately 3 dB higher than that of the 30C1.

SIEMENS EDISON SWAN LIMITED *An A.E.I. Company*
Technical Service Department, 155 Charing Cross Rd., London, W.C.2.
Telephone: GERrard 8660. Telegrams: Sieswan, Westcent, London

NEW V.H.F. FREQUENCY CHANGER EDISWAN MAZDA 30C15

The 30C15 is a triode pentode frequency changer with a conversion conductance of 3.3 mA/V, for use in television receivers.

In design, the internal layout is arranged to minimise cathode lead inductance and the basing has been selected to make the valve particularly suitable for use in printed circuits, but it can also be used with advantage in wired circuits. The triode is identical to that used in the 30C1.

In addition to the advantage of improved basing and layout the 30C15 will provide a gain approximately 3 dB higher than the 30C1.

Heater Current (amps.)	I_h	0·3
Heater Voltage (volts)	V_h	9

TENTATIVE RATINGS AND CHARACTERISTICS

Maximum Design Centre Ratings

		Triode	Pentode
Anode Dissipation (watts)	$p_{a(max)}$	1.5	1.7
Screen Dissipation (watts)	$p_{g_2(max)}$	—	0.5
Anode Voltage (volts)	$V_{a(max)}$	250	250
Screen Voltage (volts)	$V_{g_2(max)}$	—	175
Heater to Cathode Voltage (volts r.m.s.)	$V_{h-k(r.m.s.)max}$	200	
Cathode Current (mA) ..	$I_{k(max)}$	14	14

Inter-electrode Capacitances (pF)†

Pentode	Anode to all	c_{a-all}	5
	Grid 1 to all	c_{g1-all}	6.7
	Grid 1 to Anode	c_{g1-a}	0.014
Triode	Anode to Earth	c_{a-E}	3.2
	Grid to Earth	c_{g-E}	3.2
	Grid to Anode	c_{g-a}	1.6

†Inter-electrode capacity with holder capacity balanced out but with cylindrical screen can.

Maximum Dimensions

Overall Length (mm)	56
Seated Height (mm)	49
Diameter (mm)	22.2

TYPICAL OPERATION

As frequency changer with oscillator voltage applied to pentode grid 1.

Pentode		
Supply Voltage (volts)	$V_{a(b)}$	200
Anode Voltage (Decoupling Resistance 4.7 kΩ) (volts)	V_a	164
Screen Voltage (Dropping Resistance 27 kΩ) (volts)	V_{g2}	138
Resistance for Grid 1 Current Bias (kΩ)	R_{g1}	100
Anode Current (approximate) (mA) ..	I_a	7.6
Screen Current (approximate) (mA) ..	I_{g2}	2.3
Grid 1 Current (μA)	I_{g1}	33
Conversion Conductance (mA/V)	g_c	3.3
Heterodyne Peak Voltage (volts)	$V_{het(pk)}$	3.7
Triode		
Anode Voltage (volts)	V_a	120
Anode Current (Average) (mA)	$I_{a(av)}$	6

APPLICATIONS NOTES

The base connections of the 30C15 provide the following advantages for printed circuit use:

(a) The pentode g_1 and cathode are brought out on adjacent pins. This enables the grid trimmer to be placed very close to the g_1 to k capacitance thus minimising errors in alignment that can occur at differing frequencies if the trimmer has series inductance.

(b) The g_2 connection is conveniently placed close to the cathode.

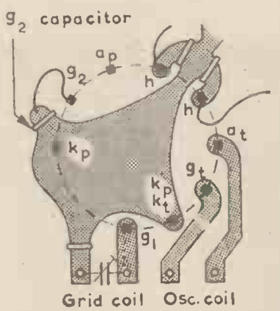
(c) The heater pins are easily accessible for series connection in a printed circuit board while still allowing easy decoupling to the strapped cathodes.

(d) The position of the grid and anode pins of the triode oscillator makes it possible to use short connections to the oscillator coil.

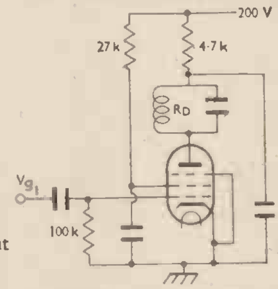
(e) The reduction in cathode lead inductance increases the gain on Band III.

These points are illustrated in the following figure which shows part of a printed circuit layout using the 30C15 where the RF stage is assumed to be a cascode amplifier using the 30L15.

Although the triode sections of the 30C15 and 30C1 are identical the internal coupling between triode and pentode in the 30C15 has been reduced. To obtain satisfactory injection of oscillator voltage into the pentode section the 30C15 requires additional external coupling.

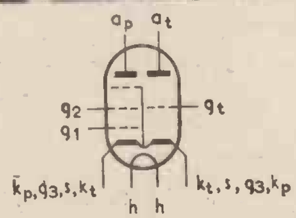


TEST CIRCUIT AND CONDITIONS

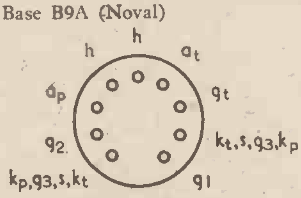


V_b	R_a	R_{g_2}	R_{g_1}
200	4·7 k	27 k	100 k
R_D	I_h	f	C_{g_1}
10·5 k	0·3A	1 Mc/s	0·02μF

HETERODYNE INJECTED IN g_1

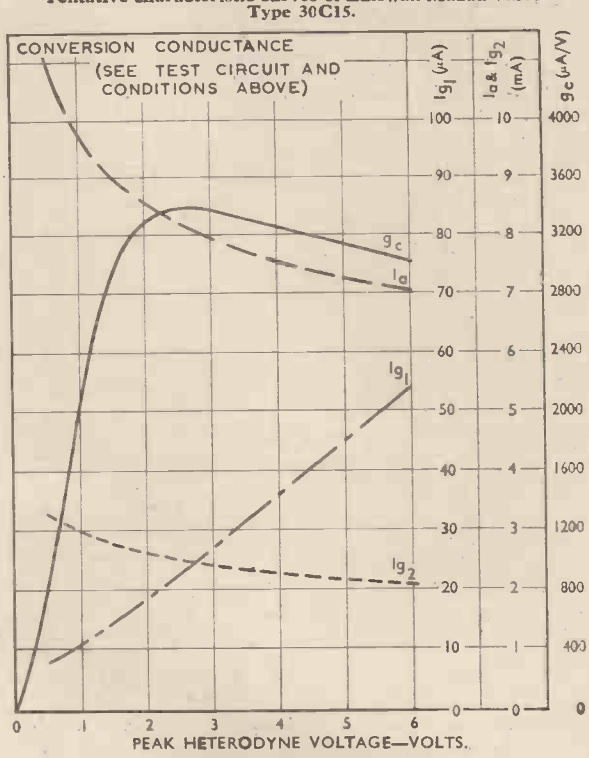


Base B9A (Noval)



VIEW OF FREE END.

Tentative characteristic curves of Ediswan Mazda Valve Type 30C15.



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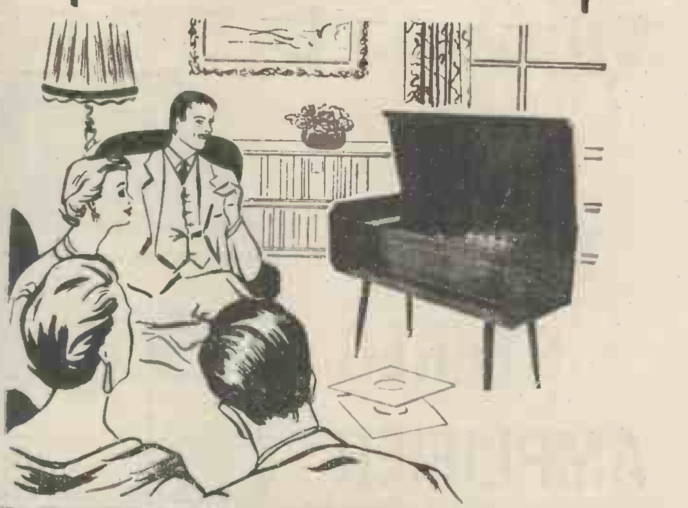

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Hum and Noise P.U. —55 db. Tape —60 db. Radio —60 db.

Frequency Response Tape 20 to 20000 cycles ± 1½ db. Radio 20 to 20000 cycles ± 1½ db. P.U. Within 1½ db of published relay curves.

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Controls Volume: Continuously variable. Bass: + 10 db to — 15 db at 50 cycles. Treble: + 10 db to — 15 db at 10000 cycles. Balance: Variation of 6 db per channel. Illuminated Push/Push on/off switch.

Selector Switch 5 Position: Tape. Radio. 78 (all 78 records). L.P.O. (Pre 1955 recordings) L.P.N. (Recordings to R.I.A.A.).

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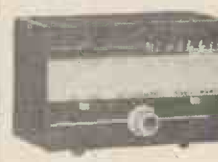
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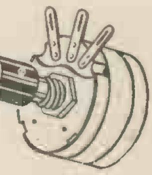

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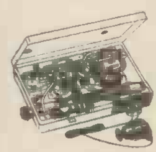

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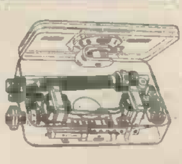

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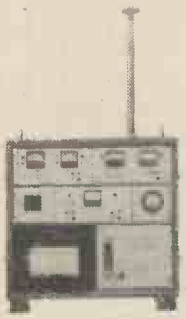

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VISCONOL TYPES, 10 mfd., 3 kv. wkg., **25/-** each. 10 mfd., 1.5 kv., **15/-** each. 6 mfd., 1 kv., **12/6** each. 8 mfd., 2.5 kv. wkg., **22/6** each, 2 mfd., 1 kv. wkg., **8/-** each.

GRAHAM GEARED MOTORS. 115 volts A.C. 50 cys., 1/6th H.P., variable speed gearbox 0·166 R.P.M. (as new). **£8/10/-** each. Transformers to operate this unit **35/-** each. Carr. 10/-.

AMERICAN L.T. TRANSFORMERS. Potted type, finished in black crackle and very conservatively rated. (1) 230 v. input, 3×5 volts CT., at 3 amps. each and 4 volts at 2 amps. output, **18/6** each. (2) 230 v., input 2×6.3 volts CT., at 3 amps. and 6.3 volts at 3 amps. output, **18/6** each. (3) 230 volts input, 2×6.3 volts at 3 amps., and 6.3 volts CT., at 3 amps. output, **17/6** each. (4) 230 volts input, 28 volts at 2 amps. and 2 volts at 1 amp., **12/6** each. (5) 230 volts input, 3×6.3 volts at 3 amps. CT., 1, 6.3 volts 3 amp., **22/6** each. (All these transformers are new and boxed, please include postage 3/6 each.)

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SS/567/A	32/6 the set
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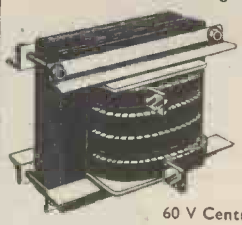
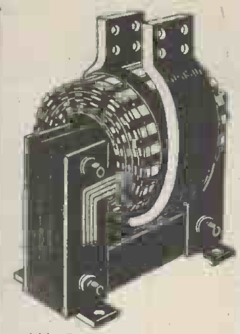
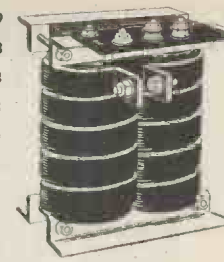


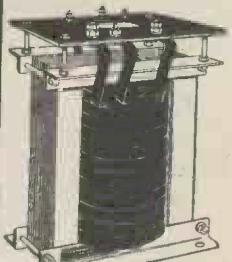
OUTPUTS:
5 V 80 Amps
12 V 40 Amps
24 V 30 Amps
30 V 25 Amps
18 V 30 Amps
110–120 V 4 Amps
4 V 100 Amps
60 V Centre Tapped 30 7 Amps
17.5 V 40 Amps
55 V 15 Amps



4 V	5,000 Amps	£100
2 V	10,000 Amps	£98
3.5 V	20,000 Amps	£127
2 V	30,000 Amps	£130
10 V	2,000 Amps	£103

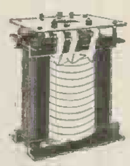


10 V	1,000 Amps	£59
10 V	500 Amps	£38
10 V	750 Amps	£48
10 V	300 Amps	£28
10 V	900 Amps	£50
12 V	1,000 Amps	£64
15 V	1,000 Amps	£75
20 V	800 Amps	£80
5 V	1,000 Amps	£39



5 V	140 Amps	£10
110–120 V	10 Amps	£15
40 V	25 Amps	£14
5 V	300 Amps	£15
6–12 V	50 Amps	£10
12 V	60 Amps	£10
12 V	100 Amps	£16
50 V	60 Amps	£25

110 V Centre Tapped 55 V 25 Amps £26
10–15–25 V 100 Amps £26
6–8–10–18–24 V 100 Amps £32
6–12–18–24–30 V 12 Amps £11
1.6 V to 49 V in 23 Combinations 12 Amps £13



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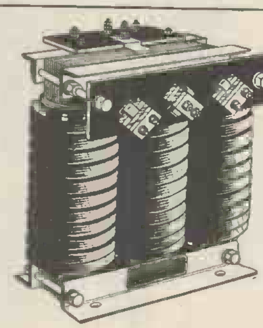
Input 400/440 V
40 V 60 Amps 3 Phase £30
230 V 50 Amps 3 Phase £78
110 V 100 Amps 3 Phase £90
4 V 5,000 Amps 3 Phase £130



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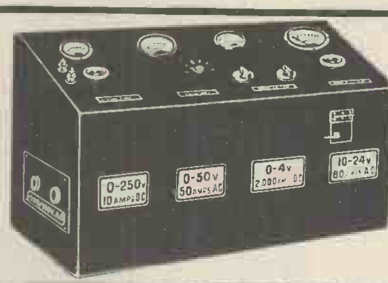

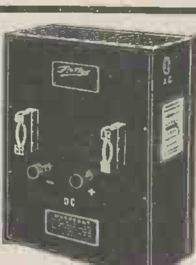

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OUTPUT 0/240 V
Change per step 3.8 4 (1.6%)

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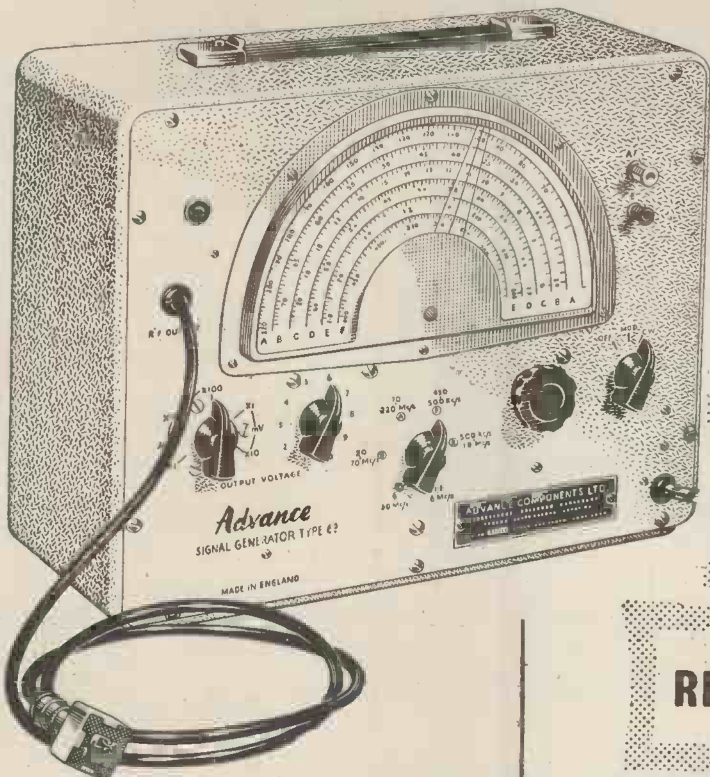

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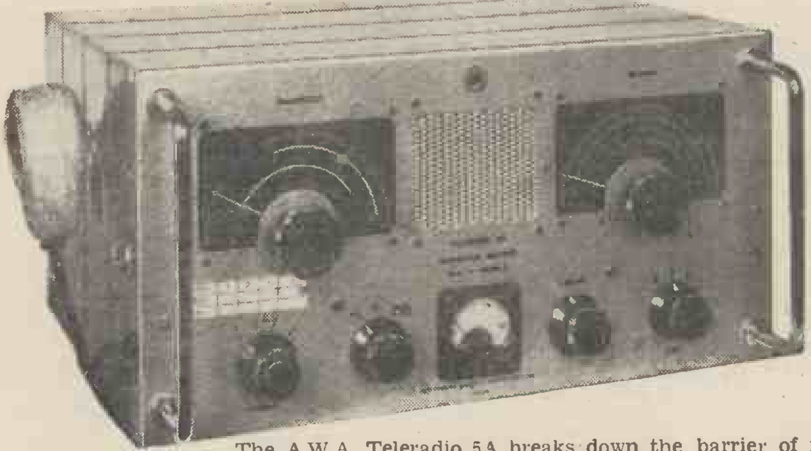

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Only six controls, no technical skill required.
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In one attractively finished case, 9" x 16" x 20".
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High-performance receiver tunes over a useful portion of the short-wave band, to provide general entertainment.
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A.W.A. provides a complete equipment ready for connecting to the battery. Full details given on aerials.
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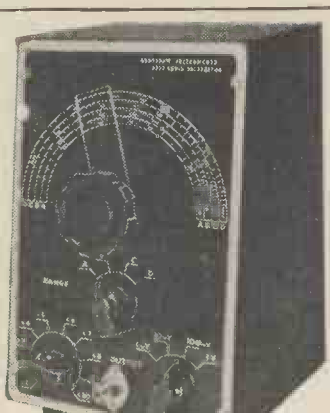

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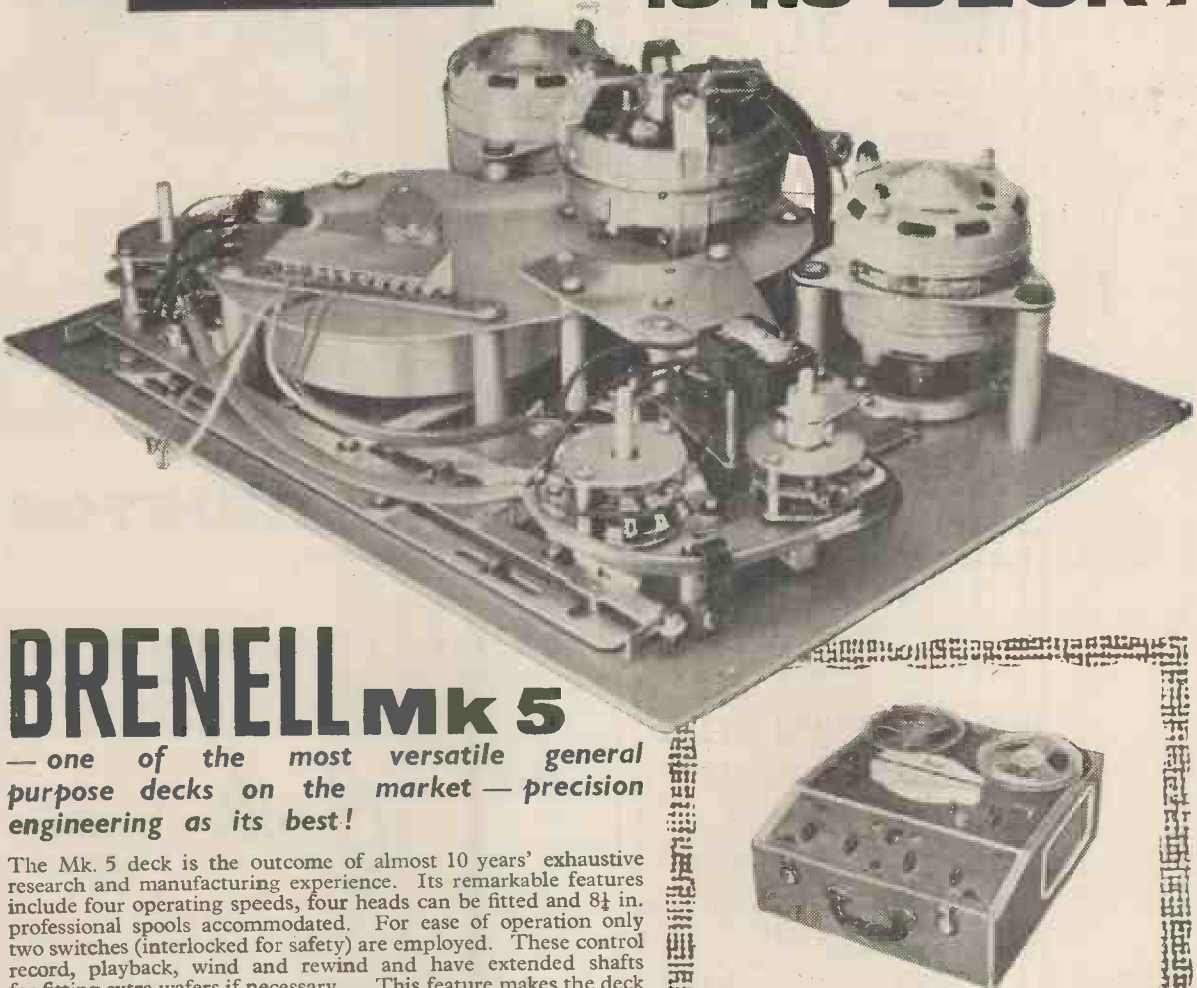

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Complete record/playback amplifier with power unit	£24
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KENNETH POPPLEWELL — *violin*
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Harold Blackburn appears by kind permission of Sadlers Wells Trust Ltd., and Kenneth Popplewell by kind permission of the B.B.C.

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Special recordings have been undertaken for this purpose by E.M.I.
A number of commercially available records will also be played.

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Stoved grey or blue hammer chassis 9½in. x 5¼in. x 6in.

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For operation on AC mains 200/250 v.

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BROTHERTON, KNOTTINGLEY, YORKS.

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No. 17

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NEW DEVELOPMENT

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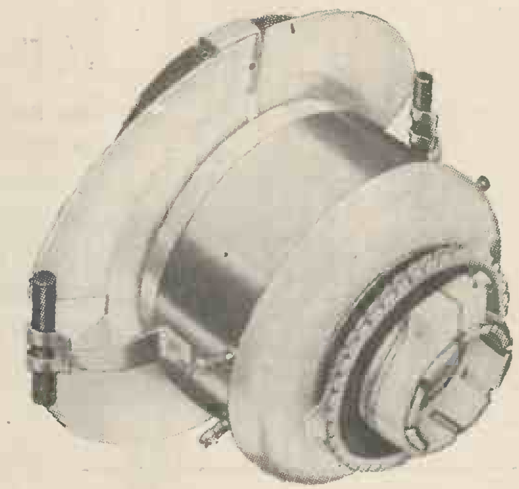


With the general introduction of 110° television tubes, increased scanning power is required for both line and frame. This can be obtained either by more power from larger valves or by improving the efficiency of the circuit and reducing losses. For obvious reasons, the latter method is preferable, since it prevents a rise in power consumption and a consequent increase in heat dissipated by the components.

One of the most obvious reasons for losses, is the presence of metallic picture centring magnets on the tube neck behind the deflection coils. These magnets, due to their electrical conductivity, absorb about 10% of the scanning power, and convert it into heat.

Due to mechanical considerations, picture shift magnets are required to be made from a comparatively thin and tough material which can be accurately and inexpensively fabricated. Consequently, it is usual to employ one of the ductile sheet magnet materials such as the low percentage cobalt, chrome or tungsten steels. These, however, have a low electrical resistance and a low coercive force, which give rise to shunting of the magnetic field and demagnetisation of the magnet due to the leakage field.

The Mullard Laboratories have given this problem some consideration, and have produced a new type of magnet material specially for this application. This gives an improvement in scanning power of approximately 10% for frame and 5% for line width compared with the usual metallic magnets.

The photograph illustrates the position of the shift magnets on a set of 100° deflection coils. Two "Magnadur" rod magnets for pin cushion picture correction are also shown.

Some of the outstanding characteristics of this new material are:—

1 High electrical resistivity of approximately 10^6 ohm. cm.

2 High coercive force of approximately 1,500 oersteds giving a high resistance to demagnetisation.

3 Can be formed to required shape within small limits by normal and inexpensive methods.

4 Requires no subsequent heat treatment.

5 Tough, flexible and resiliant.

For further details of these magnets and other Mullard magnetic components, write to the address below.

If you wish to receive reprints of this advertisement and others in this series write to the address below.

Mullard

'TICONAL' PERMANENT MAGNETS
'MAGNADUR' CERAMIC MAGNETS
FERROXCUBE MAGNETIC CORES

MULLARD LIMITED, COMPONENT DIVISION, MULLARD HOUSE, TORRINGTON PLACE, W.C.1. LANgham 6633

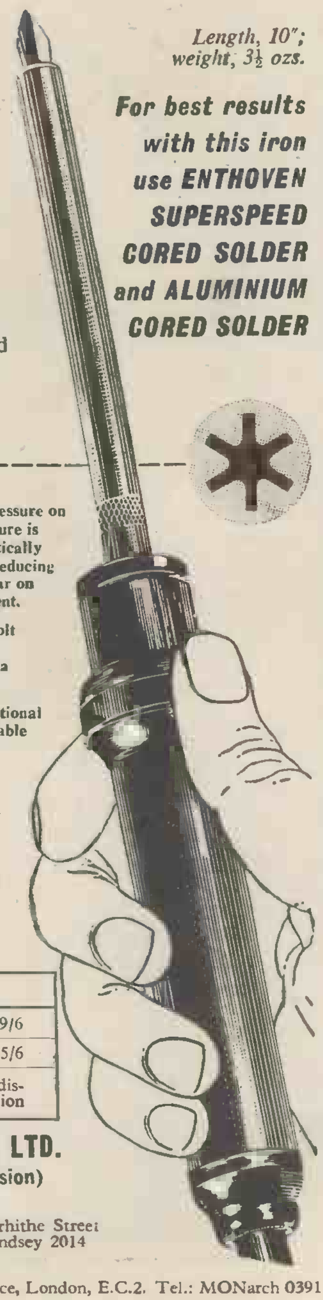
The
Superspeed
Soldering Iron

heats up from cold in 6 seconds

Designed on an entirely new principle, this lightweight, versatile iron is eminently suitable for soldering operations in the radio, television, electronic and telecommunication industries. For test bench and maintenance work it is by far the most efficient and economical soldering iron ever designed.

Length, 10"; weight, 3½ ozs.

For best results with this iron use ENTHOVEN SUPERSPEED CORED SOLDER and ALUMINIUM CORED SOLDER



- **Activated by light thumb pressure on the switch ring. When pressure is released, current is automatically switched off—thus greatly reducing electricity consumption, wear on copper bit and carbon element.**
- **Can be used on 2.5 to 6.3 volt supply (4 volt transformer normally supplied) or from a car battery.**
- **More powerful than conventional 150-watt irons; equally suitable for light wiring work or heavy soldering on chassis.**
- **Simple to operate; ideal for precision work.**
- **Requires minimum maintenance—at negligible cost; shows lowest operating costs over a period.**

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TRANSFORMER	35/6
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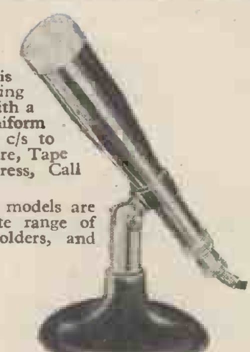

The Grampian DP4 Microphone is ideally suited to the recordist requiring a high quality instrument for use with a tape recorder. Designed with a uniform wide frequency response from 50 c/s to 15,000 c/s, it fulfils the needs of Wire, Tape and Disc Recording, Public Address, Call Systems, etc.

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600 ohms—
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For use in cases where it is desired to use a low impedance microphone with a recorder or amplifier having a high impedance input. It can also be used in cases where very long microphone leads are necessary. Retail price £3/5/-.

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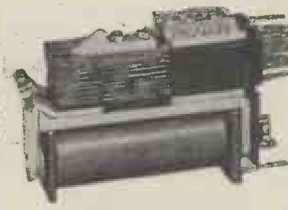

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3. C/O	3/6	12/-
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Other build ups to order; all types of relays built to your specification.

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Up to 100 Ohms	3/-	5/-
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„ „ 5,000 „	6/6	8/6
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„ „ 40,000 „	16/-	20/-
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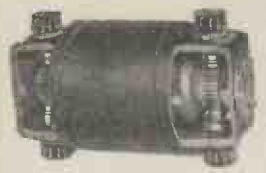

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Input 11.5 v. Output 250 v. at 125 mA.	Input 11.5 v. Output 490 v. at 65 mA.

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PC/4

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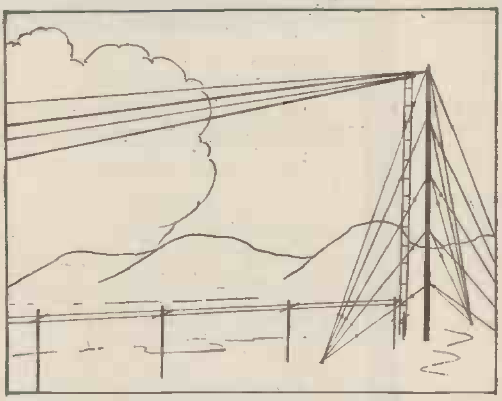

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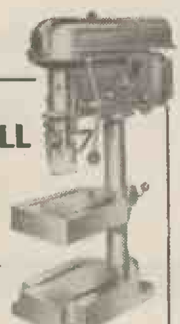

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Fitted with curvilinear cone, foam plastic surround and extra long voice coil winding which permits large amplitude movements without harmonic distortion. Recommended for use as single speaker for any heavy duty requirement such as public address or home cinema or as bass unit in multi-speaker system. Suitable for use in all types of reflex enclosure horn loading or open baffle mounting. £9.

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As above but with aluminium wire voice coil giving improved transient response and useful range extended up to 10,000 c.p.s. 9 gns.

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A higher powered (12 watt) version of the AXIOM 110. 16,000 gauss magnet system.

You are invited to visit Stand No.23 in the main hall where the new loudspeaker systems are shown in a typical room setting designed to simulate normal listening conditions in the average living room.

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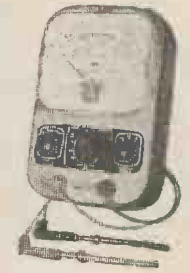
FREE GIFT. To extend the uses of this instrument for instance to measure capacity, inductance, E.H.T. etc., we have developed a range extender scale and operating notes, these will be sent free to purchasers of this instrument.

All sent immediately for **10/-** deposit, balance by 21 payments of **10/-**, which includes free insurance against accidental damage for 12 months. Non-callers add 3/6 post and ins. Cash price **£9/10/-**.



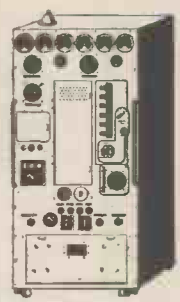
Building a Scope?

3in. oscilloscope tube, American-made type No. 3FP7, octal base 6.3 v. .6 amp. heater, electrostatic deflection, brand new and guaranteed. 15/- each, plus 1/6 post and ins.

£100 TRANSMITTER FOR £30

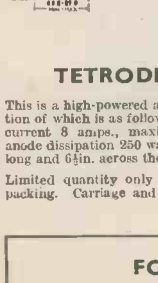
TRANSMITTER NAVY MODEL TCK-7

We have a few only American transmitters still in original packing cases. Designed for the Navy, these are really beautifully made and most impressive, standing 5ft. high by 2ft. wide and finished in instrument crackle. All meters and controls are on the front panel. The transmitter tunes over the range of 2 megacycles to 18 megacycles and it is designed for high speed precision communication without preliminary calling. Frequency control and stability is particularly good, being better than .005% under the worst conditions. Power output is 400 watts on C.W. and 100 watts on phone. Tuning is very simple—a unit control mechanism—gives a direct reading in frequency. Complete with valves and instruction manual. Price **£30** ex works.



NOTE—The transmitter will work off A.C. or D.C. with the appropriate power unit. Power units are not available at present.

SPECIAL PURPOSE VALVES



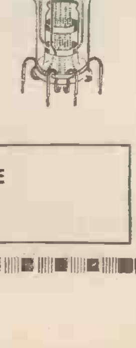
Triode Type CV 1098, this is a high-powered air-cooled triode. Specification of which is as follows: Filament voltage 8.2 v., filament current 35 amps., anode dissipation 750 watts. Anode volts 25 kv. This valve is very suitable for R.F. heating at high frequencies and two of these in push-pull under Class C conditions would have an output of approximately 2 kilowatts. Brand new, still in original shockproof packing, price **£5** each. Carriage and insurance 10/-.

MAGNETRON 725A American make and type. Brand new, unused, few only, **£5/10/-**. Others available, state your requirements.

TETRODE TYPE VT31

This is a high-powered air-cooled tetrode. Specification of which is as follows—heater volts 11.25, heater current 8 amps., maximum anode voltage 5 kV., anode dissipation 250 watts, size approximately 14½in. long and 6½in. across the bulb.

Limited quantity only at £4 each, still in original packing. Carriage and insurance, 10/-.



FOR ADDRESSES SEE OPPOSITE PAGE

SUMMER SALE

Walkie Talkie 46, has range of approx. 5 miles, makes fine battery receiver, complete with six valves and in metal case, but less crystal, not tested nor guaranteed. Sale price **19/6**, plus 2/6 carriage.

Wire Jointer (welder for 28 gauge or thinner), in bakelite case with trigger switch, works off step-down transformer. Sale price **2/6**, plus 9d. postage.

Sniperscope, "Cats Eye," for seeing in the dark. Will work burglar alarms, counting circuits etc. Sale price **4/-**, plus 1/- post.

Telephone Handset, sound powered, just join two together with a pair of wires and you have telephonic communication. **25/-** pair, plus 3/- post and ins.

Ex R.N. Sound-powered Telephone, complete with sounder. Sale price **49/6** each.

12-24 v. D.C. Converter. Sale price **32/6**.

R.F. 25 Tuner Unit, complete, new condition. Sale price **8/6**, plus 2/6 post.

Stud Switch, heavy duty, 30 amp. contacts, for dimmer, charger, regulator, etc. Sale price **7/6**.

Tabby Binocular equipment, complete. Sale price **£4/19/6**, carriage 10/-.

Packard Bell Pre-Amp., complete with 6SL7 and 28D7 valves, relay, leads, jack, input and output transformers, etc., etc. **6/6**, plus 2/- post.

Centre zero meter 3½in. movement, flush mounting, 500-0-500 microAmp. Sale price **30/-**, plus 1/6 post.

Headphone Adaptor, changes high resistance to low, or low resistance to high by altering connections. Sale price **2/6**, plus 1/- post.

Push-Pull Transformers, input and output, midget, potted. Sale price **5/-** pair, plus 1/6.

P.O. Type 3000 Relays, 2,000 ohm coil, 6 contacts **7/6**, 4 contacts **6/6**, 2 contacts **5/6**, plus postage 1/-.

5 amp. 12 v. full-wave Charger Rectifier, normal price 17/6. Sale price **10/-**, plus 1/6 post and ins.

Westinghouse Meters, 0-500 mA., 0-250 mA., 0-150 mA., 0-100 mA., 0-50 mA., D.C. 0-1.5 kv., 0-2.5 kv., 0-15 v. A.C. All **15/-** each, plus 2/- postage.

Moving Coil Meter, 2½in. movement, 0-750 microAmp. Sale price **19/6**. 0-30 mA., **15/-**, plus 2/-.

Low Resistance Headphones, good British make. Sale price **6/-**, plus 1/6.

Chest Microphone, excellent American make, with adjustable mouthpiece. **6/6**, plus 1/6.

Throat Microphone, excellent American make **6/6**, plus 1/6 post.

American lightweight Headphones, Type H830. Sale price **17/6**, plus 1/6 post.

Regulator Resistors, slider type, 11 ohm, **15/-**, 3 ohm **12/6**, 1 ohm **2/6**, plus 2/- post.

Converter 12, 24 v. D.C. Sale price **32/6**.

E.H.T. Transformer, standard mains input, 3 secondaries, heavy duty potted transformer in cast case, normal price 20/-. Sale price **15/-**, plus 3/6 post.

Suppressor Condenser, stops drills, etc. interfering with radio or television, simple instructions included, normal price 1/6 each. Sale price **1/-** each.

GOVERNMENT SURPLUS
Bi-Metal Contact Strip for making thermostat, **1/3** or **12/-** dozen.

250 v. ½ amp. Rectifier, 6/6.

3-Phase Contactor, 17/6.

Filament Transformer, 6.3 v. 1½ amps., normally 8/6. Sale price **6/6**, plus 1/- post.

Filament Transformer, 6.3 v. 2 amp., normally 10/6. Sale price **8/6**, plus 1/- post.

80 ohm Coax, low loss expanded polythene, normally 9d. per yard. Sale price **6d.** yd.

Midget 3in. P.M. Loudspeaker, for transistor set. 3 ohm coil, normally 22/6. Sale price **17/6**, plus 1/6 post.

Midget 208 pF two-gang Tuning Condenser, for transistor set, normally 15/-. Sale price **9/-**, plus 1/- post.

Transistor OC44 (H.F. or oscillator), normally 30/-. Sale price **20/-**.

Transistor OC45 (I.F.), normally 25/-. Sale price **17/6**.

Transistor OC78D (A.F.), normally 10/-. Sale price **7/6**.

Transistor OC72 (output), normally 20/-. Sale price **14/-**, or matched pair **30/-**.

Push-Pull Output Transformer, for transistors OV72, etc., made to sell at 15/-. Sale price **8/6**, plus 1/- post.

Ditto, but single ended. Sale price **7/6**, plus 1/- post.

SUMMER SALE

Transistor A.F. Transformer or driver, made to sell at 15/-. Sale price 8/6.

Sub-miniature electrolytic Condensers, for transistor sets: 1 mfd., 18 v.; 1.5 mfd., 6 v.; 2.5 mfd., 6 v.; 6 mfd., 6 v.; 6 mfd., 6 v.; 5 mfd., 12½ v.; 8 mfd., 6 v.; 10 mfd., 6 v.; 16 mfd., 12 v.; 25 mfd., 6 v.; 25 mfd., 25 v.; 30 mfd., 3 v. All normally 3/- each. Sale price 1/6.

Transistor Ferrite Rod Aerial, with medium and long wave coils with circuit, normally 12/6. Sale price 7/6.

Oscillator Coil and set of 3 I.F. transformers for transistor set, with circuit, normally 35/-. Sale price 23/6.

T.V. Rectifier, RM5 equivalent, normally 25/-. Sale price 12/6.

Auto Transformer, totally enclosed primary 200-250, secondary 110-120 v. 150 w. normally 27/6. Sale price 17/6.

I.F. Coils, standard size by Weymouth 465KC. dust cores, normally 12/6. Sale price 6/6 per pair.

Isolation Transformer, 500 w., ideal in the service shop when working with A.C./D.C. chassis, normally £5/12/6. Sale price £4/12/6.

Mains Lead, 6ft. of unbreakable wire, as fitted to electric razors, makes fine lead for test meters, etc. Sale price 1/6 for three.

50 Assorted 1 watt Resistors, our assortment, well mixed, useful values. Sale price 5/-.

Ditto, but ½ watt. Sale price 4/-.

Electrolytic Condensers, standard types: 4 mfd., 150 v. 1/-; 8 mfd., 150 v. 1/-; 8 mfd. 350 v. 1/6; 15 mfd. 200 v. 1/-; 8+8 mfd. 350 v. 2/6; 8+16 mfd. 350 v. 3/-; 32+32 mfd. 275 v.+50 mfd. 50 v. 3/6; 50+50 mfd. 350 v. 3/6; 100+100 mfd. 200 v. 2/6; 25 mfd. 25 v. 1/-; 50 mfd. 12 v. 1/6; 50 mfd. 25 v. 2/-; 100 mfd. 12 v. 2/-.

Mains Dropper, vitreous, covering .3 amp 500 ohms. with voltage tapping. Sale price 3/6.

Ditto, .15 amp. Sale price 2/6.

B7G Holder, with skirt for screening can, normally 10d. Sale price 6d. or 5/6 doz.

Phillips Trimmer, 0-30 pF, normally 1/9. Sale price 9d. or 7/6 dozen.

Pot Meters, carbon 5 K., 10 K., 25 K., 50 K., 100 K., 250 K., ½ M., 1 M., 2 M. with 2¼in. spindles. Sale price, less switch, 2/6, with switch 4/-.

Ditto, with 1in. spindles. Sale price, less switch 1/-, with switch 2/6.

Clock Movement, 7-day mechanism, beautifully made and fully jewelled, few only. normal price 12/6. Sale price 8/6, plus 1/6.

Medresco Hearing Aid, as supplied by National Health, completely overhauled in good working order, complete with earphones and new earplug, but not batteries, normal price £3/15/-. Sale price £2/19/6.

Somweave, loudspeaker fabric also suitable for covering plain wooden cases for portables. Normally offered at bargain price of 12/6 per yard, 48in. wide. Sale price 10/6 per yard.

L2V 4 amp. Car Battery Charger, variable charge rate, in stove enamelled case, with meter, normally 85/-. Sale price 55/-, plus 4/6 post and ins.

250-0-250 60/80 mA. Mains Transformer, with 6.3 v. filament winding, half-shrouded dropthrough, standard replacement in many receivers, made to sell at 19/6. Sale price 12/6, plus 2/6 post and ins.

Ditto, but with additional 5 v. winding for separate rectifiers, made to sell at 21/-. Sale price 13/6, plus 2/6.

5ft. 80 w. fluorescent fitting, batten type, for hanging or direct fixing, stove enamelled white with inductive ballast, normally 49/6 (less tube). Sale price 35/-, plus 5/6.

Ditto, but 4ft. 40 w. Sale price 29/6 less tube, or 36/6 with tube, plus 5/6 post and in.

Ditto, but 3ft. 40 watt, normally 31/6. Sale price 28/6.

Pre-Amplifier made to Mullard circuit, suit Mullard 510 or most other amplifiers, normally £4. Sale price 65/-, plus 2/6 p. & i.

Band III Converter, our Estronic (Wireless World circuit) mains operated, normally 79/6. Sale price 59/6, plus 3/6 post & ins. Ditto, but less power supply, normally 49/6. Sale price 29/6, plus 3/6 post & ins.

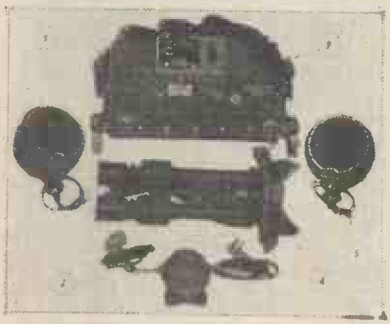
Unique Opportunity to build Fine Transistor Set

Constructor's parcel: to build Pocket 6 Transistor Set as currently being sold at £17/17/-. Parcel comprises motifed two-tone cabinet as illustrated, tuning dial, two gang tuning condenser, combined bakelite chassis/printed circuit and easy-to-follow circuit. Costing value 57/6—offered while supplies last at only 29/6, plus 2/6 post. Suitable for your own circuit or to build original circuit. All parts available at highly competitive prices. Do not miss the tremendous bargain.

EX-ROYAL NAVY SOUND-POWERED TELEPHONE

These require no batteries and will go for long periods without attention. Complete with generator and sounder which gives a high-pitched note easily heard above any other noise. Also fitted with an indicator lamp which in quiet situations can be used instead of the sounder, or, where several telephones are used together, will indicate which one is being called. Size 7¾ × 9 × 7¼in., wall mounting, designed for ships' use but equally suitable for home, office, warehouse, factory, garage, etc. Price 39/6 each, plus 4/6 carriage.

SUPER SENSITIVE (2,000 O.P.V.) MULTIMETER KIT
17 ranges including D.C. volts to 1,000 v. A.C. volts to 1,000 v. D.C. milliamps to 500 ohms to 2 meg. All the essential parts, including metal case, selected resistors, wire for shunts, selected switches, calibrated scale and instructions. 32/6, plus 2/6 post and insurance.



TABBY EQUIPMENT COMPLETE

Complete equipment for seeing in the dark, as fitted to Army vehicles for night driving, etc. Complete working equipment comprises: 2 Infra Red Radiators, adjustable binoculars, powerpack for 6 or 12 volts, control units and interconnection cables. Original cost probably around £100. Unused and in perfect order. £6/19/6 or 10/- deposit and 15 fortnightly payments of 10/-.

LAST FEW

American Receiver C646068

This is a 12 valve receiver originally designed for military operation on the 60-80 mc. band. One stage of R.F. and three stages of I.F. with additional stages for noise suppression and A.V.C. make this an extremely versatile receiver, also crystal in oscillator provides highest stability. On the front panel are all controls and moving coil input and output meters. Complete with its own power supplies, these, however, are intended to operate on American Voltage 115 v. So with each receiver we supply a step-down transformer. A limited quantity only of these offered at the extremely low price of £6/10/-. Plus 12/6 carriage and packing. Size approx. 26in. × 9in. × 17in. Note: These sets are unused but have been in store for some years and may therefore require servicing before being put into operation. At the low price charged we cannot test these nor do we give any guarantee. Complete with valves and one crystal. Circuit diagram and technical notes free with equipment or separately, price 2/6.

SUMMER SALE

Brayhead T.V. Turret Tuner, for 33/38 Mc/s. I.F., normally 79/6. Sale price 69/6, plus 3/6 post and ins.

Ditto, but for 16/19 Mc/s. I.F., normally 79/6. Sale price 69/6, plus 3/6 post & ins.

Infinite Baffle Corner Speaker, normally 45/-. Sale price 35/-, plus 3/6 post and ins.

Waterproof Heater element for pipe protection, electric blankets, etc., normally 9/6. Sale price 7/6, plus 2/- post and ins.

14in. T.V. Cabinet, modern design. Cost £4 to make. Sale price 9/6, plus 3/6 carriage.

Stick Microphone, Cosmocord 39/1, normally £3/3/-. Sale price 39/6.

Set of Four T.V. Parts, scan coils, line E.H.T. frame output and width control, normally 57/6. Sale price 39/6, plus 2/6.

200 Service Sheets, for modern T.V. sets, normally 40/-. Sale price 30/-.

12in. Hi-Fi Speaker, 12,000 lines, normally a bargain at 32/6. Sale price 29/6, plus 3/6 post and ins.

F.M. Tuner (Radio Constructor Circuit), normally £12/10/-. Sale price £6/19/6. Note: These are made up but may need attention. Plus 3/6 post and ins.

Ardente Hearing Aid, normally bargain at £7/10/-. Sale price £5/19/6, plus 3/6 post and ins.

Portable Receiver Cabinet, takes our Crispian chassis, cost 25/- to make. Sale price 12/6, plus 3/6, post and ins.

Windsor Cabinet and Chassis, comprises a veneered and polished cabinet, size 14 × 17 × 6¼in., and prepared metal chassis with glass dial to fit, normally £3/15/-. Sale price 29/6, plus 5/-.

Fluorescent Lighting kit of parts including choke, starter, 2 lamp holders, starter holder. 40 w., normally 22/6. Sale price 19/6, plus 2/6 p.; 80 w., normally 26/6. Sale price 22/6, plus 2/6 p.; 125 w., normally 39/6. Sale price 32/6, plus 2/6 p.; 6in. miniature, normally 22/6. Sale price 19/6, plus 2/6 p.; 9in. miniature, normally 22/7. Sale price 19/6, plus 2/6 p.; 12in. miniature, normally 22/6. Sale price 19/6, plus 2/6 p; 21in. miniature, normally 22/6. Sale price 19/6, plus 2/6 p.

Speakers P.M., by very good makers, 10in., normally 32/6. Sale price 27/6, 8in., normally 22/6. Sale price 18/6, 6½in., normally 19/6. Sale price 17/6, 5in., normally 19/6. Sale price 17/-. All plus 2/6 post and ins.

Output Transformer, multi-ratio, normally 10/6. Sale price 7/6, plus 1/- post and ins.

Output Transformer, fixed ratio for pentode, normally 6/6. Sale price 4/6, plus 1/-.

Valves, old types FC4-DD74, etc. Sale price half current list price.

14in. T.V. Mask, grey plastic, normally 10/-. Sale price 7/6, plus 1/6 post and ins.

17in. T.V. Mask, grey plastic, normally 12/-. Sale price 9/-, plus 1/6 post and ins.

Circular Fluorescent for 40 w. tube, with best quality inductor ballast, normally 52/6. Sale price 47/6.

Resistance Substitution Box, will give infinite variability over range 100 ohm to 2 Meg., normal price 8/6. Sale price 6/6, plus 2/- post.

Morganite Pots, standard size, single and 2-gang types available. Single types normally 1/- each. Sale price 9d. Ganged types normally 3/- each. Sale price 2/3.

Switching Outfit, 2-way, comprises 30 yd. multicore cable, two 2-way switches, two wood blocks, full instructions, normal price 9/6. Sale price 7/6, plus 2/6 post.

Crystal Microphone, miniature, suitable for all purposes, tape recorders, amplifiers, etc., normal price 4/9. Sale price 3/-.

Glass Panels, unbreakable, 10¾ × 9¼in., parcel of 5, normally 7/6. Sale price 5/6, carriage 3/6.

Box of 25, 3.5 v. Torch Bulbs, 2/6.

125 watt Choke for fluorescent tube, 22/-. Sperry Gyro, brand new, 15/-, plus 2/-.

If ordering by post, address your order to the Company nearest to you

Electronics (Manor Park) Ltd.
520, High Street North,
Manor Park, E.12.

Electronics (Ruislip) Ltd.
42-46, Windmill Hill,
Ruislip, Middx.
Phone: RUISLIP 5780.
Half day. Wednesday,

Electronics (Croydon) Ltd.
266, London Road,
Croydon.
Phone: CRO 6558.
Half day, Wednesday.

Electronics (Finsbury Park) Ltd.,
29, Stroud Green Rd.,
Finsbury Park, N.4.
Phone: ARChway 1049.
Half day, Thursday.

SAMSON'S SURPLUS STORES LTD.

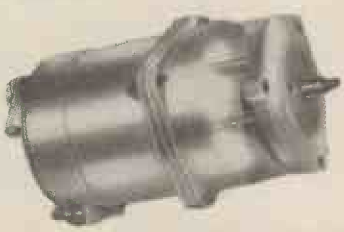
LONDON'S GREATEST DEALERS IN RADIO AND ELECTRONIC EQUIPMENT

HEAVY DUTY SLIDING RESISTORS. 26 Ω 6a., Double Tube Slider Control. 45/–. 73 Ω 1–3a. Completely enclosed. Single Tube Slider, 35/–. 120 Ω 1.75–0.9a. Completely Enclosed. Single Tube Slider Control, 30/–. 79 Ω 2.9–0.65a. Double Tube Geared Drive Control, 32/6. 1.25 Ω, 25a. Geared Drive Control, 27/6. 0.4 Ω 25a. Geared Drive Control, 17/6. 11 Ω 4.5a., 12/6. 3 Ω 10a., 12/6. 1.2 Ω 15a., 10/6. 1 Ω 12a., 8/6. All Single Tube Slider Control. 12 Ω 4a. Horizontal Sweep Control, 12/6. 0.4 Ω 24a. Tapped, 8/6. 5.3 Ω 8a. Fixed, 10/–. 605 Ω 2.8–0.45a. Fixed, 10/–. Carr. on all Resistors, 3/–.

AMERICAN OHMITE RHEOSTATS. 25 Ω 2a., 15/–. 15 Ω 2.25a., 15/–. 50 Ω 1.4a., 12/6. 15 Ω 1.3a., 12/6. 10 Ω 3.1a., 12/6. Twin Gang, 25 Ω 0.75a., each 7/6. 350 Ω 25 watt; 3/6. All Types Panel Mounting, ¼ inch dia. Spindles. Supplied Brand New. P.P. on all types 2/–.

AMERICAN CAPACITORS. 4 Mfd., 2,500v. wkg, 12/6. 8 Mfd. 1,500v. wkg., 12/6. 10 Mfd. 1,000 v. wkg., 10/6. 2 Mfd. 1,500 v. wkg., 6/6. 1 Mfd. 2,000v. wkg., 5/6. 0.1 Mfd. 7,500v. wkg., 8/6. 6 Mfd. 330 v. wkg. A.C., 10/6. All Capacitors Supplied Brand New.

BRITISH TYPES. 8 Mfd. 400v. wkg. at 71 deg. C., 5/6. Nitrogol, 8 Mfd., 750v. wkg. at 71 deg. C., 8/6. 8 Mfd. 250v. wkg. at 71 deg. C., 4/6. 4 Mfd., 800v. wkg. at 160 deg. F., 3/6. 0.5 Mfd. 2,000 v. wkg. at 60 deg. C., 3/–. P.P. on all condensers, 2/–.



B.T.H. AIRCRAFT STARTER MOTORS. Type C/W., 24 volt D.C. A very heavy duty high speed motor. Length 7¼in. dia. 4in. Length of spindle ¾in. 32/6. P.P. 3/6.

SPECIAL OFFER. H.D. TWO CIRCUIT TYPE AUTO WOUND TRANSFORMERS A.M. TYPE No. 2773. Input 225–230 v. with switch in run position. Output 225, 230, 235, 240, 245, 250, 255, 260, 270 volts, 75 amps. With either switch in start position. Output No. 1 or 2. 270 v., 290 v., 310 v., 100 amps. 1 minute in two hours. Other outputs as in run position but at 50 amps. The transformers are built in heavy metal cabinets approx. weight 3½ cwt. with sloping desk front on which the start/run switches and 2 0–100 M.I. ammeters are mounted. With an alteration of the exterior wiring 100 volts at 35 amps can be obtained. £25 ex warehouse.

IF FURTHER INFORMATION IS REQUIRED CIRCUIT WILL BE SENT ON DEPOSIT OF 10/–.

METRO-VICKERS MASTER VOLT METERS. 0–20 volts A.C., M.I. 6-inch round mirrored scale. 15/–. P.P. 3/6. Brand new in maker's carton.

We now have London's largest and most comprehensive walk-round dept. This enables you to see our enormous stocks of electronic and radio equipment too numerous to advertise. We invite you to browse without any obligation. Open all day Saturday. Official monthly account orders accepted.

WESTINGHOUSE L.T. SUPPLY UNITS. Type No. 139. A.C. input, 200-250 volts. D.C. output, 36 volts, 18 amps. Continuous Rating at 50 deg. C. Fitted with Input and Output Fuses and Mains On/Off Switch. Size of cabinet. 26 x 19 x 14 inches. £17/10/– *Ex Warehouse.*

AMERICAN NAVY SCANNERS TYPE APS4. Freq. 3 centimetres, operate on 12–24 volts. Contain geared motors, relay switch equipment, heavy gear trains, etc. Supplied new in original packing cases at a fraction of maker's price. £3/19/6. Carr. 10/–.

AMERICAN MINIATURE PANEL MOUNTING 5 OR 15 AMP. OVERLOAD SWITCHES. Size 2¼ x 2 x ¾ins., 4/6, P.P. 1/6. 18 amp., 2 Pole, Size 5 x 3 x 2ins., 10/6. P.P. 2/6. American Heavy Duty Double Pole, 250v. 60 Amp. Safety Switches. Completely enclosed, 29/6. P.P. 3/6.

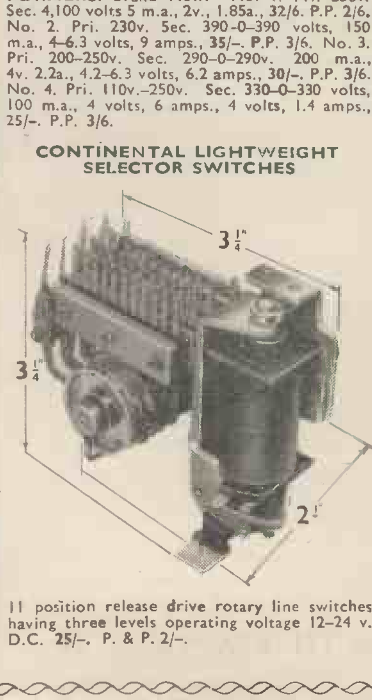
HEAVY DUTY L.T. TRANSFORMERS. All Ratings Tropical and in perfect condition. No. 1. Pri. 220–240v., Sec. tapped 42–45 volts. 50 amps., £9/15/–. Carr. 10/–. No. 2. Pri. 230v. Sec. tapped 4–6–11 volts., 200 amps., £8/10/–. Carr. 7/6. No. 3. Pri. 200–250v. Sec. 50v. 30 amps., £6/10/–. Carr. 7/6. No. 4. Pri. 200–240v. Sec. 50 volts, 20 amps., £4/10/–. Carr. 7/6. No. 5. Pri. 200–250v. Sec. tapped 28–29–30–31 volts. 21 amps., £4/17/6. Carr. 7/6. No. 6. Pri. 100-250v. Sec. Two Separate Windings., tapped 15–16–17 volts, 4 amps., 35/–. Carr. 4/–. No. 7 Pri. 220–240v. Sec. Three Separate Windings 6–15 volts, 50 amps, 6 V.C.T. 15 amps., 6 V.C.T., 2.5 amps., £4/19/6. Carr. 7/6. No. 8. Pri. 220–240v. Sec. 6.3 volts, 15 amps., 25/–. P.P. 3/6. No. 9. Pri. 220–240v. Sec. Four Separate Windings. 5v. C.T. 4 amps., 5 v. C.T., 4 amps., 5v. C.T., 4 amps., 4v. 4 amps., Potted Type, 32/6. P.P. 3/6. No. 10. Pri. 220–240v., Sec. Three Separate Windings, 6.3v. C.T., 4 amps., 6.3v. C.T., 4 amps., 6.3v. 4 amps. Potted Type, 29/6. P.P. 3/6. No. 11. Pri. 115–230v. Sec. 5 volts, 15 amps, 15 kv. Insulation, 37/6. Carr. 5/–. No. 12. Pri. 220–240v. Sec. 45 volts, 2 amps, 17/6. P.P. 3/6. No. 13 Pri. 220–240v. Sec. 6 volts, 7.7 amps, 15/–. P.P. 2/6. No. 14. Pri. 220–240. Sec. tapped 10–17–18 volts, 10 amps., 52/6. Carr. 4/–.

CARBON PILE VOLTAGE REGULATORS. LILIPUT MINOR MK. II.

Load 3/0.73 amps. 11 v. Supply voltage 19/25 v. With spare pile. Brand new. 12/6. P.P. 3/6.

SPECIAL OFFER OF WODEN TRANSFORMERS. Brand New. No. 1. Pri. 230v. Sec. 4,100 volts 5 m.a., 2v., 1.85a., 32/6. P.P. 2/6. No. 2. Pri. 230v. Sec. 390-0-390 volts, 150 m.a., 4–6.3 volts, 9 amps., 35/–. P.P. 3/6. No. 3. Pri. 200–250v. Sec. 290–0–290v. 200 m.a., 4v. 2.2a., 4.2–6.3 volts, 6.2 amps., 30/–. P.P. 3/6. No. 4. Pri. 110v.–250v. Sec. 330–0–330 volts, 100 m.a., 4 volts, 6 amps., 4 volts, 1.4 amps., 25/–. P.P. 3/6.

CONTINENTAL LIGHTWEIGHT SELECTOR SWITCHES



11 position release drive rotary line switches having three levels operating voltage 12–24 v. D.C. 25/–. P. & P. 2/–.

THE CHEAPEST CHARGER ON THE MARKET THAT GIVES THESE SPECIFICATIONS

S.T.C. BATTERY CHARGER TYPE ZB 10234

A.C. input 100-260 volts, 45-65 c/s. D.C. output 24 volts 10 amps. at max. ambient temperature of 131°F. but guaranteed max output of 20 amps. All components are rated by manufacturers at this current. The charger is fitted with 20 amp. fuses on the D.C. output, 10 amp. fuses on the A.C. input. 2½in. 0-20 M.C. D.C. ammeter. On/off full charge/trickle charge switch. Heavy duty output terminals and mains neon indicator lamp. Behind control panel are mounted full charge ballast and trickle charge resistances.

These units are designed to charge all 24 volt lead-acid battery combinations. That is two 12 volt or four 6 volt batteries in series at a 20 amp. max. rate. Can also be used for trickle charging 24 volt batteries at 125, 350 and 700 m.a.; are ideal for the electronic industry, research laboratories, schools etc., as a general purpose L.T. supply unit.

Supplied brand new at a fraction of maker's price.

Size: 2ft. x 1ft. 3½in. x 2ft. 8in. Weight: 141lbs. **£22-10-0** Ex warehouse.

We proudly state this is the finest ex-Govt. purchase on the market today. If further technical details are required, Instruction Book will be forwarded against a deposit of £1/10/-. Export enquiries are welcomed. We have a limited number of these units ready packed in original transit cases at a small extra charge.

SPECIAL OFFER OF BRAND NEW FIELD TELEPHONE CABLE AT A FRACTION OF MAKER'S PRICE. D.8 TWIN COILED ON HEAVY WOOD DRUMS £7/10/- EX. WAREHOUSE. D.3 SINGLE, ONE MILE DRUMS 85/-. Carr. 7/6. COMMANDO ASSAULT TELEPHONE WIRE P.V.C., 1,000 YARD DRUMS, VERY USEFUL IN THE HOME AND GARDEN, CHEAPER THAN STRING 8/11. P.P. 3/6. FIVE DRUMS IN MAKER'S CARTON. 42/6. CARR. 7/6.

S.T.C. FIELD TELEPHONES TYPE YA.7783. A self contained unit easily held in one hand. Size 9¼ x 2¼ x 2¼in. Buzzer calling complete with 4½ volt flat battery. Ideal for aerial riggers, building sites, farms, workshops and offices. Brand new at a fraction of maker's price, £5/19/6 per pair.

AMERICAN AIRCRAFT ACTUATOR UNITS. Type ML/PM. Motor voltage 12-24 volts D.C. reversible. Four inch thrust 47/6, carr. 5/-. Brand new.

SPECIAL OFFER OF HENLEY EQUIPMENT. Wire rubber-covered braided with cotton, in various colours, 40/0076 50 yd. coils 6/-. P.P. 2/-. 23/0076 100 yard coils 10/6. P.P. 2/6. 110/0076 50 yard coils 8/6. P.P. 2/6. Ericsson equipment wire 1/.020, single 220 yard coils 8/6. P.P. 2/-. Screen equipment wire, single 40/0076 100 yard coils 27/6. P.P. 2/6. Rubber-covered equipment wire, 23/0076 100 yard coils 8/6. P.P. 2/-. Henley three-core flat P.V.C. 23/0076. Cores coloured, Red, Green and Black. 9d. per yard. Min. Qty. 12 yards. P.P. 2/-.

A.M. ALKALINE CELLS. 1.2 volts 75 A.H. Heavy duty suitable for engine starting. Brand new 35/-. P.P. 3/6. Miniature A.M. alkaline cells 1.4 volt 3 A.H. Size 3⅜in. x 2⅜in. x ⅞in., 4/6. P.P. 1/6. Pritchet and Gold 2 volt 75 A.H. 100 hr. rate accumulators, brand new. With carrying handle, 15/-. P.P. 3/6. Admiralty 24 volt 3 A.H. batteries. Banks of cells built into strong wood crates with charging instructions. Brand new 22/6. Carr. 5/-.

Single cells 2 volt 3 A.H. Size 4½ x 1¾ x 1¼in., 2/6. P.P. 1/6. Heavy duty bell batteries 1½ volts.

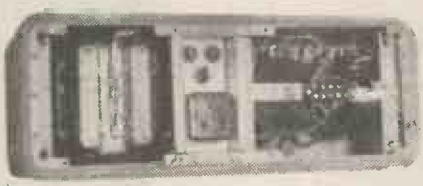
VENNOR EIGHT DAY CLOCKWORK TIME SWITCHES in perfect condition. One make and one break every 24 hours. Complete with two pin socket and key 1 amp. switch contacts 27/6. 5 amp. 32/6. P.P. 1/6.

AMERICAN 110 VOLT GEARED MOTOR. R.p.m. 95.8, torque 5.4 lbs. per S.I. Cap start, cont. duty, 52/6. P.P. 3/6. Step down 110-230 v. Transformer. Suitable for above motors 17/6. P.P. 2/6.

HEAVY DUTY A.C. 200-250 VOLT ALARM BELLS. Twin six inch gongs. Ideal for burglar alarm circuits, factory and outside warning. Brand new in maker's cartons 35/-. Carr. 4/-. Suitable heavy duty press switches for above bells 3/6.

Small oddments always needed in the workshop. 2.4 6 BA. nuts. bolts, washers and tags. Special bargain offer 5/- carton. P.P. 1/-.

4BA. ⅞in. CS steel, 15 gross cartons 27/6. P.P. 3/- or 2/6 per gross. P.P. 9d. 4 BA. ⅜in. CS steel. 20 gross cartons, 32/6. P.P. 3/6 or 2/6 per gross. P.P. 9d.



L.T. SUPPLY UNIT No. 19 YA 8087. A.C. input 100-250 v. D.C. output tapped 12/24 volts, continuous tropical rating, 3 amps. Built-in metal case 17 x 7 x 6½in., with fuses and switch. An ideal L.T. supply unit for operating relays, contactors, battery charging, etc. In perfect condition £3/17/6. Carr. 7/6.

SPECIAL OFFER PERIFLEX SLEEVING. 3 mm. one gross yard coils. Yellow, Blue or Black, 10/-. P.P. 1/6. Mixed bundle of sleeving 1-4 mm. various colours, 2/6. P.P. 1/-. Carbon resistors ½-3 watt carton of 100. Good selection of valves 10/- per carton. P.P. 1/-.

SMOOTHING UNIT No. 2 FOR ABOVE. Containing two L.T. chokes, one 2½in. M.C. D.C. 0-50 voltmeter and 6-way terminal block built in metal case. Size 17 x 7 x 6½in. 35/-. Carr. 7/6.

ADMIRALTY THREE-PHASE TRANSFORMERS. Pri. 400-440 v. 50 cycles. Sec. 50 v. 6 amp. Completely tropicalised. Size 7½ x 14 x 5in. Weight approx. 60lb. 85/-. Carr. 7/6. Brand new in maker's cases.

OIL FILLED HEAVY DUTY L.T. TRANSFORMER. Pri. 420 v., 400 v., 380 v. Single phase. Sec. 19 v. 150 amps. Weight 141lbs. Supplied dry £10. Carr. 15/-.

WHEATSTONEBRIDGE. Housed in wood cabinet size 16 x 7½ x 6in., with four stud switch controls and centre zero 2.5 ma. F.S.D. galvanometer in perfection condition, 37/6. Carr. 5/-.

CARBON BRUSHES. Assorted cartons containing over 200 brushes. 17 sizes and 100 springs, 3 sizes. Sealed cartons 19/6. P.P. 2/-.

AM L.T. CHOKES. Resistance 6.5 ohm. Ideal for smoothing 12-24 volts D.C. 5 amps. tropical 15/-. Carr. 4/-.

ADMIRALTY MIRROR INTEGRATORS. A very fine Galvo. movement. Coil 40 ohms. Centre zero to F.S.D. 1 micro. amp. Every instrument guaranteed, 59/6. Carr. 5/-.

JUST ARRIVED. BRAND NEW. AMERICAN RETRACTABLE LANDING LIGHTS 8in. reflector. 250 watts lamp and motor voltage 12 volts. Ideal for flood lighting, etc., 47/6. Carr. 5/-. 24 volt type 37/6. Carr. 5/-.

One only A.M. double wound 15 KVA 230-115 v. transformer. New, £27/10/-, ex. warehouse.

Do you need metal or wood transit cases for storing instruments. Films, tape, tools etc. We have London's largest selection. Prices ranging from 2/- to 30/-.

SMITHS 1-15 MINUTES TIME SWITCHES 2 pole 15 amp. switch contacts 15/-. P.P. 2/-.

A.C. 200-250 v. 50 CYCLE CHECK METERS. Reconditioned and guaranteed, 10 amp. 19/6, 20 amp. 22/6. Carr. 4/-.

HEAVY DUTY A.M. AIR BLOWERS. A.C. 200-240 v. Large selection available. Let us know your requirements.

169-171 EDGWARE RD., LONDON, W.2. Telephone PAD 7851, AMB 5125

COMMUNICATIONS RECEIVER B28 (MARCONI CR100)

PRICE — ONLY £21

Later Model with Noise Suppressor £25

Carriage England and Wales 30/-. *Send S.A.E. for further details.*

CR100 SPARES KITS

Contents: 15 valves, 2 or U50, DH63, KT63, X66, and seven KTW61. Output transformer, Resistors, Condensers, Potentiometers, PK screws, pilot lamps, drive cord, etc., etc. ALL BRAND NEW. 59/6. Post 4/6.

COMMUNICATIONS RECEIVERS R-1155B

A first class 10 valve Communication and D/F receiver, covering 75 Kc/s. to 18 Mc/s. (16.2-4,000 m.) in 5 bands. The large scale and superior dual ratio slow-motion drive make tuning easy, and the R.F. stage and 2 I.F. stages ensure world-wide reception. ALL the receivers we sell have been thoroughly overhauled and completely re-aligned, and are in first class order. ONLY £7/19/6.

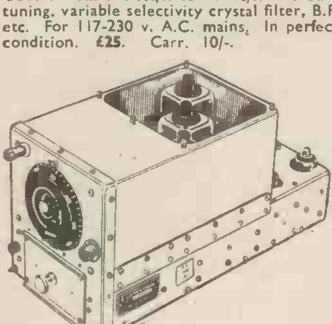
ALSO available, R-1155-N as above, but has 1.5 to 3 Mc/s. (100-200 m.) in place of the 75-200 Kc/s. band. ONLY £12/19/6.

A.C. MAINS POWER PACK OUTPUT STAGE

In handsome black-crackled steel cabinet to match the R-1155. Fitted with 8in. speaker. Just PLUG IN and switch on! Only the finest quality components are used, and we guarantee OUR power packs for 6 months. ONLY £6/10/-. Deduct 10/- when purchasing receiver and power unit together. Send S.A.E. for further details, or 1/3 for 14 page illustrated booklet giving technical data and circuits etc. (FREE with each receiver). Add 10/6 carriage for receiver, 5/- for power unit.

HALLICRAFTER SX-24 RECEIVERS

Covers from 540 Kc/s. to 44 Mc/s. in 5 bands. With separate bandspread tuning, variable selectivity crystal filter, B.F.O., "S" meter, noise limiter etc. For 117-230 v. A.C. mains. In perfect working order and first class condition. £25. Carr. 10/-.



Q5'er (BC-453)

This Command Receiver covers 190-550 Kc/s.-(I.F. 85 Kc/s.) and is ideal for double superhet conversion etc. Supplied BRAND NEW in original cartons, with all 6 valves and CIRCUIT. 89/6. Post 3/6.

MARCONI VALVE VOLTMETERS

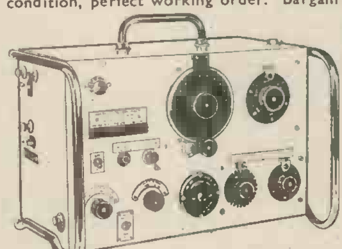
Ranges: 0 to 1.5, 5, 15, 50, and 150 volts. Fitted with probe unit for RF measurements. A.C. mains operation. In good condition and working order. A laboratory instrument for ONLY £8/19/6. Carr. 7/6.

Best Buy at Britain's

CRYSTAL CALIBRATOR

No. 10. Consists of 500 Kc/s. crystal oscillator and a variable 250-500 Kc/s heterodyne oscillator. This enables all intermediate frequencies between 500 Kc/s. and 10 Mc/s. to be produced. These frequencies are indicated on the calibrated scale. The calibrator may actually be used up to 30 Mc/s. The unit uses a CV-286 neon modulator, 1T4 crystal osc., 1T4 het. osc., and 1R5 mixer. Operates from 300 v. 15 m/a., and 12 v. 0.3 A., but can be easily modified for 120 v. and 1.4 v. working. Size 7×7½×4in. In first class condition, complete with valves, crystal, instruction manual and circuit. One of our "best buys" at ONLY 59/6. Post 3/6.

FERRANTI TESTMETER TYPE Q. An extremely compact self-contained multimeter. Volts 0 to 30, 150, 600 A.C./D.C., with additional 0-3 v. D.C. and 0-15 v. A.C. ranges: Milliamps 0 to 7.5, 30, 150 and 750 D.C.; ohms 0-25 K. Accuracy BSS first grade. 500 ohms per volt. Knife-edge pointer and clearly calibrated 2½in. scale. Complete with leads, prods, battery, and instructions in fitted velvet-lined 4 × 7 × 3in. case. Brand new condition, perfect working order. Bargain price. ONLY 59/6. Post 2/6.



ADMIRALTY G-73 SIGNAL GENERATOR/WAVEMETERS

Combines the facilities of a well made signal generator with those of a crystal checked heterodyne wavemeter. Generates 100 Kc/s. to 25 Mc/s. in 6 ranges (CW or 400 c/s. mod.), or operates as wavemeter over same ranges. Carrier or modulation level may be monitored on 500 microamp plug-in meter (not supplied). Has built-in 1 Mc/s. crystal oscillator for self checking calibration, coarse and fine attenuators. 400 c/s. output available separately. Operates from 100-230 v. A.C. mains. Size 15 × 10 × 8in. Supplied complete with valves, crystal, and list of crystal check points and instructions for drawing of individual graphs. Condition used but O.K. 79/6. Carr. 10/6

RCP 20 RANGE TESTMETERS

1,000 ohms per volt, 400 microamp basic movement.

D.C. VOLTS	A.C. VOLTS
2.5 v.	2.5 v.
10 v.	10 v.
50 v.	50 v.
250 v.	250 v.
1,000 v.	1,000 v.
5,000 v.	5,000 v.
D.C. CURRENT	RESIST'CE
1 ma.	500 ohms
10 ma.	100k. ohms
100 ma.	1 megohm
1 amp.	DECIBELS
	−10 to +69

In light oak case 6¼×6×4½in., including lid. Complete with test leads and prods, internal battery, and instructions manual. ALL BRAND NEW and tested. Post 3/-.

LIMITED NUMBER 79/6.

VOLTAGE REGULATOR TRANSFORMERS. Input 230 v. A.C., output variable from 187-250 v., OR input 187-250 v., output 230 v. at 24 amps. Rating 5.5 KVA. Wt. 42 lb. Brand new condition. £9/19/6. Carr. 10/6.

MINIATURE RELAYS (ALL BRAND NEW AND BOXED).

G.E.C. sealed, wire ends, 670 ohms.	2 H/D makes, M1099	15/–
G.E.C. sealed, wire ends. 670 ohms.	4 C/overs, platinum, M1092	19/6
G.E.C. sealed, wire ends. 5000 ohms	2 C/overs, platinum, M1052...	17/6
S.T.C. size 1½×⅞×⅞in. 250 ohms.	2 C/overs, double contacts ...	7/6
Siemens High Speed, 1K + 1K ohms.	1 C/over	10/6

FURZEHILL BEAT FREQUENCY OSCILLATOR No. 5.

Push-pull output 0-10,000 c/s. of 0-5 v. at 10 ohms, or 0-50 v. at 600 ohms, monitored by 2½in. M/C meter. Incorporates set-zero control and 50 c/s. check. Operates from 100-250 v. 50 c/s. mains. In handsome instrument case, 17½ × 9×11in. Despatched in transit case, in perfect condition, tested, complete with 7 valves, circuit and instructions. A laboratory instrument for ONLY £12/10/-. Carr. 10/-.

SEE ADVERTISEMENT OPPOSITE →

SELENIUM BRIDGE RECTIFIERS. Funnel cooled. A.C. input 45 v. RMS. D.C. output 30 v. 10 amps. BRAND NEW. Boxed. 45/-. Post 3/6.

HEAVY DUTY L.T. TRANSFORMERS. (Gresham.) Latest type potted, oil filled, Pri. 230 v. 50 c/s. Sec. 0-70-75-80 v. 4 amps. Size 5¼ × 4½ × 6½in. high. Wt. 19 lb. BRAND NEW. 42/6, carr. 5/-.

DUAL PURPOSE TRANSFORMERS (Gresham). Pri. 230/250 v. Secs. 240-0-240 v. 1.5 amps., 5 v. 12.5 amps. 5 v. 1.75 amps. Ideal for ISOLATING TRANSFORMER, to obtain TWO 240 v. 360 watt lines. Potted, oil-filled, 7 × 7½ × 10½in. high. Wt. 50 lb. **BRAND NEW.** £3/10/-. Carr. 10/-.

MAINS ISOLATING TRANSFORMERS (Vortexion). Fully-shrouded. For testing A.C./D.C. sets in safety. 230 v. input. Output 230 v. 100 watts, 22/6. Post 2/6.

ADMIRALTY HT TRANSFORMERS Pri. 230 v. 50 c/s. Secs. 620-550-375-0-375-550-620 v. (620 and 550 v. 200 m/amps., 375 v. 250 m/amps.), plus two 5 v. 3 Amp. rectifier windings. Total rating 278 VA. Upright mtg. Wt. 25 lb. Made 1953. **BRAND NEW.** Original boxes. 45/-. Carr. 5/-.

INSTRUMENT TRANSFORMERS. 230 v. A.C. input. Outputs 0-65-130-195 v. 85 m/amps., 6.3 v. 5 amps., 6.3 v. 0.3 amps. Shrouded. Size 3¼ × 3¾ × 3¾in. high. 15/- post FREE.

AR88D MAINS TRANSFORMERS. Input 110-240 v. Output 345-0-345 v. 125 m/amps., 6.4 v., 4.5 amps., 5 v. 2 amps. 4¾ × 4½ × 5½in. high. Wt. 12 lb. Potted. Tag ends. RCA BRAND NEW. Boxed. 29/6, post 3/6.

TRANSFORMER BARGAIN. Input 0-200/250 tapped. Outputs 250-0-250 v. 80 m/amps., 5 v. 2 amps.; 6.3 v. 4.5 amps. Upright mtg. BRAND NEW. Boxed. Ex-Admiralty made 1952. A fine 50 c/s. mains tranny for ONLY 16/6, post FREE.

MODULATION TRANSFORMERS. Collins type 20 watts 807 to 807, 8/6 each. Post 1/6.
FERRANTI TYPE, for T × 36 etc., push-pull 807's to plate and screen modulate push-pull 807's, ratio 2:1. Fully shrouded. Wt. 6½ lb 17/6. Post 2/6.

ADVANCE CONSTANT VOLTAGE TRANSFORMERS. Input 190-260 v. 50 c/s. A.C. mains. Output 230 v, 250 watts. 10 Gns. Carr. 7/6.

STANDARD TRANSFORMERS. Vacuum impregnated, interleaved, E.S. screen, universal mounting. Size 4 × 3½ × 2½in. ALL BRAND NEW. 18/6 each. Post 1/6.

Type 1. 250-0-250 v. 80 m/a., 6.3 v. 3 A., tapped at 4 v. 4 A., 6.3 v 1 A tapped at 4 v. and 5 v. 2 A.

Type 2. As above, but 350-0-350 v. 80 m/a.

Type 3. 30 v. 2 A., tapped at 12, 15, 20 and 24 v., to give 3-4-5-6-8-9-10 v., etc. Type 5. 0-5-11-17 v. 4 A Ideal for chargers.

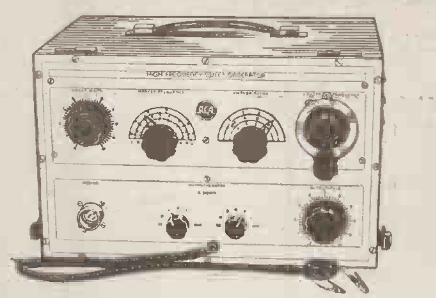
MORE METER BARGAINS

RANGE	TYPE	SIZE		PRICE
25 Microamp.	D.C. M/C	2½in.	Flush Circ. Scale " Rontgens "	69 6
25 Microamp.	D.C. M/C	2½in.	Proj. Circ. Scale " Rontgens "	59 6
50 Microamp.	D.C. M/C	3½in.	Flush Circ. Scale " Tolerance "	79/6
50 Microamp.	D.C. M/C	2½in.	Flush Circ. scaled 0-100	59/6
100 Microamp.	D.C. M/C	3½in.	Flush Circ. Scale 0-50/0-1,000 v.	62 6
100 Microamp.	D.C. M/C	2½in.	Flush Circular scaled " Megs "	42 6
1 Milliamp.	D.C. M/C	3½in.	Flush Circular	50/-
1 Milliamp.	D.C. M/C	3½in.	Flush Squ. Scaled 0-250 v.	69 6
200 Milliamp.	D.C. M/C	2½in.	Flush Circular	10 6
1 Amp. Thermocouple		2½in.	Projecting Circular	6 9
300 Volts	A.C. M/I	6in.	Flush Circular. Made 1955	79/6
300 Volts	A.C. M/I	2½in.	Flush Circular	25/-
500 Volts	A.C. M/I	2½in.	Flush Circular	25/-
40 Amperes	D.C. M/C	2in.	Flush Circular	7/6

METAL RECTIFIERS. Full wave bridge. BRAND NEW. Salford 1 mA. 8/6, 5 mA. 8/6. STC 2 mA. 5/6.

MINIATURE 373 IF STRIPS. For FM tuner described in "Practical Wireless." Complete with 3 of EF91, 2 of EF92 and 1 of EB91. A fresh release enables us to offer these once again. BRAND NEW. Complete reprint of conversion instructions and circuit supplied free. 35/- OR less valves, 12/6. Post. either 2/6.

RCA HF SWEEP GENERATORS

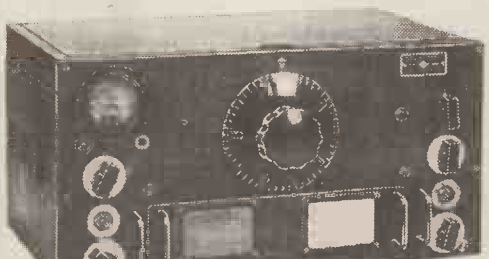


Laboratory type equipment designed for alignment of wide band RF and IF amplifiers. Comprises generator and regulated power supply unit, each housed in grey crackled steel case 17 × 10 × 12in.
Centre Frequency 5-65 Mc/s. Sweep width 0.2-20 Mc/s.
Marker oscillator frequency 5-70 Mc/s. Operates from 105-125/210-230 v. A.C. Mains. Complete with 13 valves and Technical handbook. BRAND NEW condition. £39/10/-. Carr. 10/-.

MEGGERS

E. & V. Series 2 Meggers. 500 volts, 0-100 Megohms. In leather case: First-class condition. ONLY £12/10/-.
E. & V. BONDING TESTERS. 0-5 ohms at 12 m/amps. max. Hand generator type. In leather case. 79/6.
INSULATION TESTERS. "Record" hand generator type. 0-50 Megohms at 500 volts pressure Complete in leather case. £7/19/6. Post 4/-.

HRO SENIOR RECEIVERS



Complete with ALL NINE general coverage plug-in coilsets for 50 Kc/s. to 30 Mc/s. Instruction booklet, and circuit, but less external power supply unit. Table models, as new condition. 21 GNS. Rack mounting, 18 GNS. Packing and carriage 22/- extra. Send S.A.E. for further details.
HRO POWER PACKS. 115/230 v. A.C. mains input. Tested, and in good condition, 69/6. Post 4/-.
AR-88. D AND LF. SUPERB CONDITION. NOW IN STOCK.

R.F. UNITS

RF24.	20-30 Mc/s.	5 switched positions	12/6
RF26.	50-65 Mc/s	Super slow-motion drive	17/6
RF27.	65-80 Mc/s.	Super slow-motion drive	22/6

Unboxed, but as new condition. Postage 3/6 each.

CHARLES BRITAIN (Radio) LTD.

11 UPPER SAINT MARTIN'S LANE LONDON, W.C.2 *TEMple Bar 0545*

One Minute from Leicester Sq. Station (Up Cranbourne St.)
Shop Hours: 9-6 p.m. (9-1 p.m. Thursday.) Open all day Saturday

SANGAMO-WESTON VOLTMETERS S61. Dual range 0-5 and 0-100 v. D.C. FSD 1 m/A. 3in. scale. Recent manufacture. Ideal for schools. Complete in super quality canvas carrying case, with test prods and leads. **BRAND NEW.** Boxed 27/6. Post 2/6.

SANGAMO-WESTON ANALYSER E772. A useful multi-range meter in rexine covered carrying case. Thoroughly overhauled and in perfect working order. For full details see previous adverts. £7/19/6. Carr 4/6.

AVO LC & R BRIDGES. Capacity 5 pFd to 50 mFd. Resistance 5 ohms to 50 megohms. Inductance can be measured against external standard. Balance is indicated on a meter, which can be used as a valve voltmeter from 0.1 to 15 v. Leakage test and Power Factor scale. For use on A.C. mains. Tested and guaranteed. £8/10/-. Post 3/6.

HICKOCK 1-177 VALVE TESTERS. Checks dynamic mutual conductance, shorts, emission, gas, and noise. For UX4, UX5, UX6, UX7, Octal, Loctal, B7G, and Acorn types. Portable, in wooden carrying case 15¼ × 8 × 5½in. Wt. 13½ lb. BRAND NEW. Complete with instruction book and valve testing charts. For 117 v. A.C. 10 gns. Carr. 7/6. Matching auto. transformer for 230 v. A.C. 12/6.

MARCONI TF987/1 NOISE GENERATORS. Range 100 Kc/s to 200 Mc/s. Determines noise factor of AM and FM receivers. Fully stabilised H.T. supply. A.C. mains operation. Brand new and in original boxes. £25.

MARCONI SIGNAL GENERATORS. 85 Kc/s. to 25 Mc/s. A.C. mains operation. In fair condition and working order. TF144F. £40. TF144G. £50.

MARCONI TF.340 OUTPUT METERS Perfect working order. £19/10/-.

SCR522 TRANSMITTER/RECEIVERS. 100-150 Mc/s. Comprises BC624A rec., and BC625 trans. All complete with valves, and in first-class condition. BC624A, less relay, 19/6. With relay, BC625. These two, 29/6.

MOVING COIL PHONES. Finest quality Canadian, with chamois ear-muffs and leather-covered headband. With lead and jack plug. Noise excluding and supremely comfortable. 19/6. Post 2/6.

INVICTA LOUDSPEAKERS. Good quality 10in. unit (impedance 3 ohms.) In wooden cabinet 17 × 17 × 6in. Complete with 50ft. lead and jack plug. BRAND NEW. 39/6. Carr. 5/6.

VITAVOX PRESSURE UNITS TYPE N. 20 watts. P.M. Heavy duty. BRAND NEW, boxed. 89/6. Carr. 5/6.

RESISTORS
Morgan "T" (½ watt) and "R" (1 watt). Latest types, all BRAND NEW 100 assorted. 10/-. Post 1/-.
HEAVY DUTY SLIDER RESISTORS. 1.25 ohm 20 amp., 12/6, post 3/6. 1 ohm 12 amp., 8/6, post 2/-.
PRECISION RESISTORS. 1 legohm 1% 1 watt wire wound. Ex-U.S.A BRAND NEW. 10/6 per dozen.

DC/A.C. CONVERTERS. Input 12 v. D.C. Output 230 v. 50 c/s. A.C. at 135 watts. Fitted with 0-300 v. A.C. 2½in. meter and slider resistor for voltage adjustment. In stout wooden carrying case with lid. Perfect working order £9/19/6. Carr. 10/6.
24 v. Input 230 v. A.C. 50 c/s 100 watts output. In grey metal case. BRAND NEW. 92/6. Carr. 7/6.

RADIATION METERS. Portable dose-rate meter, containing modern type rectangular 50 microAmp meter, CVX494 electrometer valve, etc. BRAND NEW. In canvas carrying case. £3/19/6. Post 2/6.
For details of other equipment, see our previous adverts.

C.W. SMITH & CO (RADIO) LIMITED

Phone: GERRARD 8204/9155
Cables: SMITHEX LESQUARE
3-34 LISLE STREET, LONDON, W.C.2

PARMEKO TABLE TOP TRANSFORMERS
Input 230 v. 50 c/s. Output 620/550/375/0/375/550/620 volts 250 mA. Also 2-5 v. 3 amp. windings Size 6¾ x 6¼ x 5½in. Brand new only, 45/- each. P/P 5/-.

AMERICAN 1,000 O.P.V. MULTI-RANGE TESTMETERS

400 microamp basic mov. Seven A.C./D.C. volt ranges 0 to 5,000v. D.C. current 1 mA, 10 mA, 100 mA, 1 amp. Res. 100 ohms, 100 K ohms and 1 meg. Decibels. Supplied brand new with test prods, batteries and instructions. £3/19/6 each. P/P 2/6.

COSSOR DOUBLE BEAM OSCILLO-SCOPES

Type 339. 10-position time base, 6 cps. to 250,000 cps. Amplifier 10 cps. to 2 mill. cps. Reconditioned, perfect working order. Complete with handbook. £27/10/- each. Carriage £1.

BENDIX BC-453 COMMAND RECEIVERS "Q" FIVER

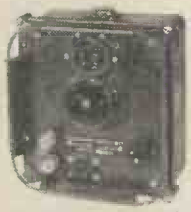
Coverage 190 to 550 kc/s. Complete with 6 valves, 3-12SK7, 12K8, 12SR7, 12A6. 85 kc/s I.F.T. Supplied brand new and boxed, 89/6 each. P/P 2/6.

ROTARY CONVERTERS

12 v. D.C. input. 230 volt A.C. 150 watts 50 cycles output. Housed in wooden case and fitted with voltage control slider resistance switch, plugs and A.C. mains voltage output check meter. Supplied in perfect condition, individually tested £9/19/6 each. P/P 10/-.

MINE DETECTORS No. 4A
Complete equipment comprises search head, amplifier, headset, control box, telescopic rods for search head, test unit, test measure and haversack. Operation from Std. 67½/1.5 v. battery. Will detect ferrous or non-ferrous metals. Very portable and sensitive. Supplied brand new in original transit cases with circuit and instructions. 99/6 each. Carr. 10/6.

CRYSTAL CALIBRATORS No. 10



An extremely useful instrument providing the following facilities: 1, Xtal controlled osc. giving fixed frequency signals of 500 kc/s and harmonics to 30 Mc/s; 2, An additional switched oscillator (250-500 kc/s) enabling all intermediate frequencies from 500 kc/s to 10 Mc/s to be produced. Compact size, 7 x 7½ x 4in. Utilises 2-IT4, IR5 and CV286 valves and 500 kc/s Xtal. Supplied brand new with instructional handbook. 59/6 each. P/P 2/6.

DON Mk. 5 FIELD TELEPHONES

Ideal for all inter-communication. Buzzer calling. Supplied fully tested, complete with batteries and instructions.
39/6 each. P/P 3/6 ea., 5/- pr.

VORTEXION PORTABLE AMPLIFIERS

Operation from 200/250 volts A.C. or 12 volts D.C. Separate inputs for microphone or gram. Output matched to 7.5, 15, 250 or 500 ohms. Incorporates volume control and full switched tone control. Valve line-up: 6Q7, 6J5, 6V6, 6V6, 5Z4. Size 8½ x 6¼ x 17½in., not brand new but supplied in perfect working order, fully tested. £10/10/- each. P/P 6/-.

PORTABLE PRECISION VOLTMETERS

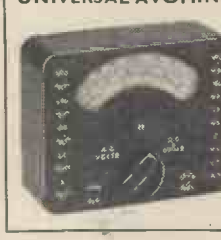
Brand new instruments by famous manufacturer. In polished teak case. Moving iron instrument reading A.C. or D.C. volts on 2 ranges 0-160 v. or 0-320 v., 8in. mirror scale. Accuracy within 2%. £5/19/6 ea. P/P 3/6.

MAINS ISOLATION TRANSFORMERS. 230 v. input, 230 v. output, 5 amp capacity. Housed in ventilated metal case, £5 each P/P 10/-

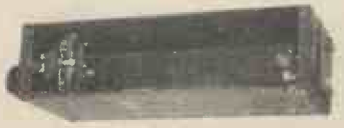
750 watt AUTO TRANSFORMERS. Tapped from 110 to 230 v. Fine heavy duty type, 69/6 ea. P/P 5/-.

A.C MAINS VOLTAGE REGULATOR TRANSFORMERS. Input 230 v. Output var. 185 to 250 v. 24 amps or 185 to 250 v. input, 230 v. output 24 amps, £12/10/-. P/P 10/-.

UNIVERSAL AVOMINOR TESTMETER

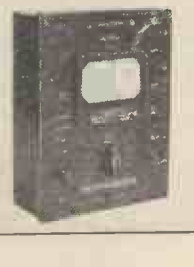


A.C./D.C. volt ranges to 500 v. Current 0 to 500 mA. Resistance 0 to 20K ohms. Supplied in perfect working order complete with batteries, leads and leather carrying case. £3/19/6 each. P/P 2/6.



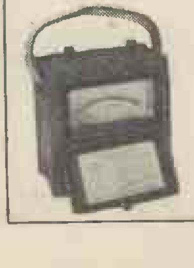
TINSLEY PHOTO VOLTAGE AMPLIFIERS
These special instruments incorporate a 1 microamp mirror galvonometer and a double selenium photo-electric cell. Housed in aluminium case complete with 12 v. lamp and housing. Brand new £15 each. P/P 7/6.

WESTON 772 TESTMETERS. Supplied in perfect working order, with leads and batteries, £7/19/6 each. Few less wooden carrying case, £7/10/- each. P/P 3/6.



A.C. volts: 2.5 v., 10 v., 50 v., 250 v., 1,000 v. D.C. volts: 2.5 v., 10 v., 50 v., 250 v., 1,000 v. D.C. current: 100 micro/A, 1 mA, 10 mA, 50 mA, 100 mA, 500 mA. Output Meter A.C. Current: 500 mA, 1 amp, 5 amp. Resistance: 100 ohms, 1,000 ohms, 100 k. ohms, 10 megohm.

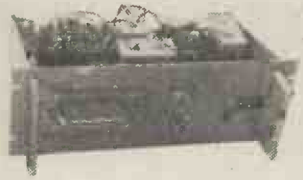
8-RANGE SUB-STANDARD D.C. AMMETERS



Ranges 1.5, 3, 7.5, 15, 30, 60, 300 and 450 amps. 6in. mirror scale. Meter housed in polished teak case. Supplied complete with all shunts and leather carrying case. £15 each. P/P 7/6.

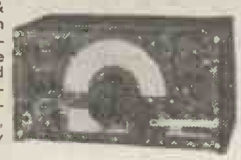
RCA PADDED MOVING COIL HEADPHONES.

Brand new boxed. Finest tonal quality, low impedance. Fitted with std. jack plug. **19/6** per pr. P/P 1/6.



ADMIRALTY POWER UNITS 234A. 200/250 volt A.C. Input. Output 250 volts 15 mA. and 6.3 volts 6 amps. Fully smoothed double choke and paper condensers, fused and fitted with input and output plugs. Sockets are provided on the front panel for meter check. Housed in grey metal case for standard 19in. rack mounting. Supplied brand new. **59/6** each. P/P 7/6.

R.1155 COMMUNICATIONS RECEIVERS. MODELS L & N. Both models incorporating the trawler and top band. Supplied in perfect condition, realigned, fully tested.



£12/19/6 each. STANDARD MODEL B. Fitted with improved N type drive, perfect order re-aligned, etc., **£7/19/6** each. Carriage 7/6 both types. COMBINED POWER PACK AND OUTPUT STAGE, to suit either models, **85/-** extra. Illustrated instruction book with all receivers.

RCA PLATE TRANSFORMERS.

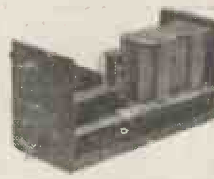
Input 200/250 volts. Output 2,000/0/2,000 volts 500 mA. tapped 1,500/0/1,500 volts. Supplied brand new boxed, **£6/10/-** each. carriage 10/-.

CR.100 SPARES KITS. 15 valves, resistors, pots, o/p trans. condensers, all new boxed, **59/6** per set. P/P 2/6.

ADVANCE CONSTANT VOLTAGE TRANSFORMERS. 190 to 260 volt input. Constant 230 volts output. 150 watts. Brand new, **£8/10/-** each. P/P 5/-.

BRAND NEW U.S.A. DRY 90 VOLT H.T. BATTERIES. Tapped 67½, 45 and 22½ v. **5/-** each. P/P 2/-.

EDDYSTONE MAINS POWER PACKS



200/250 volts input. Output 175 volts 60 mA. and 12 volts 2.5 amps. Double choke and condenser smoothed, 5Z4 rectifier. Supplied as new and unused, **32/6** each. P/P 3/6.

24 VOLT ROTARY CONVERTORS.

Input 24 volts D.C. Output 230 volts A.C. 50 cycles, 100 watts. Housed in metal carrying case with inlet/outlet plugs. Brand new, **92/6** each. P/P 7/6.

FIELD TELEPHONES TYPE L.

Generator bell ringing. Light and very portable. Ideal for all installations. Supplied complete with batteries, fully tested. As new, **59/6** each. P/P 3/-. 5/- pr.

FURZEHILL BEAT FREQUENCY AUDIO OSCILLATORS. Frequency range 0 to 10,000 cycles. Output 10 or 600 ohms. Separate 50 cycles check. Set zero control. 200/250 volt A.C. operation. Supplied in perfect working order, fully tested, **£9/19/6** each. P/P 10/-.

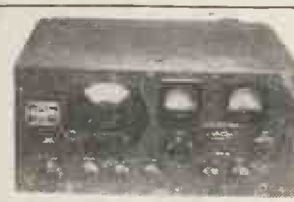
NIFE ALKALINE ACCUMULATORS. 12 volt 45 ampere. **£4/19/6** each. P/P 7/6.

MARCONI SIGNAL GENERATORS TF-517. 10-18 mc/s. 33-58 mc/s. 150-300 mc/s. Operation 200/250 volts A.C. Supplied in good working order, **£12/10/-** each. P/P 10/-.

MUIRHEADPRECISIONSTUDSWITCHES. 2 pole, 2 bank, 24 position, **10/6** each. P/P 1/-. 4 pole, 4 bank, 24 position, **17/6** each. P/P 1/3.

AMERICAN GEARED MOTORS

24 volt D.C. motor fitted with precision gearbox giving twin outputs of 20 and 6 r.p.m. Also operates on 12 volts. ¼in. shafts. Brand new. **19/6** each. P/P 1/6.

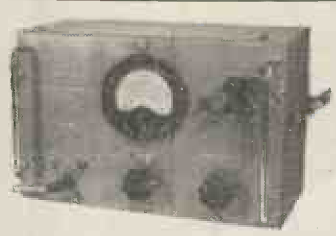


HALLICRAFTER S.27 U.H.F. COMMUNICATION RECEIVERS. F.M. or A.M.coverage 27 to 143 mc/s. on 3 bands. Incorporates S meter, variable sel. b.f.o. a.n.l. etc. Output for phone or speaker. Operation 110 or 230 volts A.C. Supplied in good working order, **£27/10/-** each. P/P 10/-.

FERRANTI TESTMETERS TYPE Q

D.C. VOLTS	A.C. VOLTS	D.C. Current	Ohms.
3 v.	15 v.	7.5 ma.	25,000
30 v.	30 v.	30 ma.	
150 v.	150 v.	150 ma.	
600 v.	060 v.	750 ma.	

500 ohms per volt on all ranges B.S.S. first-grade accuracy on all self contained ranges. Supplied in perfect working order complete with leads, battery, instructions and rexine covered carrying case. Price **52/6** each. P/P 2/6.



MARCONI TF.428 B/I VALVE VOLTMETERS. 5 ranges A.C. and D.C. 1.5, 5, 15, 50 and 150 volts. Operation 200/250 volts A.C. Supplied in perfect working order complete with internal H.F probe, **£17/10/-** each. P/P 10/-.

FIELD TELEPHONES TYPE F. Generator bell ringing. Supplied complete with batteries fully tested and complete with wooden carrying case **59/6** each. P/P 3/6. 5/- pr.

HOURS OF BUSINESS: 9 A.M. TO 6 P.M. THURSDAY 1 P.M. OPEN ALL DAY SATURDAY. SEND S.A.E. FOR LISTS.

G.W. SMITH & CO (RADIO) LIMITED

Phone: GERRARD 8204/9155
Cables: SMITHEX LESQUARE
3-34 LISLE STREET, LONDON, W.C.2

PRICES DOWN!! "THE TRANSISTOR—8"

Combined Portable/Car Radio Push-Pull Portable Superhet

★ Tunable over medium and long wavebands
★ 250mW output push-pull
★ Internal Ferrite aerial
★ Highly sensitive and selective
★ 7in. x 4in. high flux speaker
★ All components identified and carded
★ **EDISWAN** transistors throughout
★ Easy-to-follow layout diagrams

Complete set of parts including cabinet and all components. Now
£10.19.6
P. & P. 2/6
All parts sold separately
FREE BOOKLET

Car radio components 8/–; A.V.C. 4/3; now 325mW version £11/11/6. P. & P. 2/6.
Size 9in. x 7in. x $3\frac{1}{2}$in. Weight 4 lb.

NEW BARGAIN PARCEL

★ Perdio style moulded cabinet with gold trimmings (red, blue or cream)	12/6
★ J.B. 208+176pF screened gang	10/6
★ Miniature $2\frac{1}{2}$in. 3 ohm speaker	21/6
★ 20.1 output transformer to match	10/–
★ 5-transistor printed circuit	5/6
★ 5-transistor circuit diagram	1/–
★ Cabinet size $5\frac{1}{2}$in. x $3\frac{1}{2}$in. x $1\frac{1}{4}$in.	

SPECIAL INCLUSIVE PRICE 55/- P.P. 2/-

All the above components are made to fit the cabinet and printed circuit. Other components for the radio available.

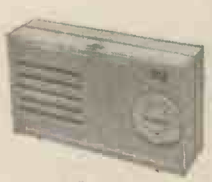
AUDIO GENERATOR

Check audio circuits easily and quickly

★ **EDISWAN** Transistor
★ Size $2\frac{1}{2}$in. x $1\frac{3}{8}$in. x 1in.
★ Clear Note
★ Ideal Modulator Morse Practice Unit.

25/- P.P. 1/-

THE TELETRON "TRANSIDYNE"



★ 6 **EDISWAN** Transistors
★ TCC printed circuit.
★ 120 mW output push-pull.
★ Med. and long waves.
★ Components identified.
★ Long-life batteries.
★ EASY TO BUILD.
★ $2\frac{1}{2}$in. high flux Speaker.

Size $6\frac{1}{4}$ x $3\frac{3}{4}$ x $1\frac{3}{4}$in. Weight 20 ozs.
All components for construction including cabinet, printed circuit, etc., can be supplied for

£11.19.6 P.P. 2/6

All parts sold separately.
SEND 1/- FOR CIRCUIT, PLANS AND PRICES

TRANSISTORS

JUNCTION PNP FULL GUARANTEE

NOW FROM **5/-** EACH.

SEND FOR **NEW** FREE LIST OF LATEST TYPES WITH FREE DATA AND SUGGEST USES.

MAJOR—2 *(two-transistor pocket radio)*

★ 4-stage reflex circuit
★ Tunable over medium waves
★ No aerial or earth
★ Over 6 months on one battery
★ Size $4\frac{1}{2}$in. x 3in. x $1\frac{1}{4}$in.
★ Weight under 4 oz.
★ Layout diagrams

Complete set of components including 2 **EDISWAN** transistors, **72/6** post free. All components sold separately.
FREE **NEW** BOOKLET.

MAJOR—3 *(three-transistor radio)*

As the Major-2 but with a third **EDISWAN** transistor and fitted with a volume control. Fantastic output! **90/–** post free. **FREE LIST ON REQUEST.**

CAR RADIO 2-watt Amplifier

A permanent power transistor stage complete with 7in. x 4in. speaker. May be used with any battery portable using a 3 ohm speaker. Use it with the "8".

Complete set of parts	**65/–** P.P. 2/6
Unit build up and tested	**77/6** P.P. 2/6

All components available separately. Free diagrams and list.

SIGNAL TRACER

AUDIO, RF and IF:

★ 2 **EDISWAN** Transistors
★ Headphone Output.
★ New Chassis; New Diagrams.

37/6 P.P. 1/6

Ideal Pocket Unit; Easy to Use; Find the Fault in Minutes; May be used as a Signal Peaker.

FREE LISTS FREE LISTS FREE LISTS

LARGEST RANGE OF TRANSISTORS AND TRANSISTOR COMPONENTS FOR THE HOME CONSTRUCTOR IN THE COUNTRY. FREE LIST ON REQUEST.
SEND FOR NEW BOOKLET DESCRIBING ALL OUR DO-IT-YOURSELF UNITS : FREE BY RETURN OF POST

HENRY'S RADIO LTD.

5, HARROW ROAD, PADDINGTON, W.2
(Opposite Edgware Road Tube Station) PAD 1008/9

VALVES

LARGE REDUCTIONS: NEW FREE LIST. OVER 500 DIFFERENT TYPES INCLUDING TUBES STABILIZERS, TRANSMITTING AND SPECIAL PURPOSE TYPES.

QUARTZ CRYSTALS

NEW FREE LIST. FROM 6 KC/S. TO 47 MC/S. FT243, BLANKS FT241A, 10X, B7G, TCS, WIRE END, 10XJ. OVER 500 DIFFERENT TYPES FOR ALL PURPOSES. THE LARGEST RANGE IN THE COUNTRY

SURPLUS UNITS

NEW FREE LIST. TRANSMITTERS, WATT-METERS, RECEIVERS, WAVEMETERS. CONVERTERS, TEST UNITS, INDICATORS, I.F.s, R.F. UNITS, RADAR UNITS, CRYSTAL CALIBRATORS, METERS, ETC., ETC.

BRAND NEW POCKET MULTIMETER

Model A-10: 500 micro-amp. movement A.C./D.C. voltage at 2,000 ohms. per volt 10, 50, 250, 500 and 1 kv.

Resistance range: 10 k. and 1 megohm.

D.C. current 500 micro-amp., 25 mA., 250 mA. Decibel range.

Accuracy: D.C. ±2%. A.C. ±3%.

Size: 5¼ x 3⅜ x 1¾. Weight 17 ozs

Price £4/17/6, inclusive of full handbook batteries and test prods. Fully guaranteed.

IDEAL POCKET INSTRUMENT FOR THE AMATEUR AND PROFESSIONAL.

CRYSTAL CALIBRATOR No. 10

Crystal controlled. Full coverage from 500 kc/s. to 10 Mc/s. 1 c/s. Modulation. Calibrated dial. Includes 2-1T4; 1R5 valves. Full handbook, 59/6. P.P. 3/6.

V.H.F. TRANS./RECEIVER TYPE 1986

124.5/156 Mc/s. coverage. 9.72 Mc/s. I.F.: 23 Kc/s. bandwidth. 10-channel V.H.F. airborne equipment. 24 volt D.C. input.

	Type	With Valves	Less Valves	P.P.
Transmitter	81	60/–	25/–	2/6
Receiver ...	114	25/–	7/6	2/6
I.F. Strip ...	476	32/6	12/6	2/6
Rotary Unit	106	15/–	—	2/6
Control unit	382	6/–	—	9d.

Full circuit diagram 1/9, post free.

"373" MINIATURE IF STRIP 9·72 Mc/s

The ideal F.M. conversion unit as described in "P.W." April/May, 1957. Complete with 6 valves, three EF91's, two EF92's and one EB91 I.F.T's, etc., in absolutely new condition. With circuit and conversion data.

12/6 (less valves) 37/6 (with valves)

Postage and Packing 2/6 (either type).

BC 906D WAVEMETER

Complete with vernier dial in black crackle case; 500 UA 2½in. meter; 150 to 235 Mc/s. Battery operated. Includes circuit. 1S5 valve. 45/-. P.P. 5/6.

SYNCHRONIZER UNIT

Valves: 3-6C6M; 12-6AC7; 6Q7; 5-717A; 6-6SN7 GT; 6H6. Transformers, chokes, dials, slow motion drive, etc. Brand new £4/19/6. P.P. 5/-.

ROTARY CONVERTER

24 v. D.C. to 230 v. A.C. 50 cycles. 100 watts. Brand new and unused.

£5/10/- Carr. 7/6.

RF 25 AND 26 UNITS

Type 25: 30 to 40 Mc/s. switched tuning. Includes 3-SP61; etc. 10/-. P.P. 2/6. Circuit diagram 9d. TYPE 26: 50 to 60 Mc/s. slow motion vernier tuning. 2-EF54; EC52. 25/-. P.P. 2/6. Circuit 9d.

AN/ARN-5D GLIDE PATH RECEIVER

3 channel UHF crystal controlled receiver: operating on 332.6 Mc/s., 333.8 Mc/s. and 335 Mc/s. Includes 28D7, 2-12SN7, 7-6AJ5, 12SR7, relays I.F.s etc. Input 24/28 volts D.C. 59/6. P.P. 5/-.

PACKARD BELL PRE-AMP.

Complete with screened case with 6SL7GT; 28D7; relay, leads, jack plugs, handbook, etc. Sealed in carton. Low impedance mic. pre-amp.

ONLY 12/6 P.P. 2/-.

426 CONTROL UNIT

Includes: 4—EF50; 2—SP61; EB34; multibank switches; pots; transformers; etc.

ONLY 30/- P.P. 2/6.

TYPE 247 INDICATOR UNIT

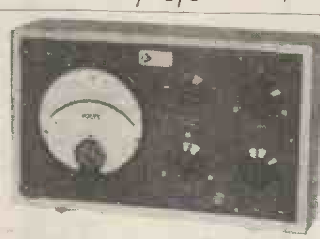
R.F. POWER WATTMETER. 1 mA. 4 inch meter; magic eye indicator; 100/240 mains transformer; chokes; EF50's; DIODES; RECTIFIERS, etc.

ONLY £3/19/6 P.P. 2/6.

APQ9 UHF UNIT

RADAR JAMMING UNIT; INCLUDES 2-807; 3-6AC7; 2-8012 HF; Gear drives; Blower motor; switches; dials; controls, etc.

£7/10/0 P.P. 7/6.



PIRANI CONTROL UNIT

Includes:
- ★ 6in. 1 mA. movement meter with mirrored scale.
- ★ Fully set Wheatstone Bridge.
- ★ Complete in best quality case.
- ★ Built-in galvo-shunt.

ONLY £5/19/6 P.P. 5/-.

Including Circuit diagram.

MARCONI No. 19 SET CRYSTAL CALIBRATOR

CRYSTAL CONTROLLED OSCILLATORS; 10 Kc/s., 100 Kc/s., and 1 Mc/s. includes 5-12SC7; handbook; on/off modulator: quartz crystal.

ONLY 79/6 P.P. 2/6.

RADAR UNIT TYPE 1683

Complete with the following valves: 2—6C40; 832A; 0829B; 2—5R4G; 3—6AC7; 6V6GTO; 931A photo multiplier with associated network. Also 2-blower motors. Input 30-115 volt 400 to 2,600 c/s cd 26 v. d.c. BRAND NEW and boxed.

£6/10/- Post free

WALKIE/TALKIE TYPE 38 TRANSMITTER/RECEIVER

Complete with 5 valves. In new condition These Sets are sold without Guarantee but are serviceable.

22/6 P.P. 2/6.

H/phone 7/6 pair. Junction Box 2/6. Throat Mike 4/6. Canvas Bag 4/-. Aerial Rod 2/6.

AIRCRAFT RADAR TYPE AN/APA-1

Complete scope indicator unit with amplifier aerial switching unit; full scope controls. Includes 3BP1 Tube; 6SN7GT; 6K6GT; 6G6GT 2X2; 6X5GT.

BRAND NEW FULL HANDBOOK. 97/6 P.P. 3/6.

VHF TRANS./RECEIVER TYPE 1920

- ★ 100 Mc/s. to 120 Mc/s. coverage.
- ★ 9.72 Mc/s. I.F. ★ 40 Kc/s. bandwidth.
- ★ 4-channel crystal controlled.
- ★ VHF airborne equipment.

Complete with 21 valves, crystal and 24 volt rotary unit all contained in metal case.

£6/19/6 P.P. 10/6.

Separate Circuit Diagram 1/9 post free.

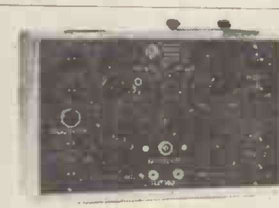
TRANSMITTER/RECEIVER

Army Type 17 Mk. II

Complete with Valves, High Resistance Headphones, Handmike and instruction Book and circuit. Frequency Range 44.0 to 61 Mc/s. Range approximately 3 to 8 miles. Power requirements: Standard 120 v. H.T. and 2 v. L.T.

Ideal for Civil Defence and communications. 45/- P.P. 5/-.

44-61 Mc/s. Calibrated Wavemeter for same, 10/- extra.



PIRANI DIFFERENTIAL LEAK DETECTOR

Includes:
- ★ 2-arm Wheatstone Bridge.
- ★ Masses of high quality switches, controls.
- ★ Best quality wood case.
- ★ Galvo-shunt.
- ★ Circuit diagram.

ONLY 59/6 P.P. 5/-.

BARGAIN OFFER

Brand new unused 90 volt U.S.A. batteries Tapped at 67½ v.; 45 v.; and 22½ volts. Ideal for portables.

5/- each P.P. 2/-.

STROBE UNIT

Complete with: 6—EF50; 5—EA50; SP61. Relays, etc.

35/- P.P. 2/6.

HENRY'S RADIO LTD.

5, HARROW ROAD, PADDINGTON, W.2

(AT JUNCTION OF EDGWARE ROAD AND HARROW ROAD) PAD 1008/9

RADAR SEARCH RECEIVER

TYPE AN/APR4
Now available

This Receiver is designed to determine the presence and measure the frequency of any radar or radio signals within the range of 38 to 2,000 Mc/s. To determine what modulation may be present on these signals giving an identification of relative strength of these signals.

The equipment consists of:—

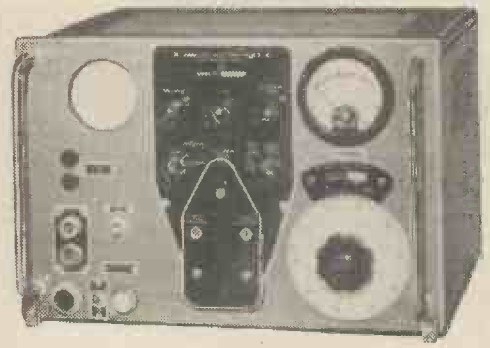
5-stage IF (30 Mc/s Amplifier provision is made to feed the IF amplifier to a panoramic adaptor)
1 Detector
2 Stage Video Amplifier (100 c/s—1 Mc/s, ±2.5 db)
1 Beat frequency oscillator

The signal is fed through RF "plug in" heads consisting of types:—

TN16 38-95 Mc/s 1 RF Triode first detector, 1 Oscillator.
TN17 74-320 Mc/s Butterfly resonant circuit 1 diode first detector, 1 triode oscillator.
TN18 300-1,000 Mc/s
Butterfly resonant circuit
1 Crystal first detector
1 Triode oscillator
The above three units are available now.
TN19 obtainable (TN19—950-2,000 Mc/s available as extra)

MARCONI

S-BAND (10 cm) SPECTRUM ANALYSER Type TF984



FREQUENCY RANGE	2,900 to 3,150 Mc/s.
SENSITIVITY	200 Micro Watt for 5 cm. deflection. 20 Mean Watt for 5 cm. deflection.
SPECTRUM WIDTH	1 to 10 Mc/s.
SWEEP FREQUENCY	4 to 10 Mc/s.
I.F.	22.5 Mc/s.
I.F. BANDWIDTH	100 kc/s for 3 db drop in level.

Prices given on request.

Prices on written request

Now available from stock —

BC221 HETERODYNE FREQUENCY METERS

Function

An accurate heterodyne, frequency meter having crystal check points for calibrating equipment using CW or modulated CW. This test set may be used for the following:

- Measurement or calibration of the frequency of transmitters, oscillators, or signal generators.
- Measurement or calibration of the frequency of receivers having a beat-frequency oscillator with zero-beat adjustment.
- Calibration of other test equipment.

Electrical Characteristics

Fundamental Frequency range: 125 kc/s to 250 kc/s; 2,000 kc/s to 4,000 kc/s.
Calibrated Frequency Range: 125 kc/s to 20 Mc/s.

Overall Accuracy: 0.01% or 25 cycles, whichever is the greater, within the specified temperature range.

Operating Temperature Range: −30°C to +50°C (−22°F to +122°F).

RF Output (Functioning as a test oscillator): 2 millivolts.

ALSO AVAILABLE V.H.F. VERSIONS OF ABOVE

Electrical Characteristics

TS174

Calibrated Frequency Range:
20 to 280 Mc/s.
Fundamental Frequency Range:
20 to 40 Mc/s.
Accuracy: 0.05% (throughout the temperature range).
Signal Input: (Sensitivity)
20 millivolts to 2 volts.
Signal Output: 50 to 20 millivolts modulated at 1,000 cycles.
Temperature Range: −40°C to +50°C (−40°F to +131°F).

TS175

Calibrated Frequency Range:
80 to 1,000 Mc/s.
Fundamental Frequency Range:
80 to 200 Mc/s.
Accuracy: 0.05% (throughout the temperature range).
Signal Input (sensitivity):
20 millivolts to 2 volts.
Signal Output: 100 microvolts to 20 millivolts modulated at 1,000 cycles.
Temperature Range: −40°C to +55°C (−40°F to 131°F).

UNIVERSAL ELECTRONICS

22-27, LISLE STREET, LEICESTER SQUARE LONDON, W.C.2. Tel: GERrard 8410 & 4447

Shop Hours: 9.30 a.m. to 6.0 p.m. OPEN ALL DAY SATURDAY *Thursday 9.30 a.m. to 1.0 p.m.*

LASKY'S RADIO

★ NEW at 207

NOW OPEN! COME LEADING MAKES OF TAPE RECORDERS,

★ HUNDREDS OF MONEY-SAVING OFFERS

ALL GOODS OFFERED IN THIS ADVT. ARE AVAILABLE AT

THE LOWEST PRICED TAPE RECORDER EVER OFFERED

Foreign

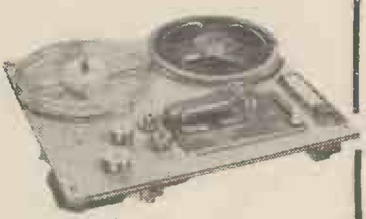
FOR A.C. MAINS 200/250 v.

Limited number only. new in maker's cartons. 2-speed 3¾ and 7½, twin track. 60 min. playing time at 3¾; 30 min. at 7½. Inputs for mike and tuner. 5in. Speaker. Smart duotone blue/grey case. 12¼ × 9¼ × 7¼in. Weight approx. 6½ lb.

TODAY'S VALUE £35

LASKY'S PRICE, including 5in. Spool of Tape and empty Spool, Crystal Hand Mike and Radio Jack, **21 gns.** Carr. and insur., 12/6.

SAVE POUNDS ON THIS TRUVOX TAPE DECK



Mk. III. New and unused, in maker's cartons, 2-spd., 3¾ and 7½, 3 shaded pole B.T.H. motors. Twin track, high impedance heads. Push-button controls, takes standard 7in. spools. Size: 14¼ × 12¾in. Limited number, fully guaranteed.

LISTED AT 22 GNS.

LASKY'S PRICE £14.19.6

Carr. and insur., 12/6. Instruction Booklet with circuit diagrams for amplifiers with each Deck.

SPECIAL TAPE OFFER

Famous make, P.V.C. base on latest type plastic spools. Brand new, perfect, boxed and guaranteed.
1,200ft. on 7in. Spool, 21/-; 850ft. on 5¾in. Spool, 16/6.

GEVAERT L.P. PLASTIC

1,700ft. (7in.), 35/-; 850ft. (5in.), 18/6; 210ft. (3in.), 6/6. Post, 1 spool 1/6. Orders over 60/- post free.

TAPE DECK OFFERS

COLLARO TAPE TRANSCRIPTOR Mk. IV, fitted digital counter. Few only. LIST £25. **LASKY'S PRICE £17/19/6.** Carr. and insur. 21/-.

TAPE RECORDER AMPLIFIER for use with Collaro Tape Deck. Maker's surplus, complete with 4 valves and power supplies. £7/19/6. Post 3/6.

TRANSCRIPTION TURNTABLES

COLLARO 4-spd., type 4T200/PX with Studio transcription P.U. LIST £19/10/-. LASKY'S PRICE £16/19/6, carr. paid. In Carrying Case, 25/- extra.

GARRARD 301. £22/7/3. Strobe, £23/18/4.

GARRARD 4HF, Stereo £19/4/8. (G.C.8), £18/9/9.

LENCO GL56 (stereo, binofluid diamond), £23/17/-,

PHILIPS, £10/10/-.

Also all other types.

TRANSISTOR TURNTABLES

6 volt. 45 r.p.m., complete with pick-up.
GARRARD BA/1, 99/6.
STAAR KINDER, 79/6.
Post 3/6.

PLASTIC TAPE SPOOLS

5in.	5¾in.	7in.	8¼in.
3/6	4/3	4/-	5/6

7in. Metal Spools, 2/6 each.
Post 1/-

AMPLIFIERS TO SUIT ALL PURPOSES

3-3 AMPLIFIER, built to Mullard's exact specification with 3 Mullard valves EL84, EF86, EZ81, complete with front panel. 8 Gns. Post free.

MULLARD 510 AMPLIFIER KIT. All specified components and your choice of transformers and chokes by Partridge, Haddon, W B, Ellison or Gilson, with printed circuit, as low as 9 Gns. Details on request. Printed Circuit separately, 22/6.

Also available built ready for use. Price according to transformers used.

3-WATT GRAM AMPLIFIER. 2 valve, ECL82 and EZ80 rectifier, double wound main transformer 100-250 A.C., tone control, record equalisation switch. Size 7¾ x 3¾in., max. height 4¼in. Controls mounted separately. LASKY'S PRICE, complete with knobs, 55/-. Post 3/6. MATCHED PAIR FOR STEREO 5 Gns. Post 5/-.

Special offer. Single valve 2-watt Gram. Amplifier, 45/-. Post 3/6.

UNIVERSAL SOUND MIXER

3 channels, for use with all tape recorders and audio amplifiers. Size: 4¼ × 3¼ × 4¼in.
LASKY'S PRICE 35/-. Post 2/6.

"LINEAR" AMPLIFIERS

"Diatonic" 10-14 watt	12 Gns.
"Conchord" 30 watt	15 Gns.
L45 4-5 watt Amplifier	£5 19 6
LT45. Tape Deck Amp.	12 Gns.
LG.3 Gram Amplifier..	55/9
L50. 50-watt Amplifier	19 Gns.
L10. 10-12 with pre-amp..............	15 Gns.
L3/3. Stereo Amplifier	7 Gns

Details on request.

EXPORT ORDERS

Goods shipped tax free to all parts of the world. We also operate the "Personal Export Service" (free of purchase tax) for visitors to Great Britain.

"INSTANT" BULK TAPE ERASER and Head De-magnetizer. Erases complete reel of magnetic tape in a few seconds. 27/6, post free.

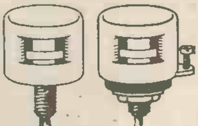
MICROPHONE BARGAINS

ACOS Mic 39-1. Crystal Stick Mike for high quality recording, broadcasting and public address work.
LIST 5 Gns.

LASKY'S PRICE 39/6.
Post free. Desk Stand available, 2/6.

ACOS 22/1. Crystal hand or table Mike with specially designed acoustic filter. Flat response 30-7,000 c.p.s. Omni-directional. Dark brown plastic. LIST 50/-. LASKY'S PRICE 29/6. Post free

HIGH FIDELITY TAPE RECORDER HEADS



Leading make, new and unused. Upper or lower track RECORD/PLAYBACK, high impedance. Double wound and will reproduce up to 12,000 c.p.c. at 7½ i.p.s. Azimuth adjustments. Output 5 milli-volts at 1 Kc. at 7½ i.p.s. ERASE, low impedance. LIST £4 PAIR. LASKY'S PRICE, per pair, 39/6. Post 1/3. Please specify upper or lower track.

LASKY'S RADIO FOR COURTEOUS SERVICE & TECHNICAL ADVICE

SHOWROOMS
EDGWARE ROAD, W.2

AND SEE THE ASTONISHING VARIETY OF ELECTRONIC, RADIO & T.V. COMPONENTS, UNITS, CONSTRUCTOR KITS, CABINETS, CASES, ETC.

★ THE LARGEST AND MOST COMPREHENSIVE STOCKS FOR ALL CONSTRUCTORS AND HIGH FIDELITY ENTHUSIASTS

207 EDGWARE RD., W.2 & 42 TOTTENHAM COURT RD., W.1

SPECIAL OFFER
P.M. SPEAKERS

Round:—

3½in.	4in.	5in.	6½in.
17/6	19/6	14/6	16/-
8in.	10in.	12in.	
16/6	26/-	27/6	

Elliptical:—

7×4	9×6	10×2½	10×7
14/6	27/6	27/6	32/6

SINGLE PLAYERS

COLLARO "Junior" 4-spd. motor and separate P.U. with cartridge and styli.

MOTOR only 55/-

PICK-UP 27/6

Special offer.—Motor and P.U. if ordered together, 75/-, post free.

COLLARO 4/564 or GARRARD 4SP, 4-speed, auto stop, T.O. crystal, £6/9/6. Post 5/-.

P.U. CARTRIDGES
BELOW HALF PRICE!

B.S.R. "ful-fi" TC8 T.O. crystal cartridge with L.P. and standard styli. Limited number. LIST 41/7. LASKY'S PRICE 18/-. Post free.

STEREO
P.U. CARTRIDGES

All makes and types in stock. Write for our bargain list.

BARGAINS IN 4-SPEED MIXER AUTO-CHANGERS

COLLARO RC.457. Manual and auto. control, complete with Studio crystal P.U. and sapphire stylus. LIST £13/17/-. LASKY'S PRICE **£7.19.6**

Post 3/6.

B.S.R. Type UA8, complete with B.S.R. "ful-fi" pick-ups, £6/19/6. Post 5/-.

B.S.R. Latest type UA12, wired for STEREO, complete with stereo cartridge, £8/19/6. Post 5/-.

FINAL OFFER OF STAAR "GALAXY"

4-spd. Mixer Auto-Changer, complete with crystal P.U. and styli. Auto and manual control. Few only. List 12 Gns. LASKY'S PRICE 79/6. Carr. and pkg. 5/-. Service Manual, 1/6 post free.

Good range of Spare Parts

SELECT YOUR HI-FI EQUIPMENT AT LASKY'S

listen to and compare a full range of the leading makes and types at either of our addresses, assisted by specialist high fidelity staff. If unable to call, write for literature and information.

AMPLIFIERS

QUAD, ROGERS, LEAK, RCA, JASON, LINEAR, PAMPHONIC, DULCI W/B, AVANTIC ARMSTRONG, etc.

SPEAKERS

WHARFEDALE, GOODMANS, LOWTHER, G.E.C., LORENZ, PHILIPS, TANNOY, etc.

PICKUPS

COLLARO, GARRARD, CONNOISSEUR, LEAK, B/J, ORTOFON, GOLDRING, etc.

TRANSCRIPTION TURNTABLES

COLLARO, GARRARD, LENCO, CONNOISSEUR.

TAPE RECORDERS

GRUNDIG, ELIZABETHAN, BRENELL, TRUVOX, SOUND, VORTEXION, FERROGRAPH, ELON, HARTING, SIMON, REFLECTOGRAPH, STUZZI, TANDBERG, TELEFUNKEN, STELLA, WALTER.

F.M. TUNERS

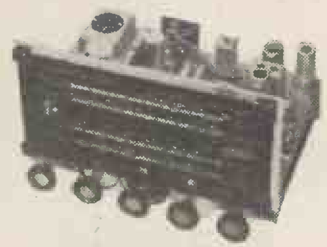
DULCI, QUAD, LEAK, JASON, ROGERS, etc.

CABINETS

Wide choice including G-PLAN, NORDYK and CAPRIOL.

LASKY'S RADIO

POUNDS BELOW LIST!



COMBINED AM/FM TUNER, CONTROL UNIT AND PRE-AMPLIFIER
(Self Powered)

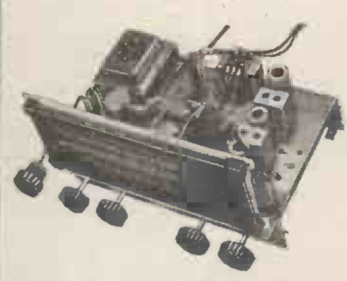
Mdl. H11 Famous make. Note these star features:

★ FM plus Long, Medium and Short.
★ High Fidelity Pre-Amplifier.
★ Independent Bass and Treble Controls.
★ Pick-up Matching Device and Switch positions for LP and 78.
★ Tape Record and Replay facilities.
★ For use with any Hi-Fi Amplifier.
★ Magic Eye Tuning Indicator.

For A.C. 200/250 v. 7 B.V.A. glass miniature valves, ECC85, ECH81, EBF89, two EF86, EZ81, EM81, and two matched diodes. Glass dial 11½ × 5½in., fine readings and "LOG" scale. Length 12in., depth from dial front, 9in. (10in. including knobs and spindles) height 7in.

LISTED AT £29/3/10. LASKY'S PRICE **20 GNS.**

Carr. and Insur. 12/6. Available on H.P. terms.



7-VALVE AM/FM RADIOGRAM CHASSIS

Famous make, for 200/250 v. A.C. Output 4 watts, matched to 3 ohms speaker. 7 valves: EC85, ECH81, EF89, EABC80, EL84, EZ80, EM81, magic eye tuning indicator. Covers medium, long and FM bands. Length 12in., height 7¾in., front to back 8¾in. Limited number only.

LISTED AT 22 GNS. LASKY'S PRICE **£16.19.6**

Carr. and insur. 12/6.

Brochure on request. Available on H.P. terms.

ALL TYPES OF CHASSIS

We hold the largest selection of leading makes including all models ARMSTRONG, EMPRESS, DULCI, etc.

A.M. chassis, L.M.S. from 7 Gns.
A.M./F.M. chassis from 14 Gns.
A.M./F.M. STEREO from 22 Gns.

SEE OVERLEAF FOR MORE NEWS FROM LASKY'S RADIO

Still by far the finest value

MULLARD DESIGNS FOR THE HOME CONSTRUCTOR

COMPLETE KIT OF PARTS

Designed by MULLARD—presented by STERNS strictly to specification.

MULLARD "5-10" MAIN AMPLIFIER

For use with the MULLARD 2 stage preamplifier (described below) with which an undistorted power output of up to 10 Watts is obtained. This combination is thoroughly recommende o Hi-Fi enthusiasts who contemplate a versatile and very high quality home installation. We supply SPECIFIED COMPONENTS AND NEW MULLARD VALVES including PARMEKO MAINS TRANSFORMER (which has extra Power available to drive Radio Tuner) and the choice of the latest Ultra-Linear PARMEKO or the PARTRIDGE Output Transformer.

Price: COMPLETE KIT (Parmeko O/put Trans.) **£10.0.0** Alternatively we supply ASSEMBLED and TESTED **£11.10.0**
ABOVE INCORPORATING PARTRIDGE OUTPUT TRANSFORMER £1.6.0 extra

MULLARD'S PRE-AMPLIFIER TONE CONTROL UNIT

Employing two EF86 valves, and designed to operate with the Mullard 3-3 and 5-10 MAIN AMPLIFIERS, but also perfectly suitable for other makes.
Our kit is strictly to MULLARD'S SPECIFICATION and incorporates:
- Equalisation for the latest R.I.A.A. characteristics.
- Input for Crystal Pick-ups, and variable reluctance magnetic types.
- Input. (a) Direct from High Imp. Tape Head. (b) From a Tape Amplifier or Pre-amplifier.
- Sensitive Microphone Channel.
- Wide range BASS and TREBLE Controls.

PRICE: COMPLETE KIT OF PARTS **£6.6.0** Alternatively we supply ASSEMBLED AND TESTED **£8.8.0**
(Carriage and Insurance 5/- extra)

MULLARD 3-3 MAIN AMPLIFIER

Based entirely on the very popular "3-3" model and designed to operate with the 2-stage PRE-AMPLIFIER (shown here) thus providing all the facilities associated with the more expensive "Hi-Fi" equipment. We recommend it as the IDEAL SMALL HOME INSTALLATION where very high quality is desired at the lower volume level (up to 3 watts.).
We supply completely to MULLARD'S SPECIFICATION INCLUDING the latest PARMEKO Output Transformer specified Valves and Components. Has Power available to drive a Radio Tuning Unit.

Price for COMPLETE KIT OF PARTS **£7.0.0**
Alternatively we supply ASSEMBLED AND TESTED **£8.0.0**
(Carriage and Insurance 5/- extra.)

SPECIAL PRICE REDUCTIONS

(a) THE COMPLETE KIT OF PARTS to build both the "3-3" MAIN AMPLIFIER and the 2-stage PRE-AMPLIFIER-CONTROL UNIT................ **£12.10.0**

(b) THE COMPLETE KIT OF PARTS to build both the "5-10" MAIN AMPLIFIER and the 2-STAGE PRE-AMPLIFIER-CONTROL UNIT **£15.15.0**

*ALL PRICES QUOTED FOR THE "5-10" ARE SUBJECT TO £1/6/- EXTRA IF THE PARTRIDGE TRANF. IS REQUIRED.

(a) THE "3-3" and the 2-STAGE PRE-AMPLIFIER both ASSEMBLED and TESTED........ **£15.0.0**

H.P. TERMS DEP. £3 and 12 monthly payments of £1/2/- or DEP. £5 and 12 monthly payments of 18/4.

(b) THE "5-10" and the 2-STAGE PRE-AMPLIFIER both ASSEMBLED and TESTED........ **£18.18.0**

H.P. TERMS DEP. £3/16/- and 12 monthly payments of £1/7/8 or DEP. £6/6/- and 12 monthly payments of £1/3/1.

When ordering please include an extra 7/6 to cover the cost of carriage and insurance.

MULLARD—STERN STEREO DESIGNS

AVAILABLE FROM END OF SEPTEMBER

DUAL CHANNEL PRE-AMPLIFIER

ILLUSTRATION AVAILABLE END OF SEPTEMBER

This model incorporates two 2-Valve Pre-Amplifiers (described above) combined into a Single Unit enabling it to be used for both STEREOPHONIC or MONAURAL operation. It is designed primarily to operate with our range of MULLARD MAIN AMPLIFIERS but will also operate equally well with any make of Amplifiers requiring an input of 250 m/volts.

PRICE COMPLETE KIT OF PARTS .... Price available
Alternatively ASSEMBLED AND TESTED .... end of September

Perfectly suitable for MONAURAL Only operation, with one "3/3" or one "5/10," Main Amplifier to which the second Main Amplifier can at any time be added thus very easily providing for both STEREO or MONAURAL reproduction.
Recommended combinations for STEREO operation.
(a) The DUAL CHANNEL PRE-AMPLIFIER together with the Dual "3/3" MAIN AMPLIFIER.
(b) The DUAL CHANNEL PRE-AMPLIFIER together with two "5/10" MAIN AMPLIFIERS
FULLY DESCRIPTIVE LEAFLETS with complete price details available end of September

Model 3-3 M/S

DUAL "3-3" MAIN AMPLIFIER

DUAL "3-3" MAIN AMPLIFIER
Comprises two "3-3" MAIN AMPLIFIERS (described above) on one chassis and is designed to operate with our DUAL CHANNEL PREAMPLIFIER for both STEREOPHONIC or MONAURAL operation.

Price: COMPLETE KIT OF PARTS **£9.15.0**

Alternatively ASSEMBLED AND TESTED **£11.10.0**
H.P. Terms, Deposit £2/6/- 12 months at 17/-.
Its output power is 6 Watts (3 Watts per channel) and together with our PREAMPLIFIER provides a very acceptable STEREO installation.

COMPLETE STEREO AMPLIFIER

A thoroughly recommended design that very effectively meets the many requests for a low priced but good quality DUAL CHANNEL STEREOPHONIC AMPLIFIER.

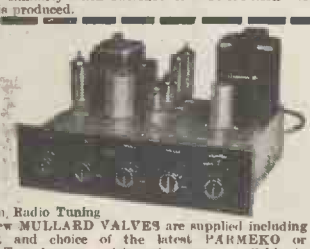
PRICE COMPLETE KIT OF PARTS **£8.10.0**
Alternatively ASSEMBLED AND TESTED **£10.10.0**

Two Mullard ECL 82 Triode Pentode Valves are incorporated in the design, they form a "CLASS A" single ended output stage in each channel. The input sensitivity is 300 m/volts, therefore when used with most STEREO Crystal Pick Ups, or Radio Tuning Units, an output of 2 Watts per channel is achieved, or similarly when switched to MONAURAL Pick-Up position a combined output of 4 Watts is produced.

Only New HIGH GRADE Specified Components and MULLARD VALVES are supplied.

Please enclose S.A.E. if ILLUSTRATED and DESCRIPTIVE LEAFLETS are required . . . alternatively the COMPLETE ASSEMBLY MANUALS containing component Price Lists and practical Drawings, etc., are available at 1/6 each

COMPLETE MULLARD 5-10 AMPLIFIER



The popular and very successful complete "5-10" incorporating Control Unit providing up to 10 Watts high quality reproduction. Input channels for high output pick-ups and all modern Radio Tuning Units, only Specified Components and new MULLARD VALVES are supplied including PARMEKO MAINS TRANSFORMER and choice of the latest PARMEKO or PARTRIDGE ULTRA-Linear Output Transformers. Adequate power available to drive Radio Tuner.

Price: COMPLETE KIT Parmeko Transformer **£11.10.0**
Alternatively we supply ASSEMBLED and TESTED **£13.10.0**
Hire Purchase (Assembled Amp. only). Deposit £2/14/-. 12 months at 19/10.
ABOVE incorporating PARTRIDGE OUTPUT TRANSFORMER £1/6/0 extra.

THE COMPLETE ASSEMBLY MANUAL AVAILABLE FOR 1/6

COMPLETE MULLARD 3-3

A VERY HIGH QUALITY AMPLIFIER DEVELOPED FROM THE VERY POPULAR 3-VALVE 3-WATT AMPLIFIER DESIGNED IN THE MULLARD LABORATORIES.

Price for COMPLETE KIT OF PARTS **£7.10.0**
(Plus 6/6 carriage and insurance).
Alternatively supplied ASSEMBLED and FULLY TESTED (Plus 6/6 carriage and insurance) **£8.19.6**
H.P. Terms Deposit £2 and 8 monthly payments of £1.

Our kit is complete to the MULLARD specification including supply of specified components, valves and PARMEKO OUTPUT TRANSFORMER. We also include switched inputs for 78 and L.P. records plus a Radio position. Extra power to drive a Radio Tuning Unit is also available:—

STERN RADIO LTD. 109 & 115 FLEET ST., LONDON, E.C.4
Telephone: Fleet Street 5812/3/4

Stern's "fidelity" TAPE EQUIPMENT

THE FINEST RANGE OF TAPE EQUIPMENT FOR THE HOME CONSTRUCTOR

A SELECTION OF HIGH FIDELITY PORTABLE TAPE PREAMPLIFIERS

Adds "HI Fi" Tape Recording to your existing Audio Installation.

IN ALL MODELS WE INCORPORATE THE

TYPE "C" PREAMPLIFIER

and offer it complete in portable case with . . .

(a) The new "COLLARO" STUDIO 3 Speed Deck. Deposit: £7/2/-. 12 months £2/12/1 .... **£35.10.0**
(b) The COLLARO Mk. IV "Transcriptor" 3 Speed Deck Deposit: £8/14/0. 12 months £3/3/11 .... **£43.10.0**
(c) The New TRUVOX Mk. VI Tape Deck Deposit: £8/14/-. 12 months £3/3/10 .... **£43.10.0**
(d) The BRENELL Mk. V 3 Speed Deck. Deposit: £10/6/-. 12 months £3/15/7 .... **£51.10.0**
(e) The WEARITE MODEL 4A Tape Deck. Deposit: £12. 12 months £4/7/1 .... **£59.10.0**

STERNS—MULLARD TYPE "C"

TAPE PRE-AMPLIFIER—ERASE UNIT

INCORPORATING THE NEW FERROXCUBE POT CORE PUSH-PULL OSCILLATOR and 3 SPEED TREBLE EQUALISATION by means of the latest FERROXCUBE POT CORE INDUCTOR.

PRICES . . . INCLUDING SEPARATE SMALL POWER SUPPLY UNIT
COMPLETE KIT OF PARTS **£14.0.0** ASSEMBLED AND TESTED **£17.0.0**
Deposit £3/8/- and 12 months of £1/4/11. Assembled unit only.
ALSO AVAILABLE EXCLUDING POWER SUPPLY UNIT FOR **£11.15.0** and **£14.10.0** respectively. (Carr. and Ins. 5/- extra)
Send S.A.E. for leaflet or 2/6 for Complete Assembly Manual.

WHEN ORDERING PLEASE STATE MAKE OF TAPE DECK TO BE USED

We present this "Hi-Fi" Pre-amplifier strictly to Mullard's specification, etc., incorporating ONLY NEW HIGH GRADE COMPONENTS and the SPECIFIED NEW MULLARD VALVES. It comprises a COMPLETELY SELF-CONTAINED UNIT, all components and valves being contained in a well ventilated Box—Chassis neatly finished in Hammered gold with a very attractively engraved PERSPEX FRONT PANEL.

FOR PERMANENT HIGH QUALITY INSTALLATIONS WE ALSO OFFER (excluding Case) the following

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Incorporating *3-SPEED TREBLE EQUALISATION by means of the latest FERROXCUBE POT CORE INDUCTOR.*

PRICE for COMPLETE KIT OF PARTS.......... **£12/15/-**
FULLY ASSEMBLED AND TESTED **£16/10/-**
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A very high quality amplifier based on the very successful Type "A" design completed in the MULLARD LABORATORIES. ONLY NEW HIGH-GRADE COMPONENTS are incorporated including MULLARD VALVES and a GILSON OUTPUT TRANSFORMER . . . other features are: Magic Eye Recording Hand Indicator—Effective Tone Control—Monitoring and Extension Speaker Sockets—has own Power Supply and can be used as independent Amplifier for direct reproduction of Gram. Records or from Radio Tuner. Overall size 11 x 6 x 6in.—Truvox—Collaro—or Brenell—please specify which. Send S.A.E. for leaflet or 2/6 for Assembly Manual.

WE HAVE THE NEW 2 SPEED TWIN TRACK
TRUVOX Mk. VI Tape Deck in stock £26.5.0 Deposit £5.5.0 12 months £1.18.6

It concorporates PRECISION REV. COUNTER and PAUSE CONTROL and operates at $3\frac{3}{4}$ and $7\frac{1}{2}$ inch/sec. speeds. It fully maintains the general high standard of all Truvox equipment, introducing refinements in appearance and ensures high quality recording, accurate timing and editing. The very popular COLLARO Mk. IV "TRANSCRIPTOR" and the BRENELL Mk. V Decks are also available from stock.

THE NEW B.S.R. "MONARDECK"

INCORPORATING A CORRECTLY MATCHED PREAMPLIFIER PRICE **£17.17.0**
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The equipment is supplied fully tested and completely assembled on an attractive wood plinth. It can therefore be "dropped" directly into an existing cabinet and only requires connections to the mains supply and the Pick-up Sockets, for which purposes "floating" leads, are incorporated on the Preamplifier.

CLYNE RADIO LTD.

THE COMPONENT SPECIALISTS

OUR NEW SUPER TRANSISTOR/CRYSTAL RECEIVER

Employing special NEW SUPER SENSITIVE circuit and incorporating built-in Ferrite Aerial. For use with headphones or deaf-aid type earpiece. Housed in attractive ivory and black plastic case measuring only 4½in. x 2⅞in. x 1⅜in. Very simple to construct. Most economical to run. (Pen torch type battery lasts for months.) Completely safe. *No external Aerial or Earth required.* Excellent quality reception on Medium Waveband. Fully comprehensive, easy to follow, practical and theoretical instructions provided. **Special Price for all required components** (inc. battery) **only 30/-** plus 2/- P. & P.

Deaf-aid type earpiece available separately complete with lead at 12/6 or DLRS headphones at 7/7 per pair.
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Our very popular three valve mains T.R.F. receiver is now available with a new De Luxe cabinet with polished Walnut finish and Cream trimming (as illustrated). Brief Spec.: Valve line-up 6K7, 6J7, 6V6. Ready drilled chassis, good quality 5in. loudspeaker, Special Denco Coils. Covers Medium and Long Wavebands. Overall dimensions: 12in. x 6in. x 5in. high. A.C. 200/250 v. Simple construction with guaranteed results. Easy to follow practical and theoretical diagrams supplied. All necessary components, down to the last nut and bolt, are offered at a **SPECIAL INCLUSIVE PRICE OF £5/10/-**, plus 2/6 p. & p. Instruction book available separately 1/6, post free.
Also available with plastic cabinet in IVORY or BROWN if preferred at **ONLY £5/5/-**, plus p. & p.

PRINTED CIRCUIT DE-LUXE SUPERHET

Housed in any of the above cabinets and employing the latest circuitry, assembly technique and miniature valves. Incorporates ferrite aerial and covers Medium and Long Wavebands. All required components at special inclusive price of **£7/19/6** (or 5/- extra for new style cabinet) plus 3/6 p. & p.
Instruction book with full description, itemised price list etc., available separately at 1/6 post free.

THE NEW LOOK RAMBLER PORTABLE

This wonderful little Medium and Long wave battery superhet incorporates 1R5, 1T4, 1S5, 3V4 miniature valves, 5in. speaker and frame aerial. Housed in smart two tone Red/Grey cabinet. All required components at only **£7/7/0** plus 2/6 p. & p. or with the latest low consumption "96 range" valves at **£7/15/6** plus p. & p. Uses all-dry batteries AD35 (1/6), B126 (9/-). Full descriptive instruction book with itemised price list, diagrams, etc., available separately at 1/6d. post free.

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The following eight outstanding features are available to the purchaser of this new, exciting receiver for home construction.

★ APPEARANCE. Second to none, being housed in a very special De-Luxe cabinet produced EXCLUSIVELY for us. Finished in the new unscratchable "Vynide" (available in either two tone Maroon/Grey or Black/White Polka Dot/Grey) with the speaker aperture completely covered, thereby blending with the clean lines of the cabinet. A very neat fold-away handle.
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★ ECONOMY. Powered by long life 7½ volt battery replaceable at only 2/-. Vidor type L5048 or Ever Ready AD38.
★ SENSITIVITY. Excellent and equal to any commercially built receiver of similar type. Seven specially selected transistors are employed.
★ EASE OF CONSTRUCTION. Designed specially for the home constructor and supplied with most comprehensive assembly instructions (that are easy to follow).
★ PRICE. All necessary components available at a Special Inclusive Price of ONLY **£9.19.6** plus 3/6 p. & p., with MAZDA transistors (250 m.w. output).
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A COMPACT TEST METER FOR HOME CONSTRUCTION. This is a very sensitive multi-range test meter (500 micro-amp. basic movement) covering the following ranges: A.C./D.C. voltage: 0-10 v., 0-50 v. and 0-500 v. Current: D.C. 0-10 ma., 0-50 ma. and 0-500 ma. Resistance (on internal battery) 2 K.ohm. to 100K.ohm. Housed in a smart grey stove enamelled case measuring 3¾in. x 7in. x 1⅞in. overall. Brand new best quality components and High Stability resistors are used throughout, resulting in a thoroughly reliable, accurate instrument. NOTE: Meter is supplied with calibrated scale fitted, and all components, including shunt, are prepared for immediate soldering into position. Comprehensive assembly instructions with practical and theoretical diagrams are supplied together with all necessary components at a SPECIAL INCLUSIVE PRICE OF ONLY 59/6, plus 1/6 P. & P. The instruction envelope is available separately if required at 1/6 post free.

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(for Home Construction)

We are proud to be able to offer this New type Car Radio employing up to the minute circuitry, special 12 volt valves and transistorised output stage. The highest degree of sensitivity is assured by the incorporation of Permeability Tuning and a tuned R.F. Stage. Covers Medium and Long Wavebands. NO VIBRATOR PACK IS REQUIRED. This is a really compact receiver that will fit any car. Comprehensive assembly instructions are provided with all necessary components, including valves and transistor at a Special Inclusive Price of Only **£12/19/6** plus 3/6 p. & p. Instruction booklet with itemised price list, full description, dimensions, etc., available separately at 1/6 post free.

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OLDHAM MINERS' LANTERN (all steel). 9½in. tall, 3¾in. dia. Complete with bulb and rechargeable accumulator. Ideal inspection lamp for garages, outhouses, etc. 19/11. Post 2/6.

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MICROPHONE STANDS. 3 sections of 18½in. per section. Extends to 56in. Stands securely on 3 legs which fold together for carrying purposes. A robust job, only 21/-. P. & P. 2/6.

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Ditto 16 A.H., 5/-. P. & P. 2/-; 6 for 24/-. P. & P. 10/-.
Ditto 14 A.H. less handle, 5/-. P. & P. 2/-; 6 for 24/-. P. & P. 10/-.

TRANSFORMERS

VARIABLE VOLTAGE TRANSFORMER. (BERCO Regulator) Pri. 440 v. 50 cycles, sec. 0-440 v. at 6.5 amps. or can be connected for 230 v. to give 0-230 v. at 12 amps. Brand New and Unused £18/10/-. Carr. 10/-.

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20 kVA AUTO-TRANSFORMER. 230/115 v. 50-60 cycles, by Jefferies Transformer Co., U.S.A. Perfect condition. £20. Carr. £1.

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SELENIUM METAL RECTIFIERS FB 6 or 12 v. 1 amp. 7/6; 24 v. 1 amp. 13/6; 12 v. 2 amp. 10/-; 24 v. 2 amp. 20/-; 12 v. 2½ amp. 15/-; 24 v. 2½ amp. 25/-; 12 v. 4 amp. 16/6; 24 v. 4 amp. 30/-; 12 v. 6 amp. 23/6; 24 v. 6 amp. 35/-; 12 v. 10 amp. 40/-; 24 v. 10 amp. 80/-.

RECORD MEGGERS. 500 v. insulation tester, 0–20 megohms. In leather case, good condition, £8.

EVERSHED & VIGNOLES WEE MEGGER. 250 v. New and unused. £10/10/-. P. & P. 3/- on each.

BATTERY CHARGER REGULATOR 12 ohm, 6 amp. resistor on porcelain base. Knob control. Ideal for Battery Chargers and all types of low voltage regulation. 15/-. P. & P. 1/6.

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TRANSMITTER TYPE 1131J. Output 50 watts approx. Freq. range 100-150 Mc/s. In good order £40 ex-stores.

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SIX TRANSISTOR PLUS DIODE POCKET SUPERHET £7/19/6 plus 3/6 Regd. p.p.

12 Special Features :

- Sensitivity—1 mV. for 50 mW. output
- Power output—150 mW.
- Low consumption—9 ma. (no signal) 18 ma. mean average signal.
- AF response—25 to 5000 cycles.
- Waveband coverage—MW and LW—550 kc/s. to 1500 kc/s.—150 kc/s. to 270 kc/s.
- Mullard Transistors—OC44, OC45(2), OC71. OC72 (matched pair), OA70.
- Printed circuit. Size 6in. x 3¼in.
- Internal hi-Q Ferrite aerial.
- 150Ω 3in. loudspeaker.
- Push-pull output.
- Completely detailed Instruction manual.
- Easy to build.

This receiver is very sensitive and its performance compares most favourably with anything obtainable. It embodies the latest design developments together with the utmost simplicity of construction thereby producing the most amazing results.

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Mixer stage—two I.F. stages—Germanium detector—A.F. driver stage and Push-Pull output.
All components, excluding cabinet and batteries, supplied at special inclusive price of £7/19/6. Plus 3/6 P.P. All parts sold separately.

MINIATURE BIAS CONDENSERS
25 MFD. 25 v. 50 MFD. 12 v., 50 MFD., 25 v. ⅝in. x ¾in. 1/6 each.
25 MFD. 50 v. ⅝in. x 1¼in., 1/9.

DISC CERAMIC CONDENSERS 500 v. Wkg.
500 PF., .001 MFD., .0025 MFD., .002 MFD., .003 MFD., .005 MFD. 6d. each. .01 MFD. 9d.

VARIABLE GANG CONDENSERS
Twin Gang 20 pF. Ideal for F.M. 2in. x 1½in. x 1in. 2/-.
Twin Gang. .0005 MFD. 2⅜ x 2in. x 1⅞in. Spindle 5/16in. 4/-.
Min. Twin Gang. .0005 MFD. 2¼in. x 1⅜in. x 1⅜in. Spindle ¾in., 5/6.
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Twin Gang. .0005 MFD. Geared with SM., 3/6.
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1 pole 10 way. 1 pole 12 way. 2 pole 2 way. 2 pole 3 way. 2 pole 4 way. 2 pole 5 way. 2 pole 6 way. 3 pole 3 way. 3 pole 4 way. 4 pole 3 way.

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Moulded Tracks. Diam., 1in.-2½in. spindles. 5K, 10K. 25K. Linear only. 50K. 100K, 250K, 500K, 1M. 2M. Log or Linear, less switch, 2/6 each. With switch, 4/6.

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Knurled knob and 6BA fixing holes. Diam. 1in. 5K, 25K, 50K, 100K, 250K, 500K, 2M, 1/3 each. 25K, wire wound, 1/6.

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.1 mfd. 12 v., .25 mfd. 15 v., 2-6-8-10 mfds. 3 v., 2-6-8-10-12-16-30-50 mfds. 6 v., 1 mfd. 10 v., 30 mfds. 12 v., 2 mfds., 8 mfds., 15 v., 8 mfds., 16 mfds., 30 v., 2 mfds. 70 v.

SUB MINIATURE TRANSISTOR COILS
Set of 3 I.F. Transformers 470 Kc/s plus Oscillator coil.
As specified for Mullard Circuits 23/6 complete.
As specified for Mazda Circuits 23/6 complete.

TRANSISTOR GANG CONDENSERS
with intermediate screen as specified for MULLARD Transistor circuits, 9/6.
As above with switch for L.W. pre-selection, 11/-.

SUB MINIATURE CARBON POTS
1K, 2K, 5K, 50K, 220K, 330K, 1M, 2/- each. 5M, with switch, 4/6. 5K. 1/6, 500K preset 1/-. 1M Transistor Pots, 2/-. 5K Transistor Pots, 1/6.

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⅝in. x ¼in. 100v. working.
.005 MFD., .0022 MFD., .002 MFD., .001 MFD., 8d each. .01 MFD., .02 MFD. Price 9d. each. .04 MFD. 10d.

WIMA TROPIDUR PAPER CONDENSERS
Small, non-inductive, insulated, high-grade capacitors, 500 v. working, 680 pf., 1,000 pf., 1,500 pf., 2,200 pf., 7d each. 3,300 pf., 8d. 5,000 pf., 6,800 pf., .01 mfd., .012 m 9d. each. .022 mfd., 10d. .05 mfd., 11d. .1 mfd., 1/2. .1 mfd. 250 v. 1/1. .25 mfd. 1/6. .5 mfd. 1/9.

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4 pin Brit. Pax. 2d. 4 pin UX. Amp. 7d. 5 pin Brit. Pax. 2d. 7 pin Brit. Pax. 3d. 7 pin Brit. Amp. 4d. Int. Octal Pax. 3d. Mazda Octal Pax. 3d. Loctals Amp. 6d. B7G Pax. 6d. B7G P.T.F.E. 8d. B7G Cer. with saddle and valve retaining spring 1/-. B8A Pax. 4d. B8A Amp. 6d. B8A Cer. 8d., B9A Pax. 6d. B9A Amp. 8d. B9A Amp. with skirt 10d. B9A Cer. 10d. B9A Cer. with saddle and valve retaining spring 1/-. B9A ceramic with skirt 1/-. B9A printed circuit 1/-. B9A Valve Cans 6d.

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Audio Output Types. 4,500Ω to 3Ω. 5,000Ω to 3Ω, 2/6 each. 6,000Ω to 3Ω, 3/6, 10,000Ω to 3Ω, 3/9, 13,000Ω to 3Ω, 4/-.
Universal CRT Boosters with tapped primaries 2 v.-6.3 v.-13 v., 25% boost all taps 10/6. Filament transformers, centre tapped, 6.3 v. output, 1.5 amp., 5/9; 3 amps., 9/6.

Please allow full postage and packing charges. Stamped and addressed envelope with any enquiry please

TERMS OF BUSINESS : CASH WITH ORDER OR C.O.D. ON ORDERS OVER 10/-

RECORDING TAPES
S.A.E. for money saving price list.

CRYSTAL CALIBRATOR No. 10

(Battery powered 1.4 v. valves). Brand new and unused. Complete with full working instructions, circuit diagram, carrying haversack, connecting lead and spare valves. Frequency range: 1.5 to 10 Mc/s. (Nominal), but can actually be used up to 30 Mc/s. Wgt. 5 lbs. Size 7in. x 7½in. x 4in. A miniature B.C.221 in every respect. A must for every Laboratory, etc. ONLY £4/19/6.- P. & P. 2/6.

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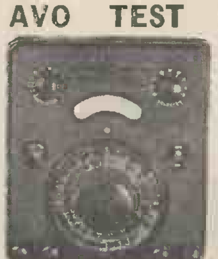
Admiralty Pattern No. 47A. Supplying 40 ranges of current, voltage and resistance tests. Complete in specially made wooden carrying case with leads and batteries, ready for use. Perfect cond. £10. Carr. 5/-.

AVO TEST BRIDGE



A.C. mains operated from 200-250 v. Will test resistance from 5 ohms to 50 megohms and capacity from .00001 to 50 mfds. A most useful instrument for everyday uses. In good order. Our price ONLY £7/19/6. P. & P. 3/6.

EVERSHED & VIGNOLES MEGGER CIRCUIT TESTER (low reading ohm meter). 2 ranges. 0-3, 0-30 ohms. The perfect meter for continuity and polarity testing: Complete with test leads and ready to use. Brand new. Only £4/17/6. P. & P. 3/-.

GEE BROS RADIO Ltd.

15, LITTLE NEWPORT STREET, LONDON, W.C.2. *GER 6794/1453*
ADJOINING LEICESTER SQUARE TUBE STATION — Open 9-6 Weekdays 9-1 Sat.

MARCONI SIGNAL GENERATOR. TYPE TF517-F/1. Covering 10-18 Mc/s. 33-58 Mc/s. 150-300 Mc/s. Used but in very good condition. Complete with full technical data and instructions. Limited quantity. Unrepeatable at only £12/10/-. Carr. 20/-.

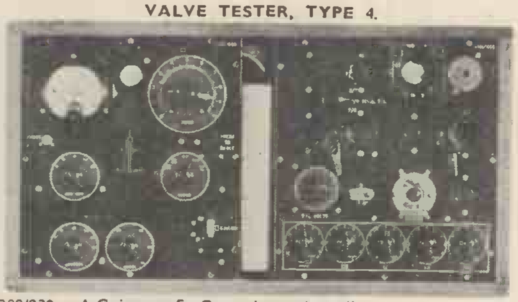
ALSO MARCONI SIGNAL GENERATOR TYPE TF 390G for 200-250 v. A.C. mains input. Freq. range 4-16 Mc/s. and 32-100 Mc/s. indirect calibration. Output 1 uv to 100 M/V 400 c/s internal modulation. In good order Only £12/10/-. Carr. 20/-.

BRIDGE MEGGERS

Evershed and Vignoles Series 2 in perfect condition. 250v. £22 carr. paid Leather case available at 20/- extra.

See opposite page for MORE BARGAINS

VALVE TESTER, TYPE 4.



200/230 v. A.C. input. Ex Govt., in good condition, with descriptive book containing circuit diagram of instrument and how to test valves from 1.4 v. to 40 v. With valve holders for Brit., 4, 5, 7 pin and Octal, U.S., 5 and 7 pin, I/Octal, side contact large Brit., 4 and 9 pin. Acorn and diode. Housed in substantial wooden case with hinged lid. £7/19/6. Carr. 10/-.

D.C./A.C. ROTARY CONVERTERS

ROTARY CONVERTER. 24 v. D.C. to 230 v. A.C. 50 cycles, 150 watts. Brand new and unused £8/10/-. Carr. 7/6. Ditto, 100 watts, £6/9/6. Carr. 7/6.
ROTARY CONVERTER (as illus.). Ex-Govt. 12 v. D.C. input 230 v. A.C. Output 50 cycles at 135 watts. Complete in carrying case with lid. Voltage control, sliding resistance, mains switch and 0-300 v. A.C. flush meter. In good condition, £10. Carr. 10/-.
Motor only, without case, etc. Brand new and unused, £8/10/-. Carr. 5/-.

PRECISION SERIES 834-S. (U.S.A.). Multi range tester for A.C./D.C. volts, ohms and milliamps. Basic movement 400 microamps. Housed in wooden box with carrying strap. Overall size 7½ x 7in. x 5in. Complete with test prods, batteries, etc. Ready to use £5. Post 2/6.

RE-ENTRANT LOUD HAILERS (Ex-Govt.)
Heavy duty 20 watts all-metal. 15 ohms. Diameter 15in., length 15in. (approx.) Perfect condition. £6/10/-. Carr. 10/-.
Ditto. Brand new £8. Carr. 10/-

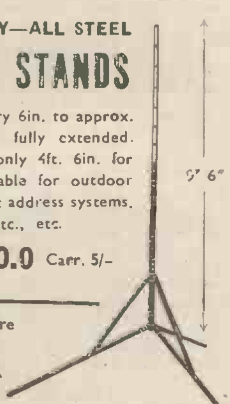
BAKER'S SELHURST SPEAKERS
12in. P.M. 15 ohms 15 watts, 30-14,000 c.p.s. Our price £4/10/-.
"HI-FI MASTER" 12in. 15 ohms. 12 watts, 20-16,000 c.p.s. Flux density approx. 14-15,000. OUR PRICE £7/10/-.
"SUPER HI-FI 25," 12in., 15 ohms, 25 watts 25-20,000 c.p.s. Flux density 17,600. OUR PRICE £9/9/-. All the above speakers are Brand New and full descriptive specification is available.

HEAVY DUTY—ALL STEEL

TRIPOD STANDS

Adjustable every 6in. to approx. 9ft. 6in. when fully extended. (Folds up to only 4ft. 6in. for storage). Suitable for outdoor speakers, public address systems, floodlighting, etc., etc.

OUR PRICE **£3.10.0** Carr. 5/-



These stands are ideal for our RE-ENTRANT LOUD HAILER as described on left.

R.S.C. HI-FI TAPE RECORDER KIT

29½ GNS (Carr. 17/6)

INCORPORATING THE LATEST MK. IV COLLARO TAPE TRANSCRIPTOR. THE LINEAR LT45 HIGH QUALITY TAPE AMPLIFIER. A HIGH FLUX 7 × 4in. LOUDSPEAKER, 850 ft. Reel of Best Quality L.P. TAPE. Spare Tape Spool and a Portable Cabinet, size approx. 18 × 13 × 9in., finished in Veneered walnut or Sapele.

FEATURES INCLUDE

★ 3 SPEEDS. ★ FREQUENCY RESPONSE ± 3d.b. 50-11,000 c.p.s. ★ SWITCHED NEGATIVE FEEDBACK. EQUALIZATION FOR EACH SPEED. ★ OUTPUT 4 WATTS ★ MAGIC EYE RECORDING LEVEL INDICATOR. ★ TWIN TRACK OPERATION. Both bottom and top tracks can be recorded or played back without removing tape. ★ INSTANTANEOUS CHANGES can be made from one track to another. Fast rewind in either direction. ★ TAPE MEASURING AND CALIBRATING DEVICE. ★ TAKES FULL 7in. DIAMETER REELS OF TAPE. ★ NEGLIGIBLE HUM.

YOU CAN PAY TWICE THE COST FOR THE SAME QUALITY. Full descriptive leaflet supplied on receipt of S.A.E.

H.P. TERMS. DEPOSIT 6 Gns. and 12 monthly payments 47/7.

HI-FI 8 WATT AMPLIFIER

SPECIAL PURCHASE DUE TO CANCELLED EXPORT ORDER

£4-19-6

For 200-250 v. A.C. mains Carr 7/6.

A REMARKABLE OPPORTUNITY!

Push-pull output Latest high efficiency B.V.A. valves. Dual separately controlled inputs for mike and gram. Separate bass and treble controls. High sensitivity. Output for 15 ohm loudspeaker. Guaranteed brand new, tested, and in perfect working order.

AUTO-CHANGER
COLLARO RC54 3-SPEED MIXER

Fitted Studio pick-up with turnover head. Brand new cartoned, but for 110 v. 50 c.p.s. A.C. mains. So that the unit can be operated from normal 200-250 v. A.C. mains we are supplying free with every changer a suitable auto-transformer with input and output voltage clearly marked. Limited number only. £5/19/6. Carr. 5/6.

GARRARD 4 SPEED AUTO-CHANGERS

Type RC/120H. Limited number, at £3 19 6. (approx. half price) Carr. 5/6. Brand New.

THE SKY FOUR T.R.F. RECEIVER

A design of a 3 valve 200-250 v. A.C. mains. L. and M. wave T.R.F. receiver with selenium rectifier. For inclusion in cabinet illustrated or walnut veneered type. It employs valves 6K7, SP61, 5F6G, and is specially designed for simplicity in wiring. Sensitivity and quality are well up to standard. Point-to-point wiring diagram. Instructions and parts list. 1/9. This receiver can be built for a maximum of £4/19/6 including cabinet. Available in brown or cream bakelite or veneered walnut.

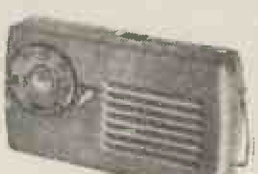
R.S.C. BATTERY TO MAINS CONVERSION UNITS

Type BM1. An all dry battery eliminator. Size 5½ × 4½ × 2in. approx. Completely replaces batteries supply 1.4 v. and 90 v. where A.C. mains 200-250 v. 50 c/s is available. **Suitable for all battery portable receivers requiring 1.4 v. and 90 v.** This includes latest low consumption types. Complete kit with diagram 39/9 or ready for use 46/9.

Type BM2. Size 8 × 5½ × 2¼in. Supplies 120 v., 90 v. and 60 v., 400 mA. and 2 v. 0.4 a. to 1 amp., fully smoothed. THEREBY COMPLETELY REPLACING BOTH H.T. BATTERIES AND K.T. 2 v. ACCUMULATORS when connected to A.C. mains supply 200-250 v. 50 c/s. SUITABLE FOR ALL BATTERY RECEIVERS normally using 2v. accumulator. Complete kit with diagrams and instructions. 49/9 or ready for use 59/6.

SIX TRANSISTOR POCKET RADIO RECEIVER

All parts including cream or coloured plastic case, printed superhet circuit. ferrite aerial. Transistors, 2½in. P.M. speaker. Long and medium wavebands. Size of unit 5¾ × 3¼ × 1¼in. Detailed construction booklet supplied.



£9-19-6

Total cost of parts. A working unit can be demonstrated at our County Arcade premises. All items are available separately.

ACOS HI-FI CRYSTAL 'MIKES'

33-1 hand or Desk type **29/9**

39-1 Stick type **39/6**

Limited number.

R.S.C. TRANSFORMERS

FULLY GUARANTEED

INTERLEAVED AND IMPREGNATED

MAINS TRANSFORMERS

Primaries 200-230-250 v. 50 c/s.

FULLY SHROUDED UPRIGHT MOUNTING

250-0-250 v. 60 mA., 6.3 v. 2 a., 5 v. 2 a.	17/6
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9
300-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	25/9
350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	25/9
300-0-300 v. 130 mA., 6.3 v. 4 a., c.t., 6.3 v. 1 a. suitable for Mullard 510 Amplifier	33/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.	33/9
350-0-350 v. 150 mA., 6.3 v. 2 a., 6.3 v. 2 a., 5 v. 3 a.	33/9
425-0-425 v. 200 mA., 6.3 v. 4 a., c.t., 6.3 v. 4 a., c.t. 5 v. 3 a.	49/9

TOP SHROUDED DROP-THROUGH TYPE

260-0-260 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a.	16/9
350-0-350 v. 80 mA., 6.3 v. 2 a., 5 v. 2 a.	18/9
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	22/9
300-0-300 v. 100 mA., 6.3 v. 4 a., 4 v. 3 a.	23/9
350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.	29/9

ELIMINATOR TRANSFORMERS

Primaries 200-250 v. 50 c/s.

120 v. 40 mA., 5-0-5 v. 1 a.	14/9
90 v. 15 mA., 60-0-6 v. 250 mA.	9/11

FILAMENT TRANSFORMERS

Primaries 200-250 v. 50 c/s.

6.3 v. 1.5 a.	5/9	6.3 v. 3 a.	8/11
6.3 v. 2 a.	7/6	6.3 v. 6 a.	17/6
0-4-6.3 v. 2 a.	7/9	12 v. 3 a. or 24 v. 1.5 a.	17/6
12 v. 1 v.	7/9		

OUTPUT TRANSFORMERS

Midget Battery Pentode 66 : 1 for 3S4, etc.	3/9
Small Pentode 5,000Ω to 3Ω	3/9
Standard Pentode 5,000Ω to 3Ω	5/6
Standard Pentode 8,000Ω to 3Ω	5/6
Push-pull 8 watts 6V6 to 5 ohms	8/9
Push-pull 10-12 watts 6V6 to 3Ω or 15Ω	16/9
Push-pull 10-12 watts to match 6V6 to 3-5-8 or 15Ω	17/9
Push-pull EL84 to 3 or 15 ohms	17/9
Push-pull 15-18 watts, sectionally wound, 6L6, KT66, etc., or 3 or 15 ohms	23/9
Push-pull 20 watt high-quality sectionally wound, 6L6, KT66, etc., to 3 or 15Ω	47/9

SMOOTHING CHOKES

250 mA., 5 H., 100 ohms	11/9
150 mA., 7-10 H., 250 ohms	11/9
100 mA., 10 H., 200 ohms	8/9
80 mA., 10 H., 350 ohms	5/6
60 mA., 10 H., 400 ohms	4/11
1 amp. 0.5 ohm L.T. type	6/6

EXTENSION SPEAKERS

Limited number in handsome Walnut veneered cabinets. 2-3 ohm speech coils, 6½in. 29/9. 8in. 35/9. 10in. 56/9.

DRY SHAVERS. Brand new in carrying case. Operation from 3 U2 batteries, fitted in case. Just the thing for travel. Only 59/6 (approx. half price).

RECORDING TAPE. 600ft. reels, 8/9. 1,200ft. reels 14/9. **GEVASONOR** Best quality L.P. 5in. 850ft. reels 22/6, 7in. 1,700ft. reels 35/-. Less than wholesale price.

SUPERHET RADIO FEEDER UNIT

Design of a high quality Radio Tuner Unit (specially suitable for use with any of our Amplifiers). A Triode Heptode F/changer is used. Pentode I.F. and double Diode Second Detector, delayed A.V.C. is arranged so that A.V.C. distortion is avoided. The W. Ch. Sw. incorporates Gram. position. Controls are Tuning, W. Ch. and Vol. Output will load most Amplifiers requiring 500 mV. input depending on Ae location. Only 250 v. 15 mA. H.T. and L.T. of 6.3 v. 1 amp. required from amplifier. Size of unit approx. 9-6-7in. high. Send S.A.E. for illustrated leaflet. Total building cost is £4/15/-. Point-to-Point wiring diagrams and instructions 2/6.

LITTLE STAAR BATTERY OPERATED RECORD PLAYING UNITS. Complete with Pick-up to take 45 r.p.m. records. Used by leading manufacturers in Transistorised Record Players. Require 6 v. battery. Only £3/19/6. Carr. 3/6.

COLLARO JUNIOR 4-SPEED RECORD PLAYER

with separate pick-up having dual point sapphire stylus. Brand new, cartoned. For 200-250 v. A.C. mains only. Only £3/15/-. Post 3/6.

B.S.R. MONARCH AUTO-CHANGERS

Type UA8. 4 speed, T/O Pick-up with sapphire styli £6/19/6. Carr. 4/6.

UA12 De luxe version wired for stereophony £7/19/6 Carr. 5/6.

R.S.C. A12 STEREO AMPLIFIER KIT

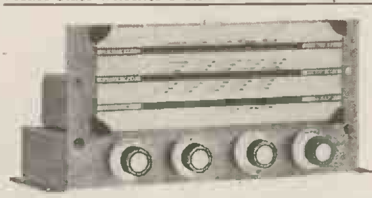
A complete kit of parts to construct a good quality 3 + 3 watt (total 6 watt) stereo amplifier providing really life-like reproduction.

£3-19-6 Carr. & packing 7/6.

Suitable for use with all stereo, pick-up heads at present available. Ganged volume and tone controls. Preset balance control. Outputs for matched 2-3 ohm speakers. For 200-250 v. A.C. mains. Astonishing value.

W.B. "STENTORIAN" HIGH FIDELITY P.M SPEAKERS

HF1012, 10 watts 15 ohms (or 3 ohm) speech coil. Where a really good quality speaker at a low price is required, we highly recommend this unit with an amazing performance. £4/10/9. Please state whether 3 ohm or 15 ohm required.



AM/FM RADIOGRAM CHASSIS, HIGH QUALITY. PUSH-PULL. 6-8 WATT OUTPUT. Current manufacture. 12 months guarantee. For 200-250 v. mains. Covers L. and M. wavebands plus F.M. Includes 8 latest type miniature B.V.A. valves. Only 22 gns. plus 7/6 carr. Or deposit £2/12/- and 9 monthly payments of £2/12/-.

GARRARD 4 Speed Single Players £6/19/6. Carr 4/6.

PHILCO F.M. RADIO TUNERS

With self-contained power pack. A 6-valve de luxe unit housed in beautiful walnut veneered cabinet. For 110-200-250 v. A.C. mains. Magic eye tuning indicator **12½ GNS.** Carr. 5/-.

Or Deposit 22/6 and 12 monthly payments of 22/6.

R.S.C. A.10 ULTRA LINEAR 30 WATT AMPLIFIER

HIGH FIDELITY PUSH-PULL UNIT EMPLOYING SIX VALVES. EF86, EF86, ECC83, 807, 807, GZ34. Tone Control Pre-amp. stages are incorporated. Sensitivity is extremely high. Only 12 millivolts minimum input is required for full output. THIS ENSURES THE SUITABILITY OF ANY TYPE OR MAKE OF MICROPHONE OR PICK-UP. Separate Bass and Treble controls give both "lift" and "cut" with ample tone correction for long playing records. An extra input with associated vol. control is provided so that two separate inputs such as "mike" and gram, etc., etc., can be simultaneously applied for mixing purposes. AN OUTPUT SOCKET WITH PLUG IS INCLUDED FOR SUPPLY OF 300 v. 20 mA. and 6.3 v. 1.5 A. FOR A RADIO FEEDER UNIT. Price in kit form with easy-to-follow wiring diagrams.

Only **11 Gns.** Carr. 10/-. Cover as illustrated 18/9 extra.

Or Factory built with 12 months' guarantee £13/19/6. TERMS ON ASSEMBLED UNITS. DEPOSIT 24/9 and 12 monthly payments of 24/9.

Type 807 output valves are used with High Quality Sectionally wound output transformer specially designed for Ultra Linear operation. Negative feedback of 20 D.B. in main loop. CERTIFIED PERFORMANCE FIGURES ARE EQUAL TO MOST EXPENSIVE UNITS AVAILABLE. Frequency response ± 3 D.B. 30-20,000 c/cs. Tone Controls ± 12 D.B. at 50 c/cs. + 12 D.B. to − 6 D.B. at 12,000 c/cs., hum and noise 70 D.B. down. Good quality reliable components used. Chassis finish blue hammer. Overall size 12 × 9 × 9in. approx. Power consumption 150 watts. For A.C. mains 200-250-250 v. 50 c/s. Outputs for 3 and 15 ohm speakers. EQUALLY SUITABLE FOR THE CONNOISSEUR OR FOR LARGE HALLS, CLUBS OR OUTSIDE FUNCTIONS. IDEAL FOR USE WITH MUSICAL INSTRUMENTS SUCH AS STRING BASS, ELECTRONIC ORGAN, GUITAR, etc. FOR DANCE BANDS, GARRISON THEATRES, etc., etc. We can supply Microphones, Speakers, etc., at keen cash prices or on terms with amplifiers. EXPORT ENQUIRIES INVITED.

LINEAR "DIATONIC" 10 WATT HIGH FIDELITY AMPLIFIER. A compact attractively finished unit. 12 gns. Cash. Send S.A.E. for leaflet. H.P Terms. Dep. 22/3 and twelve monthly payments of 22/3.

LINEAR L45 MINIATURE 4/5 W. QUALITY AMPLIFIER. Suitable for use with any record playing unit and most microphones. Negative feedback 12 D.B. Bass and Treble controls. For A.C. mains input of 200-250 v. 50 c.p.s. Output for 2/3 ohm speaker. Three miniature Mullard valves. Size only 6 × 5 × 5½in. high. Chassis fully isolated from mains. Guaranteed 12 months. Only **£5/19/6.** Or Deposit 22/- and 5 monthly payments of 22/-. Send S.A.E. for leaflet.

LG3 MINIATURE 3 WATT GRAM AMPLIFIER

For 200-250 v. 50 c.p.s. A.C. mains. overall size only 6½ × 4¾ × 2½in. Fitted vol. and Tone Control with mains switch. Designed for use with any kind of single player or record changing unit. Output for 2-3 ohm speaker. Guaranteed 12 months. Only 55/9.

R.S.C. A7 3-4 WATT QUALITY AMPLIFIER. Spec. exactly as A5 below with exception of output wattage. Complete kit of parts, diagrams and instructions £3/15/-, carr. 3/6.

R.S.C. A5 4-5 WATT HIGH GAIN AMPLIFIER

A highly sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolts input is required for full output so that it is suitable for use with the latest high-fidelity pick-up heads in addition to all other types of pick-ups and practically all mikes. Separate Bass and Treble controls are provided. These give full long playing record equalisation. Hum level is negligible being 71 D.B. down. 15 D.B. of negative feedback is used. H.T. of 300 v. 26 mA. and L.T. or 6.3 v. 1.5 a. is available for the supply of a Radio Feeder Unit or Tape Deck pre-amplifier. For A.C. mains input of 200-230-250 v. 50 c/cs. Output for 2-3 ohm speaker. Chassis is not alive. Kit is complete in every detail and includes fully punched chassis (with baseplate) with the blue hammer finish, and point-to-point wiring diagrams and instructions. Exceptional value at only £4/15/- or assembled ready for use 25/- extra, plus 3/6 carriage. Or Deposit 22/- and five monthly payments of 22/- for assembled unit.

P.M. SPEAKERS

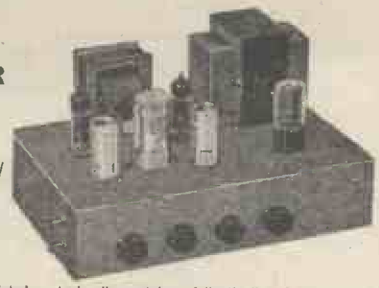
2-3 ohm 2½in. Rola 17/9. 5in. Goodmans 17/9. 7 × 4in. Goodmans Elliptical 19/9. 6½in. Rola 19/9. 8in. Rola 19/9. 8in. Goodmans 21/9. 10in. R.A. 28/9. 10 × 6in. Elliptical Goodmans 29/9. 12in. Plessey 29/11. 12in. Plessey 3 or 15 ohms, 10 watts, 12,000 lines, 59/6.

COLLARO CONQUEST 4-SPEED AUTO-CHANGERS. With studio pick-up with turnover head. BRAND NEW. Cartoned latest model. For 200-250 v. A.C. mains. Very limited number. Conquest £7/19/6. Continental 9 gns. Carr. 5/6.

ACOS Crystal Microphone Inserts. Brand new. Only 5/11 ea. Ex. Equip. 4/11 ea. ACOS HGP59 Hi Fi Crystal Cartridges. (Turnover type with sapphire stylus.) Standard replacement for Garrard and B.S.R. Only 17/9. B.S.R. Ful-fi 17/9.

HIGH FIDELITY 12-14 WATT AMPLIFIER TYPE A11

PUSH PULL ULTRA LINEAR OUTPUT "BUILT IN" TONE CONTROL/ PREAMP STAGES.



Two input sockets with associated controls allow mixing of "mike" and gram. as in A10. High sensitivity. Includes 5 valves, ECC83, ECC83, EL84, EL84, 5Y3. High Quality sectionally wound output transformer specially designed for Ultra Linear operation, and reliable small condensers of current manufacture. INDIVIDUAL CONTROLS FOR BASS AND TREBLE "Lift" and "Cut." Frequency response ±3 D.B. 30-30,000 c/cs. Six negative feedback loops. Hum level 60 D.B. down ONLY 23 millivolts INPUT required for FULL OUTPUT. Suitable for use with all makes and types of pick-ups and microphones. Comparable with the very best designs. For STANDARD or LONG PLAYING RECORDS. For MUSICAL INSTRUMENTS such as STRING BASS, GUITARS, etc. OUTPUT SOCKET with plug provides 300 v. 30 mA. and 6.3 v. 1.5 a. For supply of a RADIO FEEDER UNIT. Size approx. 12-9-7in. For A.C. mains 200-250 v. 60 c/cs. Output for 3 and 15 ohms speakers. Kit is complete to last nut. Chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied. (Or factory built 45/- extra).

Only **8** Gns. Carr. 10/-

If required louvred metal cover with 2 carrying handles can be supplied for 18/9. TERMS ON ASSEMBLED UNITS. DEPOSIT 18/9, and 12 monthly payments of 18/9. Send S.A.E. for illustrated leaflet detailing Ready-to-assemble Cabinets, Speakers, Microphones etc. with cash and credit terms.

R.S.C. PORTABLE GUITAR AMPLIFIER

JUNIOR 5 WATT. High Quality Output. Separate Bass and Treble "cut" and "boost" controls. Sensitivity 15 m.v. High Flux 8in. l/speaker, Handsome strongly made cabinet (Size approx. 14 × 14 × 7ins.). Finished in satin walnut and fitted carrying handle. **£8.19.6** Carr. 7/6. Or Deposit £1 and nine monthly payments £1.

SENIOR 10 WATTS. High Fidelity Push Pull output. Separate Bass and Treble "cut" and "boost" controls. Twin separately controlled high gain inputs so that two instruments such as Guitar and String Bass can be used at the same time. Two Loudspeakers are incorporated, a 12in. P.M. for Bass notes, and a 7 × 4in. elliptical for Treble. Cabinet is well made and finished satin walnut. Size approx. 18 × 18 × 8in. H.P. TERMS. DEPOSIT 23/6 and 12 monthly payments 2°/6. Both models for 200-250 v. A.C. mains.
13 Gns. plus 10/- carr.

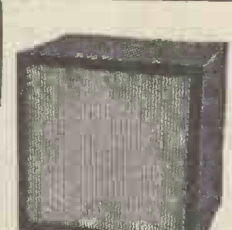
STAAR GALAXY 4 SPEED MIXER AUTO-CHANGERS. Brand New, cartoned. Turnover sapphire styli. Many exclusive features. Unique design motor virtually free from rumble. for 200-250 v. A.C. mains. Limited number tested and guaranteed £5/19/6.

PORTABLE CABINETS

Rexine covered. Wide selection in attractive designs and colour combinations. PRICES FROM **29/6**

12in. 10 WATT HIGH QUALITY L/SPEAKERS IN POLISHED WALNUT FINISHED CABINET

Gauss 12,000 lines. Speech coil 3 ohms or 15 ohms. Only £4/19/6. Carr. 5/-.
Terms: Deposit 11/- and 9 monthly payments of 11/-. 12in. 20 watt 15,000 line l/speakers 15 ohms, in Cabinet finished as above. Size Size 18 × 18 × 8in. £7/19/6 or Deposit 13/10 and 12 monthly payments 13/10.



PORTABLE CABINETS. Attractive design. Two-tone rexine covered. Will take Collaro, B.S.R., Garrard or Staar Auto-changer, amplifier and 7in. × 4in. or 5in. speaker. Slightly soiled. Only 49/6.

ACOS HIGH FIDELITY PICK-UPS. GP54 with HGP59/52 Cartridge. Turnover sapphire Styli, cream finish. Limited number at approx. half price. Only 35/9.

SPECIAL OFFER

Above cabinet Staar Changer. Gram amplifier, and 5in. or 7in. × 4in. speaker £9/19/6. Carr. 10/-. Or with B.S.R. changer in lieu of Staar 11 Gns. Carr. 10/-.

PLESSEY DUAL CONCENTRIC 12in. P.M. SPEAKERS

(15 ohms), consisting of a high quality 12in. speaker of orthodox design supporting a small elliptical speaker ready wired with choke and condensers to act as tweeter. This high fidelity unit is highly recommended for use with our A11 or any similar amplifier. Rating is 10 watts. Gauss 12,000 lines. Price only £5/17/6 Or Deposit 10/6 and 12 monthly payments of 10/6.

R.S.C. (Leeds) Ltd. MANCHESTER and LEEDS.

Personal Shoppers to Universal Bazaars Ltd., 8-10 Brown St., (Market St.), Manchester, 2. and Radio Supply Co., (Leeds) Ltd., 5-7, County (Mecca) Arcade, Leeds, 1.

Mail Orders to 29-31, Moorfield Road, LEEDS, 12.

Terms: C.W.O. or C.O.D. No C.O.D. under £1. Postage 1/9 extra on all orders under £2 2/9 extra under £5 unless carriage charge stated. Full Price List 6d. Trade supplied. Open to callers: 9 a.m. to 6 p.m. Wednesday until 1 p.m. S.A.E. please with all enquiries.

RADIO SUPPLY CO. (LEEDS) LTD.

(Dept. D) 5 and 7, County (Mecca) Arcade, Briggate, Leeds, 1

Terms C.W.O. or C.O.D. No. C.O.D under £1. Post, 1/9 under £2, 2/9 under £5 unless quoted. Open 9—6 p.m. Weds until 1 p.m.

CO-AXIAL CABLE, 75 ohms, ¼in., 8d. yard. Twin screened feeder 11d. yard.

VOLUME CONTROLS with long spindles, all values, less switch, 2/9; with S.P. switch, 3/9.

EX GOVT. STEP UP/STEP DOWN TRANSFORMERS. Double wound. 10-0-100-200-220-240 v. to 9-0-110-122-136-148 v. or Reverse. 300 watts, 35/9, plus 7/6 carr.

2 v. 16 A.H. EX. GOVT. ACCUMULATORS. New boxed. Only 5/6 each, 3 for 15/-, plus 2/6 carr., 6 for 27/6. Carr. 3/6.

D.C. SUPPLY KITS. Suitable for electric trains. Consists of mains trans. 200-250 v. 50 c.p.s.; 12 v. lamp selenium rect. (F.W. Bridge); 2 fuseholders; 2 fuses, change direction switch, variable speed regulator, partially drilled steel case, and circuit. Very limited number, 29/9.

VIBRATORS. Oak and Wearite, synchronous 7 pin, 2 v. 7/9, 6 v. 8/9.

JUNCTION TRANSISTORS. R.F. type, 12/6. Audio type 6/9 Power type Goltop V15/10P 2 watts 16/9.

R3683 UNITS. Comprising chassis and strong cover 16 × 10 × 8in. Over 70 resistors (many high stability) and condensers, valve holders, IFTs, co-ax. sockets, controls, fuseholders, tagboards, etc., etc. Exceptional value at only 12/9 carr. paid.

JACK PLUGS. Standard type complete with 4ft. screened lead. 1/11 each. New Jack Sockets (moulded type), Igranic 2/9 each.

EX GOVT. MAINS TRANSFORMERS

All 200-250 v. 50 c/s. input.

Pr. 0-110-200-230-250 v., 275-0-275 v. 100 mA., 6.3 v. 7 a., 5 v. 3 a.	22/9
250-0-250 v. 150 mA. 5 v. 3 a.	16/9
350-0-350 v. 160 mA., 6.3 v. 5 a., 5 v. 3 a.	27/9
400-0-400 v. 250 mA. 5 v. 2 a., 5 v. 2 a.	18/9
450-0-450 v. 250 mA. 6.3 v. 3 a. 6.3 v. 1 a., 5 v. 6 a.	49 9
12.5 v. 3 a., 5 v. 3 a.	12 9

0-24-26-28 v. 15 amps. A.C. conservative Govt. rating (marked with D.C. rating after rectification) 69/9. Carr. 15/-.
0-10-20-25 v. 24 a. (Govt. rating) 79/6. Carr. 15/-.

ARDENTE DEAF AID EARPIECES with lead and plug. Brand New. Only 15/6

SPECIAL OFFER. Brand New Ex. 24 v. 15 amp. F.W. Bridge Selenium Rectifiers. Only 25/9 ea.

EX. GOVT. SMOOTHING CHOKES

200 mA., 3-5 H., 50 ohms. Parmeko	8/9
150 mA., 10 H., 50 ohms.	9/9
120 mA., 12 H., 100 ohms	8/9
100 mA., 10 H., 100 ohms	6/9
100 mA., 5 H., 100 ohms, tropicalised	3/11
80 mA., 20 H., 900 ohms	5/9
50 mA., 50 H., 1000 ohms	6/9
60 mA., 5-10 H., 250 ohms	2/11

EX. GOVT. CASES. Well ventilated, black crackle finished, undrilled cover. Size 14 × 10 × 8½in., high. IDEAL FOR BATTERY CHARGER OR INSTRUMENT CASE, COVER COULD BE USED FOR AMPLIFIER. Only 9/9, plus 2/9 post.

BATTERY CHARGING EQUIPMENT

All for A.C. Mains 200-250 v. 50 c/s Guaranteed 12 months

SELENIUM RECTIFIERS

L.T. Types

2/6 v. ½ a.h.w.	1/9
6/12 v. ½ a.h.w.	2/9

F.W. Bridge

6/12 v. 1 a.	3/11
6/12 v. 2 a.	6/11
6/12 v. 3 a.	9/9
6/12 v. 4 a.	12/3
6/12 v. 5 a.	14/6
6/12 v. 6 a.	15/6
6/12 v. 10 a.	25/9
6/12 v. 15 a.	35/9

H.T. Type H.W.

120 v. 40 mA.	3/9
250 v. 50 mA.	5/9
250 v. 80 mA.	7/9
250 v. 250 mA.	10/9

ASSEMBLED CHARGERS

6 v. 1 a.	19/9
6 v. 2 a.	29/9
6/12 v. 1 a.	27/9
6/12 v. 2 a.	38/9
6/12 v. 4 a.	56/9

Above ready for use with mains and output leads. Cases well ventilated and finished in stoved blue hammer. Carr. & pkg. 3/6

CHARGER TRANSFORMERS

200-230-250 v. 50 c/s.
0-9-15 v. 1½ a., 11/9;
0-9-15 v. 3 a., 16/9;
0-9-15 v. 5 a., 19/9;
0-9-15 v. 6 a., 23/9.

BATTERY CHARGER KITS

Consisting of Mains Transformer F. W. Bridge. Metal Rectified, well ventilated steel case. Fuses, fuse-holders, grommets, panels and circuit. Carr. 2/6 extra.

6 v. or 12 v. 1 amp...	22/9
As above, with ammeter	32/9
6 v. 2 amps.	25/9
6 v. or 12 v. 2 amps.	31/6
6 v. or 12 v. 2 amps. (inclusive of ammeter)	41/6
6 v. or 12 v. 4 amps.	53/9

BATTERY CHARGER KIT 6/12 v., 6 amp., consisting of F.W. Bridge Rectifier Mains Trans. and ammeter. 49/9. Post 4/6.

ASSEMBLED CHARGER 6 v. or 12 v. 2 amps.

Fitted Ammeter and selector plug for 6 v. or 12 v. Louvred metal case, finished attractive hammer blue. Ready for use with mains and output leads. Double Fused. Only **49/9** Carr. 3/9.

ASSEMBLED 6 v. or 12 v. 4 amps.

Fitted Ammeter and variable charge selector. Also selector plus for 6 v. or 12 v. charging. Double fused. Well ventilated steel case with blue hammer finish Ready for use with mains and output leads. **75/-** Carr. 4/6. Or Deposit 14/11 and five monthly payments 14/11.

As above but for 6 amp. charging. 5 GNS. Carr. 5/-. Or Deposit 19/9. and five monthly payments of 19/9.

D. C. OSCILLOSCOPE

A.C. MAINS 200-250 Volts

Size
Height 10"
Width 6¾"
Depth 9"
Weight 11½lbs.

£15.15.0 Plus P. & P. 7/6

TRADE ENQUIRIES INVITED

Or 30/- deposit, plus 7/6 post & packing and 12 monthly payments of 26/6.

AS SIMPLE AS π

HERE'S THE ANSWER

SIMPLIFIED SERVICING PROBLEMS WHEN USING THE

'TESTGEAR' SCOPE

3" D. C. OSCILLOSCOPE

Engineered to precision standards, this high-grade Instrument is made available at THE LOWEST POSSIBLE PRICE, incorporating the essential features usually associated with luxury instruments.

This "SCOPE" will appeal particularly to Service Engineers and Amateurs. A HIGH GAIN, EXTREMELY STABLE DIFFERENTIAL Y AMPLIFIER (30 mV/C.M.). Provides ample sensitivity with A.C. or D.C. inputs. Especially suitable for MEASUREMENT of TRANSISTOR OPERATING CONDITIONS where maintenance of D.C. LEVELS is of paramount importance. Push-pull X Amplifier; Fly-back suppression; Internal Time-base Scan Waveform available for external use; PULSE OUTPUT available for checking T.V. LINE O/P TRANSFORMERS, etc.; Provision for external X I/P and CRT. Brightness Modulation.

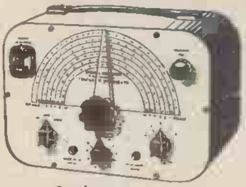
FULL 12 MONTHS' GUARANTEE INCLUDING VALVES and TUBE.

Full Technical Information on receipt of S.A.E.

RADIO & T.V. COMPONENTS (ACTON) LTD.
23 HIGH STREET, LONDON, W.3

Goods not despatched outside U.K.

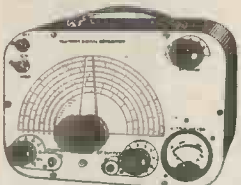
SIGNAL GENERATOR



Coverage 100 Kc/s.-100 Mc/s. on fundamentals and 100 Mc/s. to 200 Mc/s. on harmonics. Metal case 10in. × 6¾in. × 5¼in. grey hammer finish. Incorporating three miniature valves and Metal Rectifier. A.C. Mains. 200/250 v. Internal Modulation of 400 c.p.s. to a depth of 30%. Modulated or unmodulated R.F., output continuously variable 100 millivolts C.W and mod. switch, variable A.F. output. Incorporating magic-eye as output indicator. Accuracy plus or minus 2%.

£6/19/6 Or 25/- deposit and 6 monthly payments of 21/6. Post & Packing 5/- extra.

SIGNAL GENERATOR

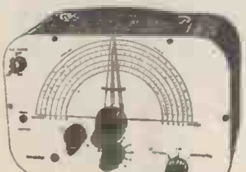


Coverage 120 Kc/s—320 Kc/s., 300 Kc/s.—900 Kc/s.. 900 Kc/s.—2.75 Kc/s., 2.75 Mc/s.—8.5 Mc/s., 8 Mc/s.—28 Mc/s., 16 Mc/s.—56 Mc/s., 24 Mc/s.—84 Mc/s. Metal case 10in. × 6½in. × 4½in. Size of scale 6½in. × 3½in. 2 valves and rectifier A.C. mains 230-250 v. Internal modulation of 400 c.p.s. to a depth of 30 per cent., modulated or unmodulated R.F., Output continuously variable 100 millivolts C.W. and mod-switch, variable A.F. output and moving coil output meter. Grey hammer finish case and white panel. Accuracy plus or minus 2%. **£4/19/6**

Or 25/- deposit and 4 monthly payments 21/6. P. & P. 5/- extra.

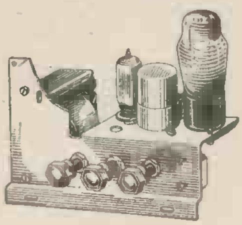
SIGNAL & PATTERN GENERATOR

£6/19/6 P. & P. 5/-



Or 25/- deposit, P. & P. 5/- and 6 monthly payments of 21/6.
Coverage 7.6 Mc/s.-210 Mc/s. in five bands, all on fundamentals, slow motion tuning audio output. 8 vertical and horizontal bars, logging scale. In grey hammer finished case with carrying handle. Accuracy ±1% A.C. mains 200-250 v.

PORTABLE AMPLIFIER



Size 6½in. long. 5in high, 2¼in. deep. Will suit any type of crystal pick-up. Output approx. 2 watts. Incorporated ECC 83 double triode. Cossor 142BT output pentode and contact-cooled rectifier. Fully isolated mains transformer for 250-250 A.C. mains. Bass, treble and volume controls.

49/6 Plus P. & P. 3/6.

5" SPEAKER WITH O.P. TRANSFORMER

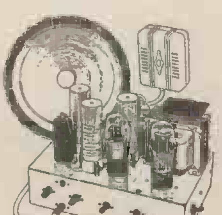
purchased with the above 18/6. Plus P. & P. 1/6.

F.M. TUNER UNIT

Permeability tuned, by famous German Manufacturer. Coverage 88—100 Mc/s. Complete with ECC85. Size 4" × 2" × 2".

25/- Plus P. & P. 1/6.

8 WATT PUSH-PULL AMPLIFIER



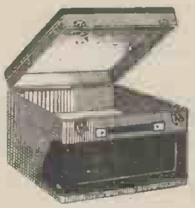
COMPLETE WITH CRYSTAL MIKE AND 8in. LOUDSPEAKER

A.C. mains 110/250 v. Size 10½in. × 6½in. × 2¼in. Incorporating 6 valves, H.F. pen., 2 triodes, 2 output pens., and rectifier. For use with all makes and types of pick-up and mike. Negative feed back. Two inputs, mike and gram., and controls for same. Separate controls for Bass and Treble lift. For use with Std. or L.P. records, musical instruments such as Guitars, etc.

£4.19.6 Plus P. & P. 7/6.

Or 20/- deposit, Plus P. & P. 7/6 and 4 monthly payments of 23/-.

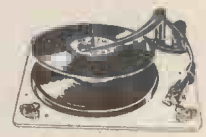
PLAYER CABINET



Finished in 2-tone leatherette, will take B.S.R. UA8, with room for amplifier and 7in. × 4in. speaker. Overall size 15½in. × 13¼in. × 9¼in.

£2.19.6 Plus 5/- P. & P.

COLLARO MIXER 4-SPEED AUTOMATIC CHANGER

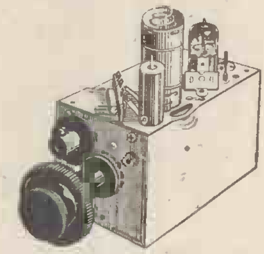


Model 457. Type "O" Pick-up, size 12in × 13¼in. Minimum clearance above baseboard 5in., below 2¾in., 10 records. A.C. mains 200-250 v. Turnover crystal head. BRAND NEW Fully guaranteed

Cash **£8/19/6**

Plus P. & P. 5/-

13 CHANNEL TUNER

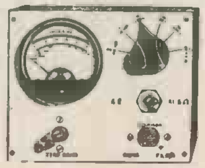


34 to 38 Mc/s. complete with PCF80 and PCC84. These have been removed from chassis.

23/- complete with knobs. P. & P. 3/6 extra.

16-19. Mc/s complete with knobs less valves. 13/- Plus P. & P. 2/6

AC/DC POCKET MULTI-METER KIT



Comprising 2in. moving coil meter, scale calibrated in A.C./D.C. volts, ohms and milliamps. Voltage range A.C./D.C. 0-50, 0-100, 0-250, 0-500. Milliamps. 0-10, 0-100. Ohms range, 0-10,000. Front panel, range switch, wire-wound pot (for ohms zero setting), toggle switch, resistors and rectifier. Basic movement, 2 mA. In grey hammer finish case.

19/6 Plus P. & P. 1/6 Built and tested 7/6 extra.

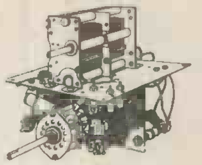
Point to point wiring diagram 1/- free with kit.

6 watt PUSH-PULL AMPLIFIER

A.C. mains 220/250 v. Incorporating 4 valves and metal rectifier. 2 inputs, high and low, and controls for same. Separate controls for Bass and Treble lift. Size of chassis 11in. × 4½in. × 2¼in

59/6 Plus P. & P. 5/-

4 WAVE BAND COIL UNIT



Complete with tuning condenser. Separate sections for short wave. Coverage 10-21 m., 21-45 m., 44-100 m., and 190-545 m. I.F. 470 Kc., BRAND NEW, by famous manufacturer. Completely assembled on sub-chassis. With circuit diagram. **19/6** Plus P. & P. 3/6.

CONSTRUCTORS' PORTABLE PARCEL

Comprising case, chassis, top plate, scale, 3in. P.M. speaker with O.P. trans., twin gang, 2 470 Kc/s. I.F.s., trimmers, four valve holders, wavechange switch and volume control with switch.

39/6 Plus 3/6 Postage and packing.

LINE E.H.T. TRANSFORMER

By famous manufacturer. 14 Kv. Complete with built-in line and width controls. Winding for EY51 Rectifier **19/6** Plus P. & P. 2/6.

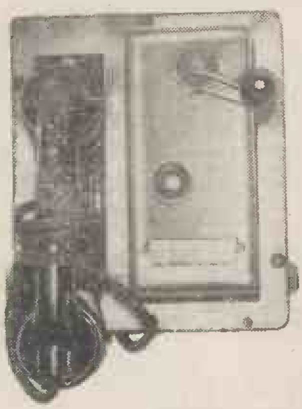
MAINS TRANSFORMERS

All with tapped primaries 200-250 volts.
0-160, 180, 200 v., 60 ma., 6.3 v. 2 amps. 10/6. 320-0-320 v. 75 ma., 6.3 v., 2.5 amp., 5 v., 2 amp., 10/6. Postage and packing on the above 3/-.

RADIO AND T.V. COMPONENTS (ACTON) LTD.

23, ACTON HIGH STREET, LONDON, W.3

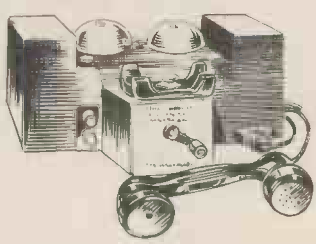
GOODS NOT DESPATCHED OUTSIDE U.K. ALL ENQUIRIES S.A.E.
TERMS OF BUSINESS C.W.O



SOUND POWER TELEPHONE UNIT. No batteries required. Fitted with neon indicator lamp and high pitched buzzer, operated by built-in generator. Entirely self-contained, ex Admiralty. Rebuilt and guaranteed working. Effective up to half a mile, waterproof.

£3 Unit or £5/17/6 pr. Carr. 7/6. Master Units to take five extensions also available £4 each.

SOUND POWER TELEPHONE HANDSETS. New, 17/6 each. P. & P. 2/-.



TELEPHONE SETS TYPE F. Portable telephones each in an individual carrying case containing telephone handset, telephone unit, ringer, bells and complete with long-life batteries. Each set perfect, tested, guaranteed working. Each pair supplied with 100ft. telephone cable. Has a range of up to 5 miles, ideal for factories, building sites, farms, etc.

Price £7/10/- per pair. Carr. England 9/6.

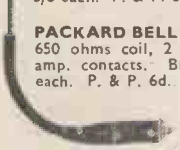
AERIAL AS ILLUSTRATED. Ideal for Car. Overall length 33in., khaki, with flexible shaft which enables the aerial to be fixed firmly in any position. Price 8/6, plus P. & P. 1/6.

NEW WIRE WOUND RHEOSTAT ON CERAMIC. 58 ohms, 50 watt, complete with instrument knob. Price 8/6. P. & P. 1/6.

HIGH SPEED RELAY. Siemens, two bobbins, 1,000 ohms each. New, 10/6 each. P. & P. 1/-.

U.S.A. 27-volt 4-pole CHANGE-OVER RELAYS. Brand new and boxed, 5/6 each. P. & P. 6d.

PACKARD BELL RELAYS. 12/24 volt, 650 ohms coil, 2 pole changeover, 1.5 amp. contacts. Brand new. Price 5/6 each. P. & P. 6d.



NEW 10 watt DUAL VOLUME CONTROL. 25 ohms, plus 25 ohms. 7/6 each. P. & P. 1/6.

EVERSHED AND VIGNOLES. Circuit testing Ohms Meter, pattern "S" complete with testing prods, inst. book, etc. Two ranges: 0–3 and 0–30 ohms. Brand new, guaranteed perfect, as illus. Offered at fraction of maker's price. £4/17/6 each. P. & P. 2/6.

EVERSHED AND VIGNOLES "Wee Megger" 500 volt in leather case. Guaranteed perfect. Price £13/15/-. P. & P. 2/6.

TRIPLE RANGE VOLTMETER, 0–5 25–250 V. D.C. M/C 3½in. meter 3in. scale, mounted in bakelite carrying case 7½in. x 4½in. x 3in. complete with handle and test leads. 27/6 each. P. & P. 2/-.

WHEATSTONE BRIDGE UNIT. 4-stud switches 0–10, 0–100 ohms, galvanometer centre zero, F.S.D. 2.5 mA. In oak carrying case 16 x 7½ x 6in., 40/- each. P. & P. 3/6.

AUTO TRANSFORMERS, step up, step down, 110–200–220–240 v. Fully shrouded. New.

300 watt type £2/2/- each. P. & P. 2/6. 500 watt type £3/3/- each. P. & P. 3/9. 1,000 watt type £4/4/- each P. & P. 6/6. Also 60 watts, 19/6 each. Plus P. & P. 2/-

12 v. D.C. AMPLIFIER, as new, for operation on 12 v. car battery, 10 watts undistorted output, with 6L6 valves in push-pull. Mike/Gram input, tapped output 7½, 15, 62, 100, 250 or 500 ohms. £12/10/- each. Carr. 15/-.

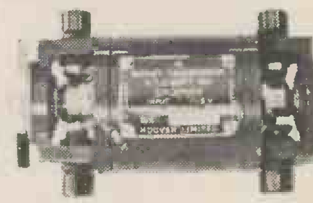
TRUVOX LOUD HAILERS, brand new complete with transformer and condenser. Impedance 7½ ohms. Handling capacity 8 watts. Ideal for speech. Price: 18/6. P. & P. 3/6 Pair 42/- postage paid.

ROTARY CONVERTER. Input 12 v. D.C. Output 230 v. A.C. 150 watts, 50 cycles. Built in a wooden case and fitted with a voltage control, slider resistance, switch, plugs and A.C. mains output meter. Tested, guaranteed perfect working order. Price £9/19/9. Carr. 10/-.

METERS BRAND NEW GUARANTEED PERFECT

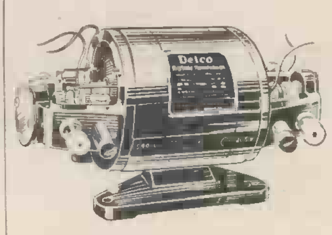
Charging Types	
2½ amp. DC M.I. 2in. fl. rnd.	7/6
5 amp. D.C. M.I. 2½in. fl. rnd.	11/6
7½in. D.C. M.I. 3½in. proj. rnd.	12/6
9 amp. D.C. Hot Wire W.R. 2½in. fl. rnd.	6/6
Voltmeters	
12 v. D.C. M.C. 2½in. proj. rnd.	8/6
20 V. D.C. M.C. 2in. fl. sq.	9/6
25 Volt D.C. M.C. 2in. fl. rnd.	7/6
30 Volt M.I. 3in. proj. rnd.	10/6
40 Volt M.C. 2in. fl. sq.	9/6
250 Volt A.C. rectified moving coil linear scale 3½in. fl. rnd.	35/-
300 Volt A.C. M.I. 2½in. fl. rnd.	22/-
400 Volt A.C. M.I. 4½in. fl. rnd.	35/-
Milliammeters	
5 mA. M.C. 2in. fl. sq.	12/6
30 mA. M.C. 2½in. fl. rnd.	9/6
50 mA. M.C. 2in. fl. sq.	8/6
200 mA. M.C. 2½in. fl. rnd.	9/6
500 mA. M.C. 2½in. fl. rnd.	9/6
0-1 mA FLUSH MOUNTING PULLEN M.C. METER, 4" x 5" CORRECTLY CALIBRATED	57/6
Thermo-coupled	
350 mA. 2in. rnd. plug-in	3/6
500 mA. 2in. rnd. plug-in	3/6

POSTAGE ON ALL METERS 1/-.



MIDGET ROTARY TRANSFORMERS. 2½in. dia. x 4½in. Input 11.5 volt. Output 310/365 volts at 30 mA. Brand new. 12/6 each. P. & P. 1/6.

DYNAMOTOR (Rotary Convertor). 6 volt in, 250 volt out at 100 mA, ex new equipment. 25/- each. P. & P. 3/-



ROTARY TRANSFORMERS made by Delco. Input: dual voltage 12 or 24 v. Output: 265 v. 120 mA., 500 v. 26 mA. Price 27/6 each. P. & P. 3/6.

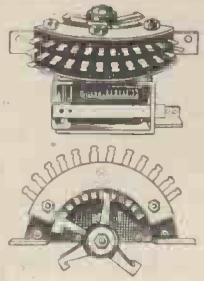
SPRING LOADED FUSED TEST PRODS, complete with wire leads and spade terminals. Price 4/6 per pair. P. & P. 1/-.

MUIRHEAD VERNIER DRIVE. Scaled 0–180 degrees, ratio 31/1, dia. 3in., as fitted to R.F.26 units. Complete with lampholder. In manufacturers' original packing. New, 8/6 each. P. & P. 1/6.

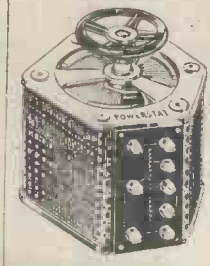
MINIATURE BUZZER twin coil 4½/6 volt nickel plated, new. Price 4/6 P. & P. 6d.

L.F. CHOKE FOR AR88. Fully shrouded, new. 10/6. P. & P. 2/-.

SERVICE TRADING COMPANY →

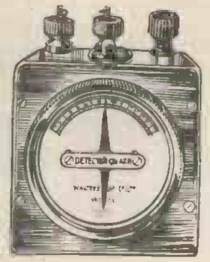


MINIATURE UNISELECTOR SWITCH, two banks of ten plus home contacts, one bank continuous of normal. 30 ohms coil for 24 volt operation. Brand new, manufacturer's packing. Price 22/6 each. P. & P. 2/6. Illustrations above and below.

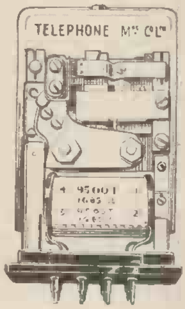


VARIABLE VOLTAGE TRANSFORMERS, as illustrated above. Brand new in manufacturers original cases. Input 230-volt A.C., output variable from 0 to 270 volt at 9 amperes. Price £15 each, plus carr. 12/6.

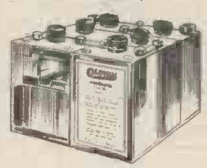
NEW GALVANOMETERS solid brass, 3in. dial, in polished wooden case. 70 degree scale, 35 mA either side. 100 ohm coil. Price 12/6 each. P. & P. 1/6.

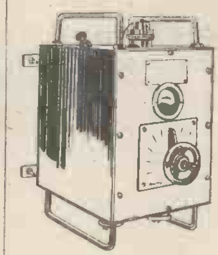


NEW CARPENTER'S TYPE POLARISED RELAYS. 2x9, 500 turns at 1,685 ohms. Price 22/6 ea. P. & P. 1/-.



NEW UNCHARGED UNFILLED 12 VOLT ACCUMULATOR 9 ampere in unspillable plastic cases. Comprises 6 x 2 volt separate cells connected by terminal strips. 6 x 5½ x 4½in. over terminals. Price 19/-, plus P. & P. 2/9. Wooden carrying case for same with lid and strap price 3/6.

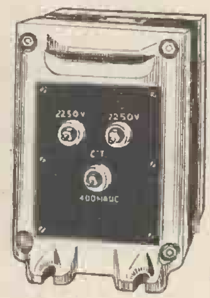




L.T. TRANSFORMER, input 230 V. Output 50 V. 50 amp. Adjustable by regulator switch on primary Steel case with mains switch. Will take 100% overload. Weight 150 lbs. Wound at 800 amps per sq inch. Brand new. Price: £15. Carr. £1.

MUIRHEAD PRECISION, 4 bank, 1 pole, 24 position Stud Switch. Heavy duty contacts, brand new, original boxes. Price 17/6 each. P. & P. 1/-.

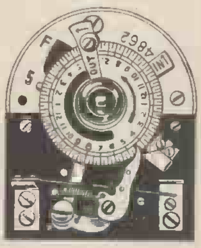
PLATE TRANSFORMER of very best U.S.A. make, brand new, original manufacturer's cases. Input tapped at 190/210/230/250 V. Output 2250-0-2250, centre tapped 400 mA. Nett weight 76lb., size 13in. x 9in. x 6½in. Price £6/10/- each. plus carr. 10/-.



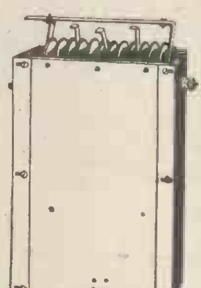
MINIATURE MOVING COIL DIFFERENTIAL RELAY. Two coils 350 ohms each. Operating current minimum 140 microamp, nominal 400 microamp, maximum 8 milliamp. One pole two way, or, centre stable. Two way contact current 100 mA at 50 V A.C. or D.C. Size 1½ x ⅞ x ⅞in. Price: 22/6 each.

CERAMIC PRECISION SWITCH
2 pole, 6 way, 4 banks. New in manufacturers' boxes. Price 10/6 each. P. & P. 1/6.

VENNER 8-day clockwork Time Switch. Contacts 1 amp. 230 volt. 24 hour phase, ½ hour divisions, allows setting for one make and one break to be made every 24 hours, complete with key. Used but guaranteed perfect. Price 27/6 each. P. & P. 1/6.



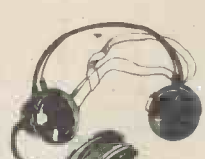
20 WAY STRIP containing standard Post Office telephone Jack Sockets, overall size 11 x 3½ x ½in. New. Price 15/- each. P. & P. 1/6.
10 WAY STRIP standard Post Office telephone Jack Sockets spacing allowing Igranic Jack Plugs. New. Price 10/-. P. & P. 1/6.



BRAND NEW SELENIUM FULL WAVE BRIDGE TYPE RECTIFIERS, in manufacturers' original packing. D.C. output 36 v. 10 amp., made up of 12 x 110 mm. dia. plates. These fitted in cooling funnel (removable), size 11½in. x 8in. x 4½in. Price 45/-. P. & P. 3/3.

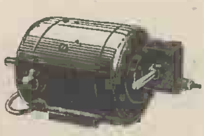
MINIATURE P.M. MOTOR 12/24 volt, reversible, 1¼in. dia. New Price 9/6 each. P. & P. 1/-.

LATEST MOST MODERN TYPE OF EX W.D. MINIATURE HEADPHONES as illustrated. Brand new, low impedance. Price: 10/6 plus P. & P. 1/6.

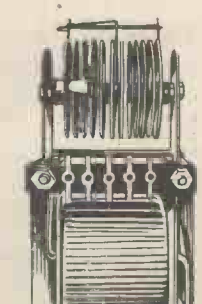


NEW MOVING COIL HEAD SETS, complete with Tannoy carbon hand microphone, with plug suitable for No. 19 set. Price: 12/6 each, plus P. & P. 2/-.

200/250 v. A.C. MOTORS. New 1/80 h.p., 2 drives, direct 6,000 r.p.m., reduction 300 r.p.m. 22/6 each. P. & P. 2/6.



TWELVE PLATE F.W. BRIDGE CONNECTED RECTIFIER mounted on 200/250 volt A.C. input transformer. Output 36/40 volt D.C. at 1.2 amps. New, perfect. Price 16/6. P. & P. 3/6.



HEADPHONES 4,000 ohms, imported, new Price 15/-.

MICROPHONES—NEW, throat, British, Magnetic. 4/6. P. & P. 1/-.

AIRCRAFT CINE CAMERA G45B Mk. III, fully modified, fitted with f/3.5 triple anastigmatic lens, takes 25ft. of 16 mm. film, fitted with 24 v. motor. 16 exposures per sec. Brand new, original packing £4/10/- each. P. & P. paid.

CHARGING TRANSFORMER 4 amp, 230 volt (tapped primary) fully shrouded for 6 & 12 volt charging. Price: 12/6 P. & P. 2/6.

MARCHING COMPASS Mk. I. Brand New, ex W.D. Price 14/6 P. & P. 1/-.

WE ARE EXPERTS AT OVERSEAS PACKING & SHIPPING!

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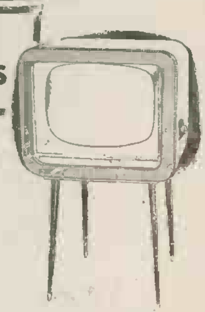
★ FOR YOUR CONVENIENCE **EASY NO DEPOSIT, INTEREST FREE, DEFERRED TERMS** ON ALL GOODS—Send for details ★

★ FEATURES ★

17" T/V WHILE STOCKS LAST 19 GNS



★ Beautiful latest finish cabinet in contemporary style. Covered and washable.

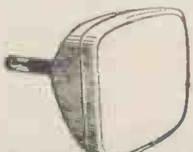
★ Polished legs, 18in., optional extra for **25/-**.

★ **17in. BRITISH** Rectangular Tube. Guaranteed fully for 12 months.

★ 12 channels. "Turret Tuned"—I.T.A./B.B.C. Extra coils at only **7/6** a pair (with order).

★ **Chassis.** 14 B.V.A. Valves. Salvaged but reconditioned and guaranteed 3 months.

Carr. & Ins. 30/-.



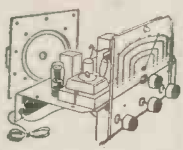
12 MONTHS' FULL GUARANTEE

£8'10'0 CASH PRICE

REPLACEMENT RE-BUILT T/V TUBES

All sizes except 10in. Completely rebuilt gun assembly new cathode, heaters, etc., giving the high standard required for long picture life, quality and value. Carr. & Ins. 15/6.
OR Yours for 8/6 initial payment (plus carr. & ins.) and 19 weekly payments of 8/6.

★ EXPRESS DESPATCH SERVICE ★
Please 'phone to confirm tube in stock. Send Telegraph Money Order. Tube despatched Passenger Train same day. This service only available with remittance by a Telegraph Money Order and cash sales—not Terms.



SUPER CHASSIS 79'6

5 valve superhet chassis including 8in. P.M. speaker and valves. Four control knobs (tone, volume, tuning w/change switch). Four wavebands with position for gram p.u. and extension speaker, A.C. Ins. & carr. 5/6.

14" T.V. CHASSIS TUBE & SPEAKER 11GNS

With 14in. Rectangular Tube. 12 months' guarantee on Tube, 3 months' guarantee on chassis and valves. Chassis with tube and speaker (less valves). 11 guineas. Complete and working with valves and Turret Tuner. 17 gns. Ins. carr. (incl. Tube) 25/-.

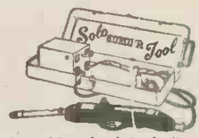
T.V. CHASSIS AT CLEARANCE PRICES

THE POPULAR 12in. PLESSEY CHASSIS 9/6

A bargain for anyone wanting to make up their own T.V. at a very low cost. A chassis in one unit. Less valves and tube. Chassis size 12×14½×11in. I.F.s 10.5-14 Mc/s. Can be adapted for a 12 channel Turret Tuner and modified to take a larger tube. Carr. & Ins. 10/6.

GANG CONDENSERS 1/9
Salvage guaranteed. Standard size two gang, .0003 and .0005. All Tested and guaranteed. P. & P. 1/3.

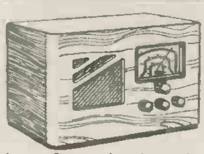
SOLO SOLDERING TOOL 12'6



110 v., 6 v. or 12 v. (special adaptor for 200/240 v. 10/- extra). Automatic solder feed including a 20ft. reel of Ersin 60/40 solder and spare parts. It is a tool for electronic soldering or car wiring. Revolutionary in design. Instantly ready for use and cannot burn. In light metal case with full instructions for use. Post 3/6.

FAMILY RADIO 99/6
Five valve (octal) superhet. A.C. 3 waveband and gram position. 4 controls. Modern attractive cabinet size 15½×18×10½in. in cream and brown. Carr. & Ins. 8/6.

DUKE & CO.



HOME RADIO 79/6

A.C./D.C. Universal mains 5 valve octal superhet. 3 waveband receiver can be adapted to gram p.u. In attractive wooden cabinet. 9¼×18½×11¾in. Ins. carr. 4/6.

CHASSIS 1/-
Six or eight valve latest type midget valve design for A.M. or F.M. Brand new. Cadmium plated. Size 12¼×7¼×2⅞in. P. & P. 1/9.

RECTIFIERS 2/9
250 v. 100 m.a. Full or half wave. Salvage guaranteed. Why hunt for those obsolete rectifier valves when you can cheaply replace with a modern selenium rectifier. P. & P. 1/3.

SOUND/VISION and I.F. STRIP 7/9
Plessey. I.F.'s 10.5 Mc/s sound. 14 Mc/s. vision. 8 valve-holders. Less valves. Size 8½×5×4½in. Circuit incl. The tuner unit plugs directly into this chassis. P. & P. 2/6.

SOUND/VISION AND I.F. STRIP 2/9
Salvaged. Complete sound and vision strip. 8 valve-holders. Less valves. I.F.'s 16-19.5 Mc/s. Size 8½×4½×4½in. Drawings free with order. P. & P. 2/6.

SOUND/VISION AND I.F. STRIP 2/9
Salvaged. Superhet. 8 valve-holders. Less valves. I.F.'s 7.25 Mc/s. sound. 10.75 Mc/s. vision. Vision complete from input up to video output. Sound complete from input to A.F. amplifier. P. & P. 2/6.

INSULATING TAPE 1/6
75ft. of ½in. tape in sealed metal container. Post 9d.

R.F. E.H.T. COIL 7/9
7-10 kV. R.F. frequency approx. 22Kc/s. Uses 6v6 or P61 as osc., suitable for Ultra Model V600, W700 and many other sets, or replacing E.H.T. mains transformers. Ideal when using a larger tube. Size 4½×2in. dia. Base: 4×4½in. Circuit drawings available with order. P. & P. 2/6.

COLVERN PRESET POTENTIOMETERS 2/9
Brand new. 200 ohms. 10 K. and 20 K. P. & P. 6d.

FOCUS MAGNET 9/9
Brand new. 38 mm. Incorporating picture shift control. P. & P. 1/3.

SCANNING COILS 10/6
Low impedance. 38 mm. Brand new. P. & P. 1/3.

SCANNING COILS 15/9
Wide angle 90°, 38 mm. Low impedance. P. & P. 1/3.

13 CHANNEL TURRET TUNER 65/-
Brand new. Well-known manufacturer. 38 Mc/s. Complete with valves. 3 series line up and channel coils, covering channels 1, 2, 3, 4, 5, 8 and 9. Carr. and Ins. 3/6.

CO-AX CABLE 6d. yard.
Cut to any length. Good quality, 1/6 postage on 20 yds.

T.V. AERIALS 23/6
For all I.T.A. channels. Outdoor or loft. 3 elements. P. & P. 2/6.

AERIALS 15/6
B.B.C. indoor type. Folded dipole with 12ft. Co-ax cable fitted. Post 1/9.

T.V. AERIALS 7/9
For all channels. Complete with co-ax cable. For use indoors or in the loft. Postage 1/3.

CAR AERIALS 6/9
Whip antennae. Plated. 50in. long collapsing to 11in. One hole fixing. Post 1/-.

★ TRANSFORMERS ★

HEATER TRANSFORMER 12/9

12 volt at ½ amp. 0-200-250 volt primary. P. & P. 1/9.

HEATER TRANSFORMER 3/9
2-1 Ratio auto transformer 2 volt at 1.4 amp. primary, 4 volt secondary. P. & P. 1/9.

EY51 7 KV. ISOLATION TRANSFORMER 5/9
1-1 ratio. Suitable 6.3 tube as isolation transformer. P. & P. 1/9.

OUTPUT TRANSFORMER 3/9
Salvage guaranteed. Standard size. 2-5 ohms. Matching pentode or tetrode. O.B. valve. P. & P. 1/9.

FRAME OUTPUT TRANSFORMERS 3/9
To match our low impedance scanning coils. P. & P. 1/3.

TIME BASE 2/9
Containing scanning coils, line transformer, etc. Less valves. Drawings free with order. P. & P. 2/6.

POWER PACK AND AMPLIFIER 19/6
R.F. E.H.T. Not tested. Amplifier stage 6V6 with O.P. trans. 3 ohms. matching. Smoothed H.T. 350 volt at 250 mA., 6.3 v. at 5 amp., 22 v. at 3 amp., 6.3 v. at 4 amp. and 4 v. centre tapped. Less valves. Drawings free. Size 14½×8×7in. Ins., carr. 5/6.

POWER PACK AND AMPLIFIER 12/6
Output stage 6V6 with O.P. trans. 3 ohms. choke. Smoothed H.T. 350 v. at 250 mA., 6.3 v. at 5 amp., 22 v. at 3 amp., 6.3 v. at 4 amp., and 4 v. centre tapped. Less valves. Ins. carr. 5/6.

HERE IS UNREPEATABLE VALUE!

RECORD PLAYER CABINET

R.P.6.

29'6

Elegant cabinet, cloth covered in grey or red with sunken control panel and speaker fret. Size 13 × 17 × 8in. deep. Takes a B.S.R. Monarch 4-speed autochanger. 7 × 4in. elliptical speaker and most of the modern portable amplifiers. Carr. and Ins. 4/6.

RP7

SINGLE PLAYER CABINET

19/6

Smart cabinet. Size 14½ × 12½ × 6¼in. deep. Various 2-tone colour schemes with white handle and piping. Takes T.U.9 B.S.R. single player unit, 4×7in. elliptical speaker and amplifier D.1. or D.2. Carr. and Ins. 4/6.

WORLD'S FINEST AUTOCHANGER

U.A.8. B.S.R. MONARCH 4-SPEED AUTOCHANGER £6.19.6

U.A.12. LATEST B.S.R. MONARCH 4-SPEED MIXER £6/19/6.
T.U.9. B.S.R. 4-SPEED SINGLE PLAYER 89/6.
B.S.R. MONARCH 4-SPEED STEREO AUTOCHANGER £9/19/6.
COLLARO CONQUEST 4-SPEED AUTO-CHANGER £6/19/6.
COLLARO CONQUEST STEREO AUTOCHANGER 11 GNS.

P. & P. on the above 5/6.

STEREOPHONIC CABINETS 99/6

Continental style cabinet including extra clip on speaker. 15⅜ × 10⅞ × 24¾in. deep. Takes B.S.R. 4-speed stereo autochanger. Printed circuit amplifier. 8in. speaker. Carr. and Ins. 12/6.

STEREOPHONIC AMPLIFIER £7/19/6

12 months' guarantee.

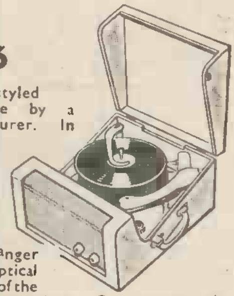
Beautifully made for portable stereophonic record players. Latest design with printed circuit. Dimensions 3×5¼×9¾in. A.C. only. Mains isolated. Twin amplifiers each side giving 3-4 watts output. Incorporating ECL82 triode pentode valve. Full tone, volume and balance controls. Complete and ready to fit. Knobs 3/6 per set extra. P.P. and Ins. 4/6.

BAKELITE CABINETS 5/9

Brand new. Colour brown. Attractive design. Size 12 × 7 × 5¼in. Ideal for small receivers, converters, etc. P. & P. 3/9.

RP2

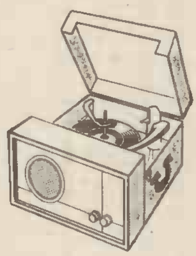
69'6



A beautifully styled cabinet. Made by a famous manufacturer. In polka dot cloth with clipped lid and carrying handle. Size 16 × 14½ × 8½ in. deep. Will take B.S.R. Monarch 4-speed Autochanger and 4 × 7in. elliptical speaker and most of the modern portable amplifiers. Carr. and Ins. 4/6.

RP3

69'6



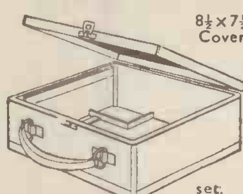
A delightful looking cabinet 14¾ × 17¾ × 8¾in. in 2-tone leatherette. Will take a B.S.R. Monarch 4-speed autochanger and 6½in. round speaker. Carr. and Ins. 4/6.

RP4

79'6

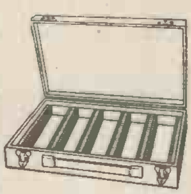
Stylish cabinet by famous manufacturer. Cloth covered in contrasting colours (red and grey). Grilled front controls panel. Size 15 × 19 × 8¾in. deep. Beautifully made—a cabinet you can be really proud of. Takes 4-speed B.S.R. Autochanger. 6½in. round or elliptical speaker. Room for any amplifier of your own choice. Carr. and Ins. 4/6.

STURDY CASE 12'6



8½×7¼×3½in. deep. Covered in burgundy and grey washable Rexine. Strong clasp, hinges and handle. Ideal for Portable Radio chassis or Transistor set. Can be adapted as a record carrying case to hold 18 seven inch long-playing records. P. & P. 2/6.

PHOTOGRAPHIC SLIDE CASE 17/6
(List price £2 10 0)



Rexine covered. Size 8 × 12¾ × 2¾in. deep. Will hold 150 of those expensive coloured transparencies in numbered partitions. This is the answer to that aggravating search for that particular photograph and will, of course, keep them safe from damage. P. & P. 2/6.

B.S.R. FUL-FI CRYSTAL TURNOVER CARTRIDGES 19/6

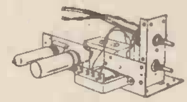
Brand new. Including sapphire needles for L.P. and Standard, giving fullest range and finest tone obtainable for any player. Can be fitted to all standard pick-up arms. P. & P. 9d.

MOTOR BOARDS 2/6

For 4-speed Autochangers. P. & P. 1/3.

★ AMPLIFIERS ★

12 MONTHS' GUARANTEE



PORTABLE AMPLIFIER MK D1 59/6

Brand new. Latest design with printed circuit. Dimensions 7 × 2½ × 5in. A.C. only. Mains isolated 2-3 watts output. Incorporating EL84 as high gain output valve. Volume and tone controls. Knobs 2/6 extra. P. & P. 3/6.

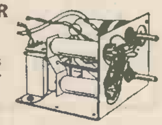
PORTABLE AMPLIFIER Mk. D.2 79/6

Printed circuit latest design. Dimensions 7 × 2½ × 5in. A.C. only. Mains isolated 3-4 watt output. Incorporating the latest ECL82-triode pentode output valve giving higher undistorted output. Volume and tone controls. Knobs 2/6 extra. P. & P. 3/6.

PORTABLE AMPLIFIER Mk. D.3 89/6

De Luxe model. Printed circuit. Latest design. Dimensions 7 × 2½ × 5in. A.C. only. Mains isolated. 3-4 watts output. Incorporating the latest ECL82 triode pentode output valve giving higher undistorted output. Volume, treble and bass control. Knobs 3/6 extra. P. & P. 3/6.

PORTABLE AMPLIFIER Mk. D4 49/6



Brand new. By famous manufacturer. Especially built for portable record players. Dimensions 4½ × 3½ × 4in. A.C. only. 2 valves EL84 as high gain output valve. EZ80 as rectifier. Volume and tone controls. Knobs 2/6 extra. P. & P. 3/6.

PORTABLE AMPLIFIER Mk. D.5 39/6

Simple circuit employing ECL80 triode pentode output valve giving 2-3 watts output. A.C. only. Mains isolated. Single control for volume and on/off switch and knob. P. & P. 3/6.

★ IDEAL FOR STEREOPHONIC SOUND ★

EXTENSION SPEAKERS 19/9

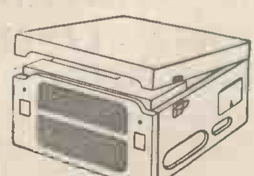
Polished oak cabinet of attractive appearance. Fitted with 8in. P.M. speaker W.B. or Goodmans of the highest quality. Standard matching to any receiver (2-5 ohms). Switch and flex included. Ins., carr. 3/6.

8in. P.M. Speakers 8/9. With O.P. transformer fitted 10/-. 6½" P.M. Speaker 12/6.

4x7" and 8x5" elliptical speaker 19/6 Post 2/9.

A "must for the build-your-own-tape-recorder enthusiast:—

TAPE RECORDER CABINETS 19/6



Suitable for the Truvox Tape Recording deck. Less front cast speaker panel. Size 13¾ × 15 × 8½in. deep. Detachable lid with compartment for spare tape. Covered in green washable plastic material. P.P. and Ins. 4/6.

DUKE & CO.

(Dept. C8) 621/3 ROMFORD RD. MANOR PARK, E.12

Tel.: ILF 6001/3

CATALOGUE FREE UPON REQUEST

CRYSTAL CALIBRATOR No. 10

A superb Crystal Controlled Wavemeter just released by the Ministry of Supply. Has directly calibrated dial for nominal coverage of 1.5–10.0 Mc/s. but may actually be used from 500 Kc/s. up to 30 Mc/s. Complete with 500 Kc/s. Crystal, 2 valves type IT4, I of IR5 and I of CV286 (Neon Stabiliser), and Instruction Book. Size 7ins. x 7½ins. x 4ins., weight 5lbs. Used but in first class condition.

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F.S.D.	SIZE AND TYPE	PRICE
25 microamps D.C.	2½in. Flush circular	69/6
25 microamps D.C.	2½in. Proj. circular	59/6
50 microamps D.C.	2½in. Flush circular	59/6
50 microamps D.C.	3½in. Flush circular	80/-
1 mA. D.C.	2in. Flush square	22/6
1 mA. D.C.	2½in. Flush circular	25/-
1 mA. D.C.	3½in. Flush circular	50/-
150 mA. D.C.	2in. Flush square	7/6
200 mA. D.C.	2½in. Flush circular	12/6
20 amps. D.C.	2in. Proj. circular	7/6
40 amps. D.C.	2in. Proj. circular	7/6
15-0-15 amps. D.C.	3½in. Flush square	25/-
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60 mV.	6 V.	3 mA	6 mA.
120 mV.	12 V.	6 mA.	12 mV.
600 mV.	60 V.	12 mA.	60 mA.
1.2 V.	120 V.	60 mA.	120 mA.
6 V.	240 V.	120 mA.	600 mA.
12 V.	480 V.	600 mA.	1.2 A.
60 V.	600 V.	1.2 A.	6 A.
120 V.	1200 V.	6 A.	12 A.
240 V		12 A.	
480 V.			Resistance
600 V.			1,000 Ohms
1200 V.			10.000 Ohms
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1C5GT 10/6	6AJ7 .. 4/8	6F1 .... 5/9	6X5G .. 5/-	25L6G .. 6/-	CV6 .... 3/6	ECC33 .. 7/6	EM34 .. 9/3	PCF82 .. 9/9	U281 .... 8/6	W77 .... 4/9
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2D21 .. 4/6	6BG6G 12/6	6J5G .. 2/9	787 .... 9/6	35L6GT .. 9/6	DAF96 .. 8/3	ECF82 10/6	EZ41 .. 8/-	PL36 .. 13/6	UBC41 .. 8/3	X79 .. 14 6
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5Y3G .. 6/-	6C5GT .. 5/6	6K8G .. 6/6	10P14 .. 12/-	53KU 10/6	DK91 .. 7/-	EF37 .. 6/6	HVR2 .. 6/6	PY80 .. 7/-	UCH42 .. 8/-	ZD152 .. 8/6
5Y3GT .. 7/-	6C6 .... 4/3	6K8GT .. 9/6	12AT6 .. 8/6	54KU .. 8/6	DK92 .. 8/6	EF39 .. 4/6	KT33C .. 6/6	PY81 .. 7/-	UCL82 .. 12/-	
5Z4G .. 9/-	6C9 .... 9/6	6K25 .. 7/6	12AT7 .. 6/-	57 .... 4/6	DK96 .. 8/6	EF40 .. 13/6	KT36 .. 9 -	PY82 .. 7/6	UCL83 13/6	
5Z4GT 11/-	6C10 .. 8/3	6L1 .. 13/6	12AU7 .. 6/9	58 .... 5/-	DL35 .. 10 6	EF41 .. 8 9	KT44 .. 9 6	PY83 .. 8/6	UF41 .. 8/9	New Valve:
6A7 .... 9/6	6CD6G 17/-	6L6G .. 7/6	12AX7 .. 7/6	61BT .. 11/-	DL92 .. 7/-	EF42 .. 8/6	KT45 .. 8/6	PZ30 .. 8/6	UF42 .. 8/6	PCF84 .. 16/7

LIST OF 1,000 ITEMS 6d. Post: 2 lbs. 1/6, 4 lbs. 2/-, 7 lbs. 2/9, 15 lbs. 3/6. No C.O.D. Callers always welcomed. (E. C. Weds.).

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H.T. 10/- (Type B126) or equivalent.

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- ★ Size only 8n. x 8in. x 4½in.
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COMPACT GRAM. AMPLIFIER 2-valve printed-circuit type for use on A.C. or D.C. 200/250 V. mains incorporating modern miniature valves. Output 2 watts, overall dimensions 6½ x 2 x 3½. Price 59/6, plus p. & p. 2/6.

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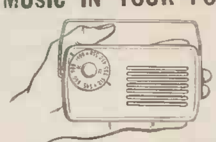
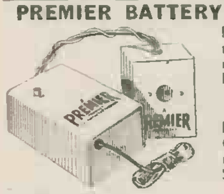
MUSIC IN YOUR POCKET with the pocket-sized transistor Superhet Receiver. Yours for an unrepeatable price of £8/19/6, p. & p. 2/6. Battery 2/- or 25/-. Deposit and 8 monthly repayments of £1/1/10. This Receiver incorporates 6 Selected Transistors and the latest-type printed circuit, it is extremely sensitive on medium waveband only, incorporating an internal Ferrite Aerial and operates on a 9-volt-type P.P.4 Battery. The Receiver is fully constructed and housed in an attractive plastic Cabinet, in Red, Cream or Blue. Size 5¼ x 3¼ x 1½in., weight 12 oz.



PREMIER BATTERY ELIMINATOR



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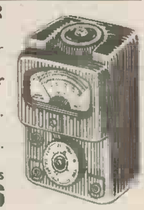

A truly efficient meter for the enthusiast.
Sensitivity 1,000 ohms per volt.
Ranges A.C. 10-1000 volts. D.C. 2-1000 volts.
Resistance 1–½ megohms.
Milliamperes 10-500.
Complete with test prods and leads. Price **99/6** plus 2/6 p. & p.

THE "MID-FI" A NEW DESIGN 4½ WATT AMPLIFIER KIT

MAY BE BUILT FOR **95/-**
Plus 3/- p. & p.

A new circuit for the home constructor requiring a good-quality medium-powered Amplifier for reproduction of Records or F.M. Broadcasts. Technical Specifications: separate bass and treble controls. Valve line-up EF86, EL84, EZ80. Voltage adjustment for A.C. mains from 200/250 volt, 3 or 15 ohms impedance. Negative feedback. Size 7 x 5 x 2in., overall height 5in. Silver-hammered finished Chassis.

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A well-designed Amplifier incorporating printed circuit of the latest type using two ECL82 triode/pentode Valves and Metal Rectifier, ganged volume and tone controls and separate balancing control, output 3 watts per channel and suitable for Speakers of 3 ohms impedance. The Amplifier is housed in an attractive black metal Cabinet with Engraved Front Panel, overall dimensions 10½ x 7½ x 4½in.
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Transistorised miniature battery-operated
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- ★ Completely transistorised circuit.
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This receiver is ideally suitable for use in the home or where normal electricity supply is not available, remarkable reception on both medium and short wavebands, incorporating the following latest-type miniature Battery Valves; DK92, DF96, DAF96, DL96 and operates on an external B.103 Battery or equivalent. The receiver is housed in an attractive two-tone metal case. Size 11½ x 7½ x 5¾in.

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RECEIVER UNIT 114 (Ex T/R 1986) Extremely compact five-stage unit of modern design tuning 124.5–156 Mc/s. Comprises RF Amplifier, Frequency changer, Crystal oscillator trebler, Trebler, and Doubler, with 2 EL 91 miniature output pentodes and 3 special quality EF91 RF pentodes.
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Ideal for 144 Mc/s Band. BRAND NEW 27/6 *post free.*

MODULATOR UNIT. (Ex T/R 1934/5/6) Modern miniature unit associated with and similar to the type 373 9.72 Mc/s I.F. strip. Only 5½in. long × 3in. wide × 3in. high with 4 screened B7G valves. Co-axial socket input to balanced primary of mu-metal microphone transformer with output from resistor bridge in secondary circuit for muting associated receiver. Microphone amplifier is a Brimar 9D6 variable-mu HF pentode RC coupled to a 7D9 pentode which feeds the centre tapped input transformer of two 6C4 triodes in push-pull. Output from substantial modulation transformer having alternative tap on secondary winding. Additional winding on input transformer provides output through co-ax. for phone monitoring. Outputs and 6.3 and 250 volt inputs through short cable terminating in miniature multi-plug.

NEW, complete with 4 valves, £1 *post free.*

H.F. AMPLIFIER CHASSIS Neat "inverted box" aluminium chassis 5 × 3 × 1½in. with 12SH7 and two 12SJ7 in three ceramic holders in line down one side. Full length tag board inside containing five silver mica and three paper moulded capacitors, fifteen miniature resistors, etc. Detachable lid on bottom. A very useful little ready-made fully screened chassis that has already been made into hundreds of different units by shrewd shop customers.

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100 WATT ROTARY INVERTER "PLUS" Remarkable example of modern American class A equipment—well designed, superbly made, of attractive appearance and high performance. Totally enclosed, attractive black crackle finish, mounted on square pedestal base incorporating three full filter sections for d.c. and a.c. connections. Input: 27.5 volts d.c. Output: 115 volts, 3-phase, 400 c/s, power factor 0.95, 100 VA. Fan-cooled four-brush armature and triple-brush slip-ring commutator with thermistor shunt and centrifugal governor acting on shunt field to control performance. Output varies only 6 volts for 5 U variation in input, and only 8 volts between full and 30 U load—with a frequency variation of only 1 c/s. Acceptance test includes 5 minutes at 15,000 r.p.m. Supplied brand new in hermetically sealed packets with full performance acceptance certificate for £4/10/-, *plus* 5/- *carriage.*

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A very popular shop sale at 3/6 *post free.*

Aircraft electronic unit of special quality originally designed for sensitive accurate measurement of very small changes in capacity of simple sensing unit such as that caused by diminishing fluid content of fuel tanks.

The capacity of the sensing unit is fed by co-axial cable to the input socket of the amplifier where any change in capacity alters the frequency of a 25L6 oscillator which in turn effects the 25L6 output valve circuit and produces an appropriate deflection on the milliameter indicating unit. A special moving coil mechanism in the anode circuit of the output valve correspondingly changes its inductance and so provides feed back to the oscillator grid, proportionally raising its frequency to the cut-off value of the filter circuits intercoupling the two valves and thereby maintaining the output current in a state of equilibrium for a constant reading.

The capacity of the sensing device, together with that of the co-axial and input circuit is tuned by an input trimmer to either 750 or 1,500 pF (depending on the type number of the amplifier) and a change of 500 or 1,000 pF respectively then produces a proportional d.c. indicating current variation from 2 to 7 mA. Operated entirely from a single 24 volt d.c. supply, and capable of being adapted by the addition of a transistor output amplifier to provide a quite extraordinarily sensitive response to capacitance changes of as little as one hundredth of one micro-micro-Farad, the possibilities of using this unit to measure any small changes in a material that effect, or can be made to effect, its capacitance (or that of a suitably designed detecting capacitor) are enormous, and satisfactory units have already been evolved for hardness and thickness testing, fluid and salinity control, proximity switches, comparators, etc.

Supplied sealed, complete with twin specially selected valves, full technical information and suggested transistor amplifier circuits, for the truly remarkable price of £2/10/- each, *plus* 5/- *packing and carriage.*

£10 GEIGER COUNTER

Circuit embodies U.K.A.E.A. patent. Specially moulded case.
Currently being supplied throughout the world.
Three ranges—highly sensitive—light — portable — visual and audible response—pulse output socket.
Ideal for introduction to radiation measurement and nucleonic circuitry. Specially written 40-page instruction manual supplied.
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Identical Parts. Guaranteed Performance.
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Fully illustrated assembly instructions.
Spares and Service permanently available.

New Model—£16.0.0.

Increasing and improved production has cut size, weight and cost.

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The specially made oil-filled casing houses a hydraulic torque conversion unit originally precision made by Westinghouse from high quality materials for the U.S. Government at an acquisition cost exceeding £150 each. Highly suitable for lathe head drive, workshop variable speed power take-off, etc.

Basically the unit is a back-to-back mounted, oil submerged, variable displacement hydraulic pump (input shaft) feeding a reversible hydraulic motor (output shaft) so that variation of the pump displacement by manual control gives very fine selection of output speed from zero up to 6% below input speed, while a changeover valve in the supply lines to the motor provides instantaneous reverse at any speed. Recommended input speed 500–1,000 r.p.m. maximum power 1½h.p. Both shafts ⅝in. dia. with Woodruff key.
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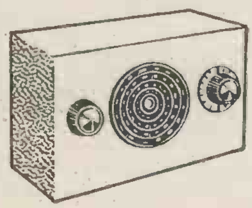
DULCI	etc.			LORENZ, etc.	



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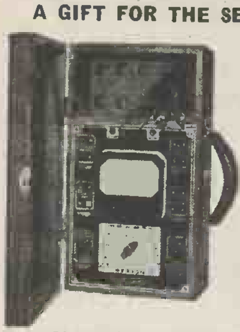

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Resistance ranges:
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Current ranges:
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BRAND NEW Acos latest HiG crystal t/o pick-up. Our price 29/6. Post & pkg. 2/6.

LIMITED NUMBER

Brand new valves by famous manufacturer. Equivalent of PX4. 5/-, plus post & pkg. 1/-.

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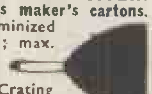

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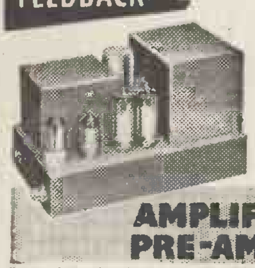

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Good salaries, adjudged and commensurate with qualifications, will be offered to suitable applicants. A contributory Pensions and FREE Life Assurance Scheme is operated by the Company.

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SWINDON, WILTS.

Commissions in the R.A.F. Technical Branch

R.A.F. Technical Officers are responsible for the organisation and supervision of all technical aspects of the R.A.F. Permanent commissions are open to men and women under 30 with suitable technical or scientific degrees. Short-service commissions are open to men and women under 37 holding Higher National Diplomas or Certificates in Engineering and a G.C.E. in English Language and to men under 21 with G.C.E. "A" level passes in Mathematics and Physics and "O" level in English Language and two other subjects. Candidates taking "A" level may be considered and accepted subject to passing examinations. Short-service officers may be granted permanent commissions. Promotion to Flight Lieutenant is by time alone. Higher promotion is by selection. A married Flight Lieutenant at 26 can earn £1,300 with full allowances, a Squadron Leader of 35, about £1,800. Write for details to the Air Ministry (A.R.1), Dept. WD.542, Adastral House, London, W.C.1.

RADAR, WIRELESS and INSTRUMENT FITTER CIVILIAN INSTRUCTORS

(Male) required by Air Ministry in the provinces. Appointments unestablished, but good prospects of becoming pensionable. Trade training, practical experience and ability to teach are essential. Pay £727 at age 26 rising to £900. Apply to **Air Ministry, C.E.4k (CIV 78), London, S.E.1.**

ULTRA ELECTRIC LIMITED
Radio and Television Division

The following vacancies now occur in the Development Department:—
- (i) SENIOR TELEVISION DEVELOPMENT ENGINEER
- (ii) TEST EQUIPMENT DEVELOPMENT ENGINEER
- (iii) DRAUGHTSMAN—RADIO AND TELEVISION
- (iv) PROCESS ENGINEER

Substantial salaries will be offered to qualified men who must have had experience with leading manufacturers.

Pension Scheme.

Please write fully and in strict confidence to:

The Personnel Manager, Ultra Electric Limited, Western Avenue, Acton, London, W.3

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murphy radio limited
COMMUNICATIONS EQUIPMENT

A Senior Engineer is required to work on the development of VHF and UHF radio links and other equipment, being responsible for one or two projects. Qualifications required are an absolute minimum of HNC and at least 5 years industrial experience, especially in the development of HF, VHF, and UHF Receivers and Transmitters. Transistor experience would be an added advantage. Experience of M.O.S. work and of collaboration with mechanical designers is also necessary. Applications should be forwarded to the Personnel Manager (E.93), Murphy Radio Limited, Welwyn Garden City, Herts.

ELECTRONICS RESEARCH LABORATORY STAFF

Senior qualified Electronics Engineers of Degree or Higher National Certificate standard are required for interesting work in connection with a number of projects in the field of Electronics, including the application of transistors to television and similar equipment. Applicants must have suitable academic qualifications and experience in laboratory procedure. They will normally be expected to be able to handle a project from its inception to its final conclusion. Box No. 1952, c/o "Wireless World."

TELEVISION RECEIVER ENGINEER
for
AUSTRALIA

A qualified Senior Engineer with experience in production test and the design of good quality domestic receivers is required for work in the factory of an Australian associate company near Adelaide.

Preference will be given to an Australian national who wishes to return home.

Applications, giving age, education, experience and salary required, should be addressed in the first instance to

THE PERSONNEL MANAGER, BUSH RADIO LIMITED, POWER ROAD, LONDON, W.4

ELECTRONIC ENGINEERS

Required for development work on test equipment connected with an advanced guided missile project. Applicants should have at least two years experience in similar work and preferably possess H.N.C. in electrical engineering, or equivalent City and Guilds qualification. Applications are invited and should be addressed to:—

The Personnel Manager (Ref. 374),

DE HAVILLAND PROPELLERS LIMITED, Hatfield, Herts.

THE GENERAL ELECTRIC CO. LTD.

APPLIED ELECTRONICS LABORATORIES
THE AIRPORT
PORTSMOUTH

The General Electric Company Limited are setting up new laboratories at Portsmouth and design teams will be required to carry out development work on a number of interesting electronic projects. Vacancies exist at all levels for engineers and scientists experienced in the following fields:—

(1) DESIGN OF V.H.F. RECEPTION EQUIPMENT AND I.F. AMPLIFIER DESIGN.
(2) MICROWAVE DESIGN AND DEVELOPMENT.
(3) GENERAL PULSE CIRCUITRY USING BOTH VALVE AND TRANSISTOR TECHNIQUES.
(4) ELECTRO-MECHANICAL AND SERVO SYSTEMS.
(5) MECHANICAL DESIGNERS.

Engineering staff will be required to have a degree in physics, electrical or mechanical engineering, or corporate membership of an engineering institution, or exemption from the examination for such membership, and about three years experience in a relevant field.

VACANCIES ALSO EXIST FOR EXPERIMENTAL STAFF AND DRAUGHTSMEN.

Apply in the first instance to the **Personnel Officer, The General Electric Co. Ltd., Brown's Lane, Allesley, Coventry.**

ELECTRONIC COMPUTERS

FERRANTI LTD. MANCHESTER

has vacancies for

TEST ENGINEERS

for the design and operation of specialised equipment used in the production of Electronic Computers. A good theoretical; as well as practical knowledge of pulse and steady state circuitry is required and some experience with transistors would be advantageous.

These appointments will afford young men, with the appropriate knowledge and experience, an excellent opportunity for advancement in the field of electronic computing equipment.

Forms of application can be obtained from T. J. Lunt, Staff Manager, Ferranti Ltd., Hollinwood, Lancs.

Please quote reference KL.3.

EKCO ELECTRONICS LIMITED

RADAR DEVELOPMENT AND ENGINEERING DEPARTMENT

vacancies for

DEVELOPMENT ENGINEERS

Ekco Electronics Ltd. is a leading company in both military and commercial applications of airborne radar equipment. Interesting new projects necessitate expansion of the design resources, and vacancies exist for qualified and experienced engineers with interests in the following fields:

Microwave components, aerial systems, etc.
Pulse and servo circuit techniques.
Heat transfer problems.
Installation and trials.

Certain of these posts are of Senior Engineer status, and will carry considerable responsibility.

Vacancies exist both at Southend-on-Sea and Malmesbury, Wilts.

Applications to:

PERSONNEL MANAGER, E. K. COLE LTD., MALMESBURY, WILTS.

DIGITAL DATA PROCESSING

The SHAPE Air Defence Technical Center has a few vacancies in the field of high-speed digital data-processing.

Applications are invited from suitably qualified persons with interest in one or more of the following fields:

Digital computation.
High-speed analog-digital conversion.
Computer input and output devices.
Transistor and magnetic-core techniques, applied to computers.
Cathode-ray tube displays.

The basic salaries will be based on the European average for corresponding background and experience. Successful applicants from foreign countries will benefit by a number of privileges including a foreign allowance of the order of 70% of the basic salary, and reimbursement of the cost of moving their families and household effects to The Hague and back to their country of origin on termination of contract. The total income is tax free in the Netherlands.

Applications, containing detailed information on training and past experience, should be sent as soon as possible to:

The Director, SADTC, P.O. Box 174
The Hague, Netherlands

FERRANTI LTD.
MANCHESTER

has vacancies in the

COMPUTER DEPARTMENT

for

SUPERVISING ENGINEERS

for post installation service to Ferranti Computers in this country and abroad. Applicants should have technical knowledge up to H.N.C. standard or equivalent. Favourable consideration will be given to applicants who have a good background of training and experience on Service electronic and radar equipment. Successful applicants will have the opportunity, if they so desire, to be considered for periods of service in this capacity on Ferranti Computers installed in many countries abroad.

The above appointments will carry salaries fully commensurate with qualifications and experience. The Company operates a Staff Pension Scheme and an Instalment Assurance Scheme.

Application is by form obtainable from:

T. J. Lunt, Staff Manager, FERRANTI LTD., HOLLINWOOD, LANCS.

Please quote ref.: KLS.

RESEARCH LABORATORY

AEI

Solid-State Physics Section require an assistant

with experience in the growth and examination of semiconductor crystals. Initiative and the ability to develop apparatus and techniques are looked for, together with qualification at least to O.N.C. level.

The Laboratory serves a large group of Companies and is situated in pleasant rural surroundings near Reading with fast train service to London.

5-day Week

Pension Scheme

Apply in writing, quoting reference No. SS/A/12, to the Personnel Officer,

Research Laboratory,
ASSOCIATED ELECTRICAL INDUSTRIES LIMITED
Aldermaston Court,
Aldermaston, Berkshire.

WIRED TELEVISION

An opportunity exists in a rapidly expanding industry for an Engineer, who will test and advise on the performance of wired T.V. distribution systems throughout England and Wales. A sound knowledge of T.V. principles is required. Apply to:—

Head of Wire T.V. Dept.,
Central Rediffusion Services Ltd.,
Stratton House, Stratton St., W.1.

VACANCIES IN GOVERNMENT SERVICE

A number of male vacancies offering good career prospects, exist for:—

RADIO OPERATORS

Write, giving details of Education, Qualifications and Experience to:—

Personnel Officer, G.C.H.Q. (3/R)
53, Clarence Street, Cheltenham

BOURNEMOUTH MUNICIPAL COLLEGE OF TECHNOLOGY AND COMMERCE

Full-time and Part-time Courses for the

INSTITUTION OF ELECTRICAL ENGINEERS PART III EXAMINATIONS

are due to commence in September 1959. Details and application forms may be obtained from the Principal, Bournemouth Municipal College of Technology and Commerce, Lansdowne, Bournemouth.

Early application is advisable.

QUARTZ CRYSTAL ENGINEERS

A limited number of permanent staff vacancies are now available to persons having experience with Quartz Crystal or the associated Piezo-electric devices. Additionally, there is a vacancy for a capable Electronic and Mechanical Maintenance Engineer to work on equipment for small component manufacture.

The posts are most suitable for those possessing drive and initiative and are in new air conditioned laboratories providing up-to-date equipment. For further information write:—

PERSONNEL MANAGER,
CATHODEON CRYSTALS LIMITED,
LINTON, CAMBRIDGE.

SENIOR ELECTRONIC TEST ENGINEERS

A leading firm of electrical manufacturers requires staff for its Test Department. For this interesting work, which is in the Midlands, electronic engineers, with thorough experience in the telecommunications field, preferably with Higher National Certificates or City and Guilds Certificates in Telecommunications, but in any case with an understanding of complicated valve and transistor circitry and an ability to use delicate electronic test gear should apply giving full details of age, education and experiance to Box No. 4058 c/o "W.W."

The positions available involve a 39½ hr. 5 day week and starting salaries are for Senior Test Engineers from £875 to £1,025 and for Test Engineers £775 to £850.

COUNTY BOROUGH OF GRIMSBY
Education Committee

COLLEGE OF FURTHER EDUCATION
Principal: E. S. GREEN, B.Sc., A.R.I.C.
Nautical Department

Applications are invited for the post of Assistant Lecturer Grade 'A' to teach Radio Telegraphy to full-time students preparing for the P.M.G. Examinations.

Applicants should hold a first class P.M.G. certificate and a M.O.T. Radio Maintenance Certificate.

Salary in accordance with the Burnham Technical Scale (at present £498 to £945 per annum, with increments for approved operating experience). These scales are now under review and may be adjusted in the near future.

Application forms may be obtained from the undersigned and completed applications should be returned within fourteen days of the appearance of this advertisement. Canvassing will disqualify.

R. E. RICHARDSON,
Director of Education
Education Office, Eleanor Street, GRIMSBY.

MIDDLESEX EDUCATION COMMITTEE
SOUTHALL TECHNICAL COLLEGE
DEPARTMENT OF ELECTRICAL ENGINEERING

The next entry to the full-time course in Electrical Engineering and Applied Electronics will take place in September. Evening courses, commencing on 28th September, will also be held on Advanced Mathematics, Analogue Computers, Digital Computers, Transistors, Servo-Mechanisms, Pulse Techniques, Industrial Electronics, Radio Telemetry, Practical Numerical Analysis and Automatic Process Control. Details from the Principal, Technical College, Beaconsfield Road, Southall, Middlesex.

ELECTRONIC ENGINEERS

Experienced Engineers, who have reached H.N.C. standards, are invited to apply for positions where energy, skill and initiative will be well rewarded.

The work relates to the development of television components for large scale production. Previous experience in the design of tuners and/or scanning components is essential.

The positions are permanent and offer scope for further advancement. The commencing salary will be in accordance with previous experience based on a generous and progressive scale. London area.

Please reply, in confidence, giving full particulars to Box No. 4059 c/o "W.W."

SURREY COUNTY COUNCIL
EWELL COUNTY TECHNICAL COLLEGE

A course of 12 weekly lectures on "Transistors and their Applications" will begin on Tuesday, 22nd September, 1959, at 7 p.m. The course will deal with basic Semiconductor Physics, transistor design and construction, transistor equivalent circuits; circuits using transtors in amplifiers, generators, computers, and power supplies. A knowledge of elementary Physics will be assumed. Course Fee £1/2/6.

Apply immediately to Head of Science Department, Ewell County Technical College, Ewell, Surrey.

Lec Refrigeration Ltd.

Require

TECHNICIANS FOR ELECTRONIC DEVELOPMENT OF TEST EQUIPMENT

Applicants aged 25 to 30 years, must have a minimum of Higher National Certificate, with a sound electrical engineering training, including Electric Motors and Control Equipment, Instruments and Protective Relays.

Call, write or telephone
The Personnel Officer,
Lec Refrigeration Ltd., Bognor Regis.
Tel.: Bognor Regis 2201

SOUTHAMPTON COUNTY BOROUGH EDUCATION COMMITTEE
SOUTHAMPTON TECHNICAL COLLEGE

Department of Electrical Engineering

A three-year full-time course in COMMUNICATION ENGINEERING AND ELECTRONICS will be started in September, 1959. The course will prepare candidates for a College Diploma. The Final Examinations will be assessed by the British Association of Radio Engineers for exemption from their Graduateship Examination. Applicants with suitable academic qualifications and/or practical experience may be admitted to the second year of the course. Details of course, fees, etc., from the Registrar, Technical College, St. Mary Street, Southampton.

ELECTRONIC TEST EQUIPMENT

Marconi's Basildon, has a vacancy for a man with minimum 3 years' experience of test equipment maintenance. He must be able to design special test units in conjunction with designers of the equipment to be tested. Higher National Certificate desirable.

House available to rent in Basildon New Town. Please write to Dept. C.P.S., Marconi House, 336,7 Strand, W.C.2., quoting reference WW2690C.

DIGITAL COMPUTERS

ENGINEERS, PHYSICISTS and TECHNICIANS, age approximately 20-35 years, with a knowledge of electronics, are required for technical supervision and maintenance of "National-Elliott 405" digital computer installations in London, the Midlands and the North.

Experience in digital computer techniques, although an advantage, is not essential.

Please apply in writing to The Personnel Manager, The National Cash Register Co. Ltd., 206-216 Marylebone Road, London, N.W.1.

IMPERIAL CHEMICAL INDUSTRIES LIMITED

require

TECHNICAL ASSISTANTS

for work on

INSTRUMENT DEVELOPMENT

preferably with O.N.C. (or equivalent) in Electrical Engineering and some experience in light instrument work, strain gauge techniques or circuit development.

The posts are concerned with the measurement of rocket motor performance and carry with them full participation in Profit Sharing Scheme and Pension Fund.

Applications should be addressed to General Services Manager, I.C.I., Metals Division, Summerfield Research Station, Kidderminster.

TEST ENGINEERS. Applications are invited from Senior Test Engineers with previous industrial experience of testing radio communications receivers and transmitters. Successful applicants will be offered positions on the Company's permanent staff. Starting salaries commensurate with qualifications and experience. Apply in writing, giving full details, to Personnel Officer, REDIFON LTD., Broomhill Road, S.W.18

TECHNICAL ASSISTANT

required in the Technical Service Department of Siemens Edison Swan Ltd.

Duties include liaison between the Department and Factories together with the handling of Technical correspondence, preparation of literature, etc.

It is essential that applicants have a good working knowledge of radio and allied subjects and possess a wide standard of English. Technical education to O.N.C. equivalent.

Apply to Ref. J.A.R., Siemens Edison Swan Ltd., 155, Charing Cross Road, London, W.C.2.

TEST GEAR

Applications are invited from electronic engineers with experience in the design and development of electronic production test equipment. Vacancies also exist for maintenance engineers and calibration engineers.

These are staff appointments and there are excellent opportunities for advancement. The successful candidates will be invited to join the company's superannuation and life assurance scheme.

Please reply, giving full details, to The Employment Manager, The Plessey Company Limited, Vicarage Lane, Ilford, Essex.

ARE YOU A RADIO or TELEVISION SERVICE ENGINEER looking for a job?

PHILIPS ELECTRICAL LIMITED, Service Department, of Purley Way, Croydon, can offer you a progressive position with excellent working conditions including canteen facilities plus full welfare services and security, a contributory pension scheme and a five-day week.

Present holiday commitments honoured.

Please write in the first instance with details of experience and salary required to:—J. Munro-Hall, Personnel Officer, Philips Electrical Ltd., Service Department, Purley Way, Croydon, Surrey.

BRITISH RELAY WIRELESS LTD.

Require Senior & Junior

TELEVISION DEVELOPMENT ENGINEERS

Candidates should have good practical experience on domestic Television design, and Theoretical knowledge to final C. & G. standard.

Write, stating age, experience, qualifications and present salary to:— Chief Engineer, B.R.W. Ltd., 6, Giltspur St., E.C.1.

COMPUTER MAINTENANCE TECHNICIAN

required at Calder Hall Nuclear Power Station to be responsible to an Instruments Engineer for the installation and maintenance of advanced data processing systems and other types of electronic equipment associated with reactor control.

A recognised engineering apprenticeship or comparable training and a knowledge of up-to-date electronic and relay techniques are essential. Experience of data presentation methods and information storage techniques as applied to computers is very desirable. Possession of an H.N.C., or equivalent, in Electronic Engineering may be an advantage.

Salary within range £1,085—£1,315 according to qualifications and experience.

Contributory Superannuation. Staff housing scheme.

Send postcard for application form, quoting reference P7/J48, to Works Secretary,

UNITED KINGDOM ATOMIC ENERGY AUTHORITY
Windscale & Calder Works, Sellafield, Seascale, Cumberland.

PYE LIMITED OF CAMBRIDGE

urgently require

AERIAL AND FEEDER DESIGN ENGINEERS

for development work on the following:

1. V.H.F. and U.H.F. transmitting aerials for television, tropospheric scatter and F.M. broadcasting.
2. Diplexers and filters.
3. Co-axial feeders and switches.
4. R.F. dummy loads.

Opportunities exist for senior engineers who have had similar previous experience and junior engineers with a sound electronic engineering background who would like to specialise in this type of work. Engineers not in these categories but who have a particular interest in this field are also invited to apply.

All enquiries and applications should quote "TXA" and be addressed to the

CHIEF ENGINEER, PYE LTD., CAMBRIDGE

UNIVERSITY COLLEGE OF NORTH WALES

ELECTRONICS TECHNICIAN required for the Department of Electronic Engineering. Applicants should hold National Certificate, City and Guilds or equivalent qualifications in electrical engineering or telecommunications, and should have had wide practical experience in some branch of electronics or radio. Salary scale £745 × £20–£825. Pension Scheme.

Applications giving details of age, qualifications and experience, together with the names and addresses of two referees, should be sent to the Registrar, University College of North Wales, Bangor, as soon as possible.

MULLARD RESEARCH LABORATORIES
Applications Division
Vacancies exist for

ENGINEERS AND PHYSICISTS

for work on television receiver techniques.

The Television Laboratory contains a large team covering a wide field ranging from research on colour television, electron optics and the use of transistor circuit techniques to circuit work associated with the Company's current production programme of cathode ray tubes, valves, ferrites, and semi-conductors.

All aspects of the work are challenging and there is ample scope for original work.

Applicants should have professional qualifications and experience of some aspects of television research or design.

Conditions of employment, superannuation scheme, life assurance benefits and salary policy are excellent.

Applicants should write, quoting ref. BRO. to
Mr. G. A. Taylor,
Mullard Research Laboratories,
Cross Oak Lane, Salfords, near Redhill, Surrey

PYE LIMITED OF CAMBRIDGE

require a

TRANSFORMER DESIGNER

to assist with the design of a wide range of transformers including power types up to 5 kVA., audio and other miscellaneous types for radio, television and electronic applications.

Preference given to applicant with similar previous experience, but training may be given to an otherwise suitable candidate with mathematical aptitude.

Applications quoting "TDS" should be addressed to the Chief Engineer.

Wilkinsons

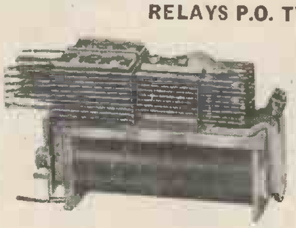
EST. 1921

METERS GUARANTEED

F.S.D.	Size	Type	Price
50 Microamps	2½in.	MC/FR	70/-
100 Microamps	3½in.	MC/FR	70/-
500 Microamps	2in.	MC/FR	25/-
500 Microamps	2½in.	MC/FR	37/6
1 Milliamp	2in.	MC/FS	27/6
1 Milliamp	2½in.	MC/FR	35/-
30 Milliamps	2½in.	MC/FR	12/6
100 Milliamps	2½in	MC/FR	12/6
200 Milliamps	2½in.	MC/FR	12/6
500 Milliamps	3½in.	MI/FR	30/-
5 Amperes	2in.	MC/FS	27/6
15 Amperes	2in.	MC/FR	10/6
25 Amperes D.C.	2½in.	MI/FR	7/6
50-0-50 Amp.	2in.	MC/FS	12/6
30-0-30 Amp.	2in.	MC/FR	15/6
20 Volts	2in.	MC/FS	10/6
40 Volts	2in.	MC/FS	10/6
300 volts	2½in.	MI/FR	25/-

CROSS POINTER METERS. 2 separate 100 microamp movements. 22/6.
MICROAMMETERS. 50 F.S.D. 2½in. proj. round. Scaled 10 Milli-rontgens. 45/-.
MICROAMMETER. 250 F.S.D. 3½in. F.R. Sangamo Mod. S.37. Scaled for valve voltmeter. Circuit available free. 55/-.
Postage 1/6 extra for above meters.
CATHODE RAY TUBES. 2AP1. 25/-. 130A 35/-. 5BP1 55/-. post 3/-.
TRANSMITTER TUBE. 212E. 70/-. Post 3/6.
TEST PRODS. Retracting points, fused, flex and terminals, 5/6. Post 6d.
ONE POLE PLUG AND SOCKET. Fully shrouded, one hole fixing, 6 pr. 18/-. Post 1/-.

RELAYS P.O. TYPE 3000.



Built to your own specification

Keen Prices

Quick Delivery

Contacts up to 8-Changeover

MINIATURE RELAYS.

Siemens High Speed.			S.T.C. and G.E.C. Sealed.			
2.2Ω + 2.2Ω	H96A	15/6	2Ω	2 C O	4184GA	18/6
145Ω + 145Ω	H96C	19/6	700Ω	2 C O	418GD	19/6
500Ω + 500Ω	H96D	22/6	2500Ω	1 make HD	4186EE	22/6
1700Ω + 1700Ω	H96E	25/-	2700Ω	2 C O	4184GE	21/6
100Ω + 100Ω	H85N	15/-	180Ω	2 m 2 b	M1087	19/6
1000Ω + 1000Ω	H95A	17/6	670Ω	4 C O	M1092	21/6
1700Ω + 1700Ω	H85L	17/6	5000Ω	2 C O	M1022	22/6
					M1052	25/-

Comprehensive range available from stock.

SWITCHES. 1 hole fixing, 3 amp. 250 volt. 1/6 each, 12/- doz.

RACKS—POST OFFICE STANDARD. 6ft. high with U-channel sides drilled for 19in. panels, heavy angle base, 4ft. 10in. in stock.
ROTARY CONVERTERS. Input 12 D.C. Output 230 A.C. 50 cy. 135 watts. In fitted case with variable resistance, 0/300 voltmeter. The ideal job for television where A.C. mains are not available. £10, carr. 15/-. Special connectors, one fitted with 6ft. heavy duty flex and clips for D.C. side. 10/- set, post 1/-. **CONVERTERS ONLY.** 12 volt or 24 volt. £8/10/-. Cge. 7/6.
SOLENOIDS. 12 volt D.C. with 3½in. lever. Ideal for remote control, model railways. 5/- ea., post 1/6. 26 in unit £4/6/8..
NIFE BATTERY. Nickel cadmium. 6 volts 75 amp., crated and connected. Alkaline filled. Brand new. £7/10/-. Carr. 15/-.
LOUDSPEAKERS. Elac 5in. round 15/6, post 1/6. Axiom 150 dual cone 12in. 15 watts 15 ohms, fully dustproof, £7/19/6, post 7/6. Pye 10in. portable 3 ohms 50/-, carr. 7/6.
JACK PLUGS. Cylindrical bakelite screw-on cover, 2 contact 2/6, post 6d.

SOCKETS. One hole fixing for above. 3/6. Post 6d.
TELEPHONE PLUGS TYPE 201 with headphone cord. Brand new available in quantity cheap.
VARIAC TRANSFORMER. Input 230 volts. Output infinitely variable 0-230 volts and 0-270 volts. 9 amp., bench or panel mounting. £15, cge.12/6.

TERMINAL BLOCKS. 2-way 4/- doz. or box of 50 for 15/-, 3-way 6/- doz., 50 for 22/6. Post 1/6.
AIR BLOWER. 230 volt A.C. 15in. fan. Volume of free air at max. r.p.m. is 1,250 cu. ft. per min. At maximum efficiency 900 cu. ft. per min. Brand new £25. Carr. 20/-.
XPELAIR EXTRACTION FANS. 7½in. blades. Baffle outlet. 190/-. Cge. 5/-.
HEADPHONES. Balanced armature type DLR5. 10/6 pr., post 1/6.
HEADPHONES. High resistance 4000 type CHR. 12/6 pr., post 1/6.
HEADPHONES. Balanced armature type DHR. 17/6 pr., post 1/6.

L. WILKINSON (CROYDON) LTD.
19 LANSDOWNE RD. CROYDON SURREY
Phone: CRO 0839 Grams: WILCO CROYDON

Z. & I. AERO SERVICES LTD.

14, South Wharf Road, London, W.2

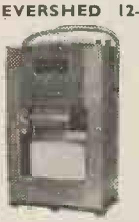
Telephone : AMBassador 0151/2 **Cables : ZAERO, LONDON**

A.R.B. Approved Stockists

TWIN PEN SWITCHBOARD PATTERN RECORDING MILLI-AMMETER

(made by Evershed & Vignoles)
Sensitivity: 5 mA D.C. Damping: Oil Dashpot. Chart width: 6in. Chart drive: Electric motor, 230 v. A.C. Chart Speed: ½in.per minute. Interior light.
PRICE: unused, complete with two gravity type pens, two syphon pens with trough, two bottles of ink, two bottles of dashpot oil and two charts, fully guaranteed... £65 0 0
Packing & carr. £1.
This model can also be supplied for 1 mA Range at an extra charge of.................... £5 0 0

EVERSHED 12-PEN TIME RECORDER



Portable 12-channel instrument for simultaneous recording of 11 events with time marks provided by 12th pen. The recording is presented in the form of "on-off" pulses. Chart Speed 2 inches per second. PRICE, unused, in original packing, complete with accessories and a spply of charts £30 0 0

WHEATSTONE BRIDGES

Sullivan Portable Wheatstone Bridge: four Switched Decades .10-1.0-10-100 ohms steps, ratio arms .001-.01-.1-1.0-10-100-1,000.
Built-in Galavanometer.
Fully overhauled and guaranteed ... £38 0 0
Cambridge Portable Wheatstone Bridge:
Four switched Decades 1.0-10-100-1,000. ohms steps
Ratio arms .001-.01-.1-10-100-1,000.
Built in Galvanometer. Fully overhauled and guaranteed- £45 0 0
Packing and Carriage 15/-.

EVERETT-EDGECUMBE WATTMETER.

Single phase, range 0-250w./0-500w. can be extended up to 100 times by means of an external transformer. Operating voltage 250V. Fully overhauled and guaranteed. £45.0.0.
Packing and carriage 15/-.

BOONTON MODEL 84 "STANDARD" SIGNAL GENERATOR

Range: 300-1,000 Mc/s. Direct Calibration.
Accuracy: 0.5%.
Output Level: 0.1μV.-100 mV. continuously variable.
Internal Modulation:—
Sinewave—30% Max. at 400, 1,000 and 2,500 c/s.
Pulse—1 to 50μsec. width, delay variable from 0 to 50μsec., p.r.r. 60 to 100,000 c/s.
Output Impedance—50 ohms.
Percentage Modulation Meter.
PRICE, in as new condition, tested before despatch and fully guaranteed.........£220 0 0
Packing and carriage.................... £2 0 0

BC-1066 TEST RECEIVERS.

Range 150-235 mc/s. Contains two tuned detector circuits (1D8GT), amplifier (957) and output stage (957).
PRICE £1 10 0
P.P. 5/-.
Power supplies 130 V. and 1.5 V.

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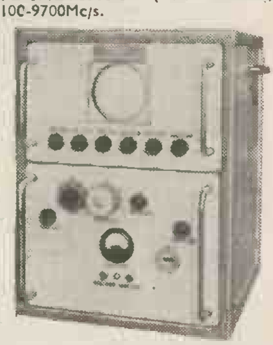

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WE undertake the manufacture of transformers singly or in quantities to any specification; all work guaranteed for 12 months.
LADBROKE Rewind Service, Ltd., 820a, Harrow Rd., London, N.W.10. Tel. Ladbroke 0914. [0222

RENEW to stock your faulty speakers of all sizes, pressure units, microphones, coils, fields and cone assemblies in cartons.—D. C. Boulton, 134, Thornton Rd., Bradford, 1. Telephone 22838. [0171

TRANSFORMERS.—Suppliers to B.B.C., I.T.A. and leading radio manufacturers, single or long runs, prompt delivery, home and export, rewinds to all makes.
FORREST (TRANSFORMERS), Ltd., Shirley, Solihull, Warwicks. Tel. Shi. 2483. [0128

MISCELLANEOUS

RADIO, Television Books, television servicing 5/-, radio servicing 4/-; list free.—J. Palmer (W), 32, Neasden Lane, N.W.10. [0211

BLOCKS, wood, 9¼in×3½in×1in, 3d ea.; 48 doz. white and 12oz brown, small quantities a little dearer.—British Distributing, 591, Green Lanes, London, N.8. [8555

METALWORK, all types cabinets, chassis, racks, etc., to your own specification, capacity available for small milling and capstan work up to 1in bar.
PHILPOTT'S METAL WORKS, Ltd., Chapman St., Loughborough. [0208

SATURABLE reactors, magnetic amplifiers, complete control units.—Able Engineering, Ltd., 12, Singer St., London, E.C.2. Tel. Clerkenwell 3695. [8636

FOR sale.—Horizontally disposed special purpose winding machine, capable winding from 90-300 t.p.i. of 33-47 SWG wire on mandrel wire 17-22 SWG.—Apply Box 4375. [8629

CABLE.—Full or random coils 10% to 20% under list prices.
CONDUIT: 5% to 10% under list; request catalogue.—British Distributing, 591, Green Lanes, London, N.8. [8559

STAR Openings.—Let us arrange the opening of your new shop, department, special sales week; stars booked, publicity arranged.—Write George Bartram Press Relations Organisation, 159, Gt. Charles St., Birmingham, 3. [8570

FOR sale, one 29-key dictograph table master station; 27 H.L.30 2-lamp dictograph sub-station; one 25-key dictograph table master station; one H.T. dictograph sub-station; ideally suited for internal telephone system.—Offers to R. L. Dudley, High Duty Alloys, Ltd., Slough. Tel. Slough 23901. [8536

PAINTS, CELLULOSE, ETC.

PANL, recognised for many years as the unique one-coat black crackle finish, brush applied, no baking; available by post in 1/8 pint cans at 3/9 from: G. A. Miller, 255, Nether St., London, N.3. [0260

AGENTS WANTED

AGENCY for Sweden.
FOR more than 30 years we have been specialising in selling components to the Swedish electrical industry, the wholesalers and the Forces, and would now be interested in extending our connections with agencies for semi-conductors and transformers, etc.—Please reply to Forslid & Co., AB, Radmansgatan 56, Stockholm Va. [8564

AGENCIES WANTED

ISRAEL.—Long established highly qualified electronic engineering and service company in Israel wants agencies of manufacturers of electronic parts, tape discs, assemblies, etc.; Principal will be in England shortly for interviews; catalogues and full details required.—Box 3820 [8571

BUSINESS & PROPERTY

MEDIUM size private company, situated in the West of England, is desirous of negotiations with large Public or Private Company with a view to being a subsidiary of same, or suggestions; present factory space, 18,000 sq. ft. owned by the company, freehold, modern building.
FACILITIES for plastic injection moulding, aluminium alloy die casting, tool room facilities, large storage space, room for further expansion.
PRESENT turnover, £75,000 per annum. Enquiries welcomed from principals only.—Box 4368. [8627

BUSINESS OPPORTUNITIES

AN opportunity to enter television's newest industry.—Associated T.A. group willing to promote a limited number of independent television picture tube manufacturing concerns; plant supplied and staff trained with full technical specifications and production techniques; £5,000 capital required; substantial returns assured; write for details.—Secretary, Teletronic (Mfg.), Co., Pallion Industrial Trading Estate, Sunderland. [8579

BUSINESS AND PROPERTY WANTED

TAX Loss Company required; radio and electrical or electronics trade; not retail; in order of £10,000.—Write to Accountants. Box 2669. [8448

CAPACITY AVAILABLE

ALUMINIUM chassis, brackets, accessories, component potting and circuit printing.—Write for catalogue. 25, Leach St., Prestwich, Manchester. [8588

ELECTRONIC assembly, coil winding and machining. A.I.D. approved.—Bel Sound Products, Marlborough Yard, London, N.19. Tel. Arc. 5078. [0185

ASSEMBLY and wiring capacity available, electronic equipment for the radio, television or aircraft industries. Encapsulation, sheet metal work, engraving.—R.E.E. Telecommunications, Ltd., 15a, Market Sq., Crewkerne, Somerset. [8517

WORK WANTED

TECHNICAL writer free to accept assignments on writing of leaflets, instruction manuals, etc.—Offers to Box 3767. [8562

SERVICES OFFERED

FREE Lance Technical Author, development, sales and technical writing experience (including published work) seeks additional commissions.—Please reply to Box 4442. [8639

SITUATIONS VACANT

LANCASHIRE CONSTABULARY.

WIRELESS DEPARTMENT.

VACANCIES exist in the Lancashire Constabulary Wireless Department for civilian radio engineers in the following grades:

SUB-SECTION LEADER

QUALIFICATIONS desirable are graduate membership of a professional institution or H.N.C. (Elect.) or equivalent. Candidates must be conversant with modern V.H.F. or U.H.F. radio techniques. Recent experience in construction of proto-type radio equipment and/or development work with transistors will be an advantage. Salary £850-£1,005 p.a.

RADIO ENGINEER

QUALIFICATIONS desirable C. & G. final certificate in telecommunications engineering or O.N.C. (Elect.) plus C. & G. Certs. Radio II and III or equivalent. Candidates must have recent experience of installing and maintaining V.H.F. or U.H.F. radio and electronic equipment. Salary £595-£850 p.a.

STUDENT APPRENTICES

CANDIDATES should be about 16 years of age, minimum entry qualification G.C.E. O-Level in four subjects; Mathematics, Physics and English are compulsory.

APPRENTICESHIP is for five years, eventually reaching the standard of Corporate Membership of a professional institution. Salary £240-£370 p.a.

A contributory pension scheme is in operation for established staff.

CANDIDATES should apply to the Chief Constable, Lancashire Constabulary, Hutton, Preston, giving details of age, education, experience and qualifications. [8583

THE UNIVERSITY OF MANCHESTER.

RADIO Telescope—Duty Controller.

A VACANCY exsts for a post of Duty Controller in connection with the 250ft steerable radio telescope at the Jodrell Bank Experimental Station of the University of Manchester. The commencing salary, which will depend on qualifications and experience, will not be less than £650 per annum. The Salary Scale is now under review.

THE Radio Telescope is driven by remote control and the person appointed will be required to work on a shift basis in the control room of the Telescope. Under normal conditions the duties will include the simple following of operating instructions as determined by the research programmes, but quick judgment may be necessary when emergencies arise. The duties include the routine maintenance of the electronic control equipment and instrumentation in the control room. Candidates must be physically fit, with good eyesight, and be capable and willing to work on a shift basis to cover the 24 hours. They must be capable of keeping full, accurate and tidy records relating to the duties entrusted to them. Candidates must hold a Higher National Certificate in Electrical Engineering, or a senior City and Guilds Certificate in some branch of light current electrical engineering or similar qualifications. Previous experience of the control of plant or apparatus containing both electrical and mechanical parts is desirable.

APPLICATIONS, giving full details of qualifications and experience, as well as the names and addresses of two referees, should be sent to Professor A. C. B. Lovell, Jodrell Bank Experimental Station, Lower Withington, Macclesfield. Cheshire. [8554

WANTED, young man with some knowledge of recording and disc cutting practice.—Magnegraph, 1, Hanway Place, London, W.1. [8542

SITUATIONS VACANT

DERBYSHIRE EDUCATION COMMITTEE.
MUSEUM Service. Park Grange, DUFFIELD Rd., Derby.
APPLICATIONS are invited for the appointment of assistant radio service engineer who is required for interesting work in connection with the service and installation of television, radio, gramophone, 16mm cine projector and aerial equipment in schools; a short course on cine equipment will be arranged if candidate is otherwise suitable; candidates with suitable experience and preferably with a certificate in radio or television servicing and holding, or willing to obtain, a driving licence, should apply in writing giving particulars of education, qualificatons and experience; salary £525-£590; the post is superannuable and a medical examination is necessary; applications should be submitted to the undersigned not later than 11th September, 1959.
J. L. LONGLAND.
DIRECTOR of Education.
County Offices.
Matlock,
Derbyshire. [8646A

SENIOR/Junior Development Engineers and LABORATORY Assistants.
ENGINEERS with experience of AM FM and SSB techniques are required for new development teams. Very good prospects and conditions. Pension scheme.—Please write with details of qualifications, experience and salary required to Personnel Officer, British Communications Corporation, Ltd., Exhibition Grounds, Wembley, Middlesex. Wembley 1212. [0244

TOP grade salesman based on London required for public company distributing famous high-quality radio receivers and components.
THIS post represents an exceptional opportunity for a man with a sound technical background, long experience and good connections with the trade and industry.—Only applicants fulfilling these conditions should write, in confidence, to Box 4456. [8609

RADIO testers required to work on production line, modern factory, permanent position, 5-day week.—Tel. Mr. Reid, Cle. 2133. [8544

ELECTRONIC engineers; a few vacancies exist for engineers to train as project leaders, to take complete charge of overseas contracts.
CANDIDATES must be single, medically fit and in the age group 25-29 years; qualifications: B.Sc., H.N.C. or equivalent; excellent remuneration and good prospects.
APPLY: The Decca Navigator Co., Ltd., Overseas Projects Division, Wymondley House, Little Wymondley, Nr. Hitchin, Herts. [8605

FIRST-CLASS Wireman wanted for wiring up prototype electronic equipment, later to act as foreman of assembly group; good salary and prospects; N.W.10.—Box 4395. [8635

TWO first-class television engineers, clean licence, good wages; also television installation engineer and aerial rigger.—Apply T. A. Berry (Lodge Radio), Ltd., 6-7, Castle Parade, Ewell. Tel. Ewell 2317. [8528

TELEVISION Sales and Service Engineer; good position and prospects for keen man; old-established N.W. London Murphy dealer; driving experience essential; state age and details of experience.—Box 4398. [8631

RADIO testers wanted for testing and repairing transistor equipment; good wages; 5-day week; modern factory.—Apply J. & A. Margolin, Ltd., 112-6, Old St., London, E.C.1. [8595

RADIO engineer wanted for laboratory assistance and technical production control; write or telephone for interview.—J. & A. Margolin, Ltd., 112-6, Old St., London, E.C.1. Clerkenwell 2133. [8596

TELEVISION bench and field engineers required at all times for vacancies in most parts of the British Isles; permanent positions with highest salaries plus bonus for suitable applicants, 5½-day week.—Box 1757. [0251

ELECTRICAL technicians req. for prototype and assembly work. O.N. preferred; pension scheme.—Write age, exp. and sal. req. to AMF Ltd., 69, Tabernacle St., E.C.2. Tel. Cle. 3137. [8642

TECHNICAL assistant to be trained in ultrasonic flaw detection for application research and instrument testing; electronic experience necessary.—Details to G.D., Ltd., Sudbourne Rd., London, S.W.2. [8606

EXPERIENCED regular mechanic required for service depot of leading motor manufacturers, used to fault finding on car radios, installation, etc.; good rates of pay, excellent conditions; 44-hour week.—Apply Box 4396. [8634

TECHNICAL Assistants (Tech. Grade III) required. Qualifications essential O.N.C. (Electrical) or equivalent standard technical education plus five years' apprenticeship engineering concern or equivalent followed by three years' practical experience electronic equipments.
DUTIES include repair and maintenance army fire control radar equipments and some knowledge of these desirable. Salary range £545 to £850 according to age.
APPLICATIONS to O.C., A.A.I.R. Wksp., R.E.M.E., Cleave Camp, Bude, Cornwall. [8541

SITUATIONS VACANT

PERSONAL Assistant required by owner of London retail radio and electrical business of good standing. Congenial position and good prospects for capable, conscientious person; state age and details of career.—Box 4397. [8630

FIRST-CLASS service engineers and salesmen required for new branch opening shortly in Croydon; non-contributory superannuation; alternate Wed. and Sat. half-day.—R.H. Television Development Co., Ltd., 4, London Rd., Bromley. Tel. Rav. 9603. [8607

ENGINEERS with some five years practical experience of radio frequency design work required for interesting new project in laboratory situated in South West outskirts of London, pension scheme.—Write giving full particulars of experience and salary required to Box 2409. [8433

SENIOR Draughtsmen for electronic and electro-mechanical work to service requirements; permanent positions, ideal working conditions, five-day week, all amenities.—Write or telephone Cottage Laboratories, Ltd., Portsmouth Rd., Cobham, Surrey. (Cobham 3191.) [8621

QUALIFIED electronic engineers wanted by large organisation for training as overseas project leaders; H.N.C. or equivalent; age group 25-32; must be single, medically fit and capable of staff control and administration in field conditions; excellent salaries for the right men.—Box 3715. [8561

EXPERIENCED electronics technician required to assist with a large new national research project; initial salary approximately £650-£700 according to age, experience and qualifications.—Apply in writing to Administrative Assistant, Department of Physics, University, Birmingham 15. [8558

ELECTRONICS; circuit development and design engineers required for work on audio frequency amplifiers and associated equipment; qualifications, H.N.C. plus recent experience in Hi-Fi, P.A. or vibration field; progressive posts in pleasant working conditions. Pamphonic Reproducers, Ltd., Dalston Gardens, Stanmore, Middlesex. Wordsworth 0226. [8593

TELEVISION engineers, intermediate grade, required with experience of studio equipment, for planning studio installations; commencing salary (pensionable) £750-£1,000 according to experience.—Apply Head of Television Broadcasting Department, Central Rediffusion Services, Ltd., Television House, London, W.C.2. [0245

ELECTRONIC technicians required by a major steel company to work upon the installation and maintenance of varied electronic equipment, and the construction of special purpose plant. The work will include the servicing of a modern digital computer and in this connection, sound mathematical ability will be advantageous.
CERTAIN special training will be given, but practical experience in the construction, operation and maintenance of electronic and electro-mechanical equipment is required together with good knowledge of working principles.
THE work will be on a shift system, although opportunities to transfer to day work will arise.
THIS is a staff appointment and applications should be made in writing to the Labour Manager, Samuel Fox and Co., Ltd., Stocksbridge Works, Nr. Sheffield. [8617

RADIO testers, men with experience of fault-finding on telecommunication and allied equipment are invited to apply for this interesting and progressive position.—Write with details of experience and qualifications to Personnel Officer, Britich Communications Corporation, Ltd., Exhibition Grounds, Wembley, Middx. Wembley 1212. [0243

YOUTH 17-20 with knowledge of electronics, good education and initiative is offered a 3-year apprenticeship in the London area in the servicing of radio, electronics and communications equipment by one of the leading companies in this field.—Please reply in own handwriting, giving full details of education and experience, Box 3821. [8573

DEVELOPMENT engineer required by an expanding company, with good practical and theoretical experience of general electronics, also a working knowledge of sheet metal and light engineering practice. Staff position, pension scheme and sick club, holiday arrangements honoured.—Write, giving full details and salary required, Grundy & Partners, Ltd., 3, The Causeway, Teddington, Middx. [8530

ASSISTANT chief designer/draughtsman required to take charge of small design/drawing office of firm of aircraft electro/mechanical equipment manufacturers; must be fully experienced and conversant with all aircraft requirements, specifications and tests, both A.I.D. and A.R.B.—Apply, giving full details of experience and salary required, to Box 3807. [8566

TEST engineers.—We have a few vacancies in our final test room, which offers a prospect of interesting jobs in this rapidly expanding company; candidates should either have had previous experience, or be at least O.N.C. standard; 5-day week; canteen; pension scheme. —Electronic Instruments, Ltd., Lower Mortlake Rd., Richmond, Surrey. Ric. 6435. Ref. TE/WCB/M. [8578

SOUTHERN RADIO'S SPECIAL BARGAINS

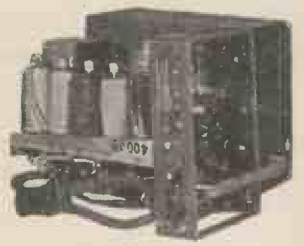
TRANSPARENT MAP CASES. Plastic 14in. x 10¾in. Ideal for Maps, Display, etc., 5/6.
STAR IDENTIFIERS. Type I A-N Covers both Hemispheres, 5/6.
CONTACTOR TIME SWITCHES. 2 impulses per sec., in case, 11/6.
REMOTE CONTACTOR. For use with above, 7/6.
MORSE TAPPERS. Midget type, 2/9; Standard, 3/6; Heavy type on base, 5/6. ALL BRAND NEW.
MORSE PRACTICE SET. TAPPER with **BUZZER** on base. Complete with battery, 12/6. BRAND NEW.
MAGNETS. Strong Bar type, 2 x ¼in., 1/6 each.
PACKARD-BELL AMPLIFIERS. Complete. BRAND NEW, with valves, relay, etc., etc., 17/6 each.
SPECIAL OFFER. 12 ASSORTED METERS. Slightly damaged. Mainly broken cases (perfect movements). Including 3 BRAND NEW Aircraft Instruments. 12 for 45/-.

SPECIAL OFFER

TRANSMITTER - RECEIVER

TYPE 38 MK II

* WALKIE-TALKIE *



Complete in Metal Carrying Case. 9in. x 6¾in. x 4in. Weight 6lb. Frequency 7.3 to 9 Mc/s. Five valves. £1/2/6. Post paid.

These TX-Rs are in NEW CONDITION, but owing to demand they are not tested by us and carry no guarantee, but should prove SERVICEABLE.

ATTACHMENTS for Type "38" Transreceivers. ALL BRAND NEW. Headphones 15/6; Throat Microphones 4/6; Junction Boxes 2/6; Aerials, No. 1 2/6; No. 2 5/-; Webbing 4/-; Haversacks 5/-; Valves—A.R.P.12 4/6; A.T.P.4 3/6; Set of FIVE VALVES 19/- the set.

OFFER No. 2:
"38," as above, complete with set of external attachments, 42/6, post paid.

OFFER No. 3:
Transmitter-Receiver "38" Mk. II. Brand new with complete set of external attachments including Webbing Haversacks and Valves. 57/6 post paid. Fully guaranteed.

RESISTANCES. 100 assorted useful values. New wire end 12/6. NEW.
CONDENSERS. 100 assorted Mica; Tubular, etc., 15/-. NEW.
LUFBRA HOLE CUTTERS. Adjustable ¾in. to 3½in. For Metal, Plastics, etc., 7/-.
QUARTZ CRYSTALS. Types F.T.241 and F.T.243. 2-pin, ½in. spacing. Frequencies between 5,675 kc/s and 8,650 kc/s. (F.T.243), 20 Mc/s and 38.8 Mc/s (F.T.241, 54th Harmonic) 4/- each. ALL BRAND NEW, TWELVE ASSORTED CRYSTALS, 45/-. Holders for both types 1/- each. Customers ordering 12 crystals can be supplied with lists of frequencies available for their choice.
TRANSRECEIVERS. Type "18" Mark III Two Units (Receiver and Sender). Six valves, Micro-ammeter, etc., in Metal Case, untested, without guarantee but COMPLETE, £2/18/6.
ATTACHMENTS for "18" Transreceivers. ALL BRAND NEW. Headphones 15/6; Hand Microphone 12/6; Aerials 5/-; Set of 6 Valves 30/-.
T1154 TRANSMITTERS. Complete in transit case. New condition, £2/5/-.
RECORDING BLANKS. Brand new. "Emidisc." Ready for cutting. 13in. 6/- each or 15 complete in metal case £4.

Post or carr. extra. Full list Radio Books, etc., 3d.

SOUTHERN RADIO SUPPLY, LTD.

11, LITTLE NEWPORT STREET,
LONDON, W.C.2. GERrard 6653

SITUATIONS VACANT

WIREMEN required by an expanding company. Men able to work on own initiative from circuit and wiring diagrams. First-class work to A.I.D. standards. Pension scheme and sick club. Holiday arrangements honoured.—Apply Grundy & Partners, Ltd., 3, The Causeway, Teddington, Middx. [8535

TECHNICIAN required in the electrical engineering department; some experience in maintenance of measuring instruments and electronic equipment; some mechanical experience an advantage; O.N.C. preferred; salary according to established University scales plus London Weighting.—Application in writing to Secretary, King's College, Strand, W.C.2. [8645

RADIO Technicians required by International Aeradio Ltd. for overseas service. Permanent and pensionable posts. Normally tax-free, inclusive salary in local currency varying with location, and additional marriage and child differentials. U.K. leave, free air passages and insurance. Kit allowance. Qualified candidates to whom replies will be sent write to Personnel Officer, 40, Park St., W.1. [0262

ENGINEER required with electronic or vacuum experience to install and service electron microscopes. Training given to those without specialised experience. Minimum qualifications O.N.C., but H.N.C. standard preferred. Good working conditions. 5-day week. Pension scheme.—Apply, giving details of education and experience, to Aeon Laboratories, Beech Hill, Ridgemead Rd., Englefield Green, Egham, Surrey. [8529

ELECTRONIC wiring assistant.—Written applications are invited from men experienced in wiring electronic equipment, able to work from circuit diagrams and preferably used to prototype work; five-day week, canteen and pension scheme.—Please write, stating age, experience and salary required, quoting Ref. C98, to the Personnel Officer, Hilger and Watts, Ltd., 98, St. Pancras Way, Camden Rd., N.W.1. [8623

TECHNICAL writers, Hilger & Watts, Ltd., invite applications from suitably experienced men interested in writing instruction booklets for users of scientific instruments; previous experience essential and some knowledge of electronics desirable. The work is interesting and the posts are permanent and pensionable.—Apply to Chief Personnel Manager, Hilger & Watts, Ltd., 98, St. Pancras Way, Camden Rd., N.W.1. [8626

JUNIOR engineer; A. V. Roe & Co., Ltd., Chertsey, have a vacancy for a junior engineer, having O.N.C. or equivalent, required in the computer laboratory to assist in the development of novel computing devices; experience of computers and transistors would be an advantage.—The reference number to be quoted is C/PRW/R.114/W, and replies should be addressed to A. V. Roe & Co., Ltd., Hanworth Lane, Chertsey, Surrey. [0023

SURREY EDUCATION COMMITTEE.—Laboratory assistant Grade B required for Physics and Mathematics Department, with some practical knowledge of electronics; encouragement given to continue part-time studies; salary, £465—£525, plus London allowance; overtime rates payable in excess of 38 hrs. p.w.—Applications to be made to the Principal, Kingston Technical College, Fassett Rd., Kingston-upon-Thames, as soon as possible. [8568

RADIO SOCIETY OF GREAT BRITAIN, 28, Little Russell St., London, W.C.1, invite applications for post of Deputy General Secretary, age range 28 to 40; salary range £800 to £1,000; sound knowledge of office administration and good organising ability essential; experience of amateur radio desirable.—Testimonials and recent photograph to General Secretary, marked "Confidential, D.G.S." Closing date 10 days after publication of this advertisement. [8569

INSTRUCTOR in marine radio required by the College of I.M.R. Commns., Overseas House, Brooks' Bar, Manchester, 16.: P.M.G. 1st Class Cert. and knowledge of modern marine W/T equipment essential; additional radio qualifications and teaching experience an advantage; salary based on Burnham Technical Scale with pension scheme for man of proved ability.—Write Principal (Ref. "Staff") giving full particulars in confidence. [8567

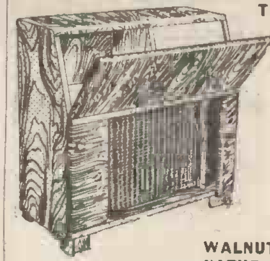
TELEVISION test engineers; a leading Midlands manufacturer has a number of vacancies for test engineers for work on the testing and fault-finding of domestic television receivers; experience is preferred and basic electronic knowledge is essential; ex-Service technicians are particularly suitable for this type of work; those interested should apply, giving details of past experience, to the Personnel Manager (Ref. T.T.), Box 4164. [8604

DIGITAL computers: A. V. Roe & Co., Ltd., Chertsey, have a vacancy for an electronics engineer in a rapidly expanding computer group which is concerned with the development of novel computing devices; qualifications required are H.N.C. or equivalent, together with experience in the design of pulse circuitry, preferably using transistors.—The reference number to be quoted is C/PRW/R.113/W, and replies should be addressed to A. V. Roe & Co., Ltd., Hanworth Lane, Chertsey, Surrey. [0022

CABINETS

FOR ANY EQUIPMENT
CABINETS TO YOUR SPECIFICATION

THE BUREAU



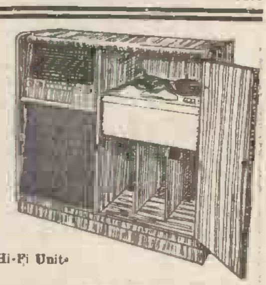
This popular bureau cabinet is veneered with the finest selected Walnut and beautifully polished in a medium shade. Designed to accommodate almost any of the many units we have available and to give generous storage compartments.

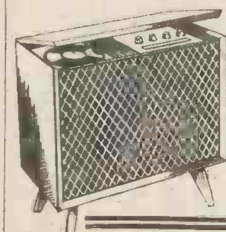
WALNUT £16.16.0
NATURAL OAK £18.18.0

THE SERENADE

Veneered with finest selected walnut, beautifully polished to a medium shade; this attractive cabinet has generous storage space, with board sliding out smoothly on metal rollers. This cabinet can be fitted with any of the latest Hi-Fi Units.

£13.19.6





THE CONTEMPORARY

This beautifully designed Contemporary Cabinet can be supplied in Oak, Walnut or Mahogany Veneer and has a waxed semi-matt finish

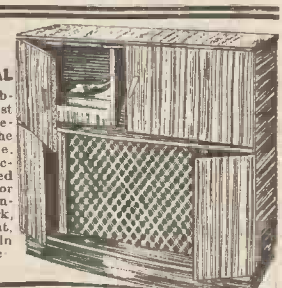
This cabinet can be fitted with any of the latest Hi-Fi Units.

£11.15.0

THE CONTINENTAL

This elegant Cabinet is the latest in our range designed in the continental style, solidly constructed and finished in oak walnut or mahogany veneers. (Dark, medium or light, high gloss or satin finish available.

£29.10.0



THE REGENT

£22.10.0

This cabinet can accommodate almost any combination of Radio-Feeder Amplifier Control, Motor Units and Loudspeaker System. There is ample storage space. Available in finest walnut or mahogany veneer and polished. Has pneumatic lid stay and castors.

Write for our NEW 24 page fully illustrated catalogue of cabinets and details of our complete range of chassis, autochangers, tape decks, speakers, etc., all available on easy terms.

LEWIS RADIO

120 GREEN LANES (Dept. WW59)
PALMERS GREEN, LONDON, N.13.
(Near the Cock Tavern)
Telephone: BOWes Park 1155/6

SITUATIONS VACANT

ELECTROMECHANICAL and electronic development engineers urgently required for interesting work on new aircraft instrumentation systems which include transistor amplifiers, data computors, instrument servo systems and gyroscopic devices.
MINIMUM qualifications are that applicants shall have some practical experience in one or two of the above fields and should be up to H.N.C. standard.—Apply in writing, stating age and experience, to S. G. Brown, Ltd., Shakespeare St., Watford, Herts. [8587

"ELECTRICAL & Radio Trading" (weekly journal published by Odhams Press) has vacancy for technical editorial assistant (25-35) with sound knowledge of TV and radio circuitry, electricity and electronics, and ability to write fluently on these subjects; previous experience on a technical journal or press agency an advantage; good salary and prospects. N.U.J.—Apply Editor, Electrical & Radio Trading, 189, High Holborn, London, W.C.1. [8620

WAR DEPARTMENT.—Male Radio Operators required for Leicester area, good education. Age limits 18-32, higher exceptionally. Good prospects of permanent appointment and pension later. Salary—trainees £422/10-£605. Up to £975 when qualified.—Apply in writing giving full details of qualifications and experience to Admin. Officer, Room 300, Northumberland House, Northumberland Ave., London, W.C.2. [8638

APPLICATIONS are invited for the post of deputy to the chief sound recording engineer of the Nuffield Talking Book Library for the Blind with the prospect of ultimately taking full responsibility for work in the field of sound recording for the blind generally but with particular emphasis on talking books. At present the disc record is in general use but work on magnetic tape recordings is actively in progress and is expected to increase in volume and importance.
THE duties of the post may include any of the following: Making master records of selected books; organising the copying of these for issue to blind "readers"; technical advice on the purchase of new reproducing machines and the maintenance of existing machines; development and application of new recording and reproducing techniques for the assistance of the blind; negotiations with manufacturers of recording and reproducing equipment and material; liaison with the head of the talking book library.
APPLICANTS should preferably be between 25 and 35 years of age but would be considered up to 45, and should desirably have had experience of sound recording in a responsible capacity. They should hold an appropriate degree, and/or be a corporate member of one of the recognised professional institutions but these qualifications might be waived in favour of a candidate who can offer exceptional previous experience of sound recording.
THE post, which is pensionable, would command an initial salary in the range of £770-£1,150 according to qualifications and experience. Applicants should be willing to serve for a probationary period of up to 2 years. There is an opportunity for promotion to a higher grade commanding a salary scale of £1,250-£1,450. Applications, which should be accompanied by copies of three recent testimonials and the names of personal referees, should reach the Secretary-General, The Royal National Institute for the Blind, 224, Great Portland St., London, W.1, by 15th September. [8641

OVERSEAS Oil Exploration Company, with world-wide seismic parties, offers permanent career to electronic technicians; maintaining and operating field equipment; men prepared to accept responsibility and to live in camp conditions; academic qualifications to H.N.C. or equivalent essential, and genuine practical experience to this standard; National Service completed and an advantage if in relevant work; home leave every two years.—Box 4229. [8608

ELECTRONIC engineering.—A vacancy exists in the research department of a company of scientific instrument manufacturers for an assistant in the electronic laboratory. Applicants should possess H.N.C. in Electrical Engineering and have had at least four years' employment in this field. Advanced conditions of employment and salary commensurate with ability and experience.—Apply, with details of age, qualifications, experience, salary required, to Box 3519. [8531

ASSISTANT required in Patents Office of large telecommunications group for a wide range of details and responsible investigations; technical qualifications are essential, at least H.N.C., with preferably some knowledge of automatic exchange switching and electronic circuitry and a real interest in technical liaison and report writing; age 25/30; excellent prospects and good starting salary.—Write for application form to Staff Officer. Ref. 744/56, Siemens Edison Swan. Ltd., London. S.E.18. [8553

CHIEF technician for brain wave laboratory required for Kingston General Hospital, Kingston, Ontario, Canada. Requirements include grammar school education, knowledge of electronics essential, with ability to repair, some interest in human physiology, nervous diseases and research desirable; salary according to experience, $275.00 to $400.00 per month, might be supplemented.—Reply fully, giving experience, personal data, interests, etc., to Director of Personnel, Kingston General Hospital, Kingston, Ont. [8619

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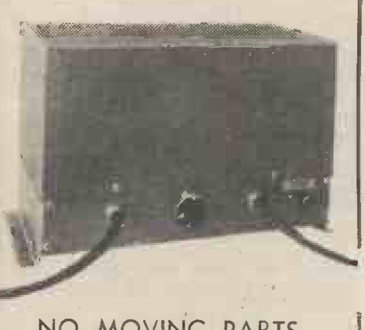

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RADIO operators.—Air Ministry have vacancies for temporary radio operators (male); good prospects of permanent, pensionable appointments and promotion; initial appointments in U.K. but subsequent tour of duty in Far East likely; trainees £422/10 to £605; qualified operators £507/10 to £975 (these rates are subject to a small deduction at provincial stations and a small increase in London and overseas); special allowances payable for overseas service.—Apply Air Ministry, C.E.4m., Cornwall House, Stamford St., S.E.1. [0231

ELECTRONIC engineering assistant required for work on the prototype construction and the development of industrial electronic instruments; candidates, who should be under 30 years of age, should preferably be able to work from circuit diagrams and have some experience in workshop practice associated with the maintenance of electronic and other equipment; the position is progressive and there is a pension scheme in operation.—Please write, giving full details, to the Staff Manager, High Duty Alloys, Ltd., Research Division, Slough, Bucks. [8615

BATTERSEA College of Technology, London, S.W.11, Physics Department. The next series of lectures on Microwave Physics will begin on Monday, October 5th, 1959, at 6.30 p.m. The Course will deal with microwave theory, techniques and applications and is suitable for graduates in mathematics, physics and electrical engineering; suitably qualified students may proceed, as part-time students, to the Internal M.Sc. degree of the University of London or the post-graduate Diploma of the College.—Further details and enrolment forms may be obtained from the Secretary (Microwave Courses). [8610

THE BRITISH RUBBER PRODUCERS' RESEARCH ASSOCIATION requires an assistant for the electrical engineering department to undertake the construction and maintenance of an increasing range of electronic apparatus and other instruments; applicants should have previous experience of similar work, or suitable educational qualifications; salary will be on a progressive scale, the starting point being determined by age, qualifications and previous experience; every encouragement and financial assistance will be given for part-time study leading to appropriate professional qualifications.—Applications to the Director of Research, B.R.P.R.A., 48-56, Tewin Rd., Welwyn Garden City, Herts. [8591

MINISTRY OF SUPPLY require a Technician at South Marston, Swindon, Wilts, to assist at the works of a contractor, in the supervision of the inspection of prototype and production aircraft, including electrical, radio and instrument installations. Quals. Recognised engineering apprenticeship or equiv. training in appropriate trade; O.N.C., appropriate C. & G. Final Certificates or equiv. qual. desirable; sound knowledge of aircraft and light electrical engineering and preferably also of electronics as applied to aircraft installations. Rate of pay: £850 (age 30)-£1,005 p.a. —Application forms from Ministry of Labour and National Service, Professional and Executive Register (P.E.868), Atlantic House, Farrington St., London, E.C.4. [8575

SENIOR Scientific Officers (a); Scientific Officers (b). Pensionable posts for men or women in all major scientific fields, including physics, chemistry, biology, meteorology and mathematics. Age limits: (a) at least 26 and under 31, (b) at least 21 and under 28. Extension for regular Forces Service and Overseas Civil Service. Qualifications: normally first or second class honours degree in science, mathematics or engineering, or equivalent attainment; additionally for (a), at least 3 years' relevant (e.g., post-graduate) experience. London salaries (men): (a) £1,233-£1,460, (b) £655-£1,150; provision for starting pay above minimum. Promotion prospects.—Write Civil Service Commission, 17, North Audley Street, London, W.1, for application form, quoting (a) S53/59, (b) S52/59. [8538

THE Air Ministry have vacancies for civilian radio technicians at Royal Air Force Sealand and at other selected R.A.F. stations throughout the United Kingdom for the servicing, repair, modification and testing of air and ground radio and radar equipment. Commencing salary (national) (according to age) is £525-£635 p.a. Max. salary £745 p.a. These rates are subject to a small deduction at certain provincial stations and a small increase in London. Annual leave 3 weeks 3 days increasing to 4 weeks after 3 years' service. A limited number of houses may be available for renting at Sealand. These houses are at West Kirby, some 15 miles distant.—Apply, giving details of quals. and exp., direct to the Commanding Officer No. 30 Maintenance Unit, Royal Air Force, Sealand, or to Air Ministry C.E. 4m Cornwall House, Waterloo Rd., London, S.E.1, for other vacancies. [0242

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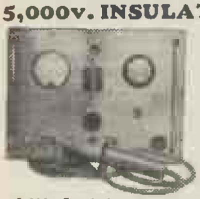

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CHIEF technical officer required by Posts and Telegraphs Department, Nigeria Federal Government on contract for tour of 12 24 months in first instance. Salary scale (including Inducement Addition) £1,350 rising to £1,674 a year. outfit allowance £60, gratuity at rate of £150 a year, free passages for officer and wife, assistance towards children's passages and grant up to £150 annually towards maintenance in U.K. liberal leave on full salary; established Civil Servant's pension rights may be preserved; candidates, should have about five years practical experience in radio systems including V.H.F. and V.F.T. multiplex systems; possession of appropriate C. and G. cert. an advantage.—Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters full qualifications and experience and quote M2C/42585/WF. [8551

MINISTRY OF SUPPLY require technician at Shrewsbury, Shropshire, to be responsible for supervision of approved inspection organisation at the works of contractors engaged on the development and manufacture of electrical and electronic equipment for guided weapons. Quals.: Recognised engineering apprenticeship or have had equivalent training in an appropriate trade; sound knowledge of light electrical engineering with some electronics experience is required, and a knowledge of computers and high frequency technique an advantage; possession of O.N.C. (Electrical), appropriate C. & G. Final Certificates, or equiv. qual. desirable; salary: £850 (age 30)—£1,005 p.a.—Application forms from Ministry of Labour and National Service, quoting P.E.1053, Professional and Executive Register, Atlantic House, Farringdon St., London, E.C.4. [8548

INSTRUCTOR (Telecommunications) required by Sierra Leone Government Technical Education Department on contract for three tours of 10/12 months each in first instance; salary according to age and experience in scale (including Inducement Addition) £966 rising to £1,528 a year; gratuity at rate of 15% of total salary drawn; outfit allowance £60; children's allowances £48 to £288 per year; liberal leave on full salary; free passages for officer, wife and 3 children under 18 years; candidates should be between 22 and 45 years of age and must possess C. and G. Full Technological Certificate in Telecommunications or similar qualification with at least five years practical experience; experience in Technical Education desirable.—Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters. full qualifications and experience and quote M2C/50686/WF. [8264

MINISTRY of Supply Research and Development Establishments require Assistant Experimental Officers (minimum age 17, male or female) in areas Farnborough (Hants), Bedford, Aberporth (Wales), Sevenoaks (Kent), Waltham Abbey (Essex), Salisbury (Wilts), Malvern (Worcs), Aylesbury (Bucks) and London (3 only) for experimental work in physics, electronics, aero. elect. and mech. engineering, chemistry, chem. eng. or mathematics; qualifications: G.C.E. (A.L.), pass degree, H.N.C. or C. & G. final cert. of the grouped course (Advanced Grade in Telecomms.: candidates may apply before summer examination results are known. Salary range £382 (age 18)—£670 (age 26)—£830 (male). Women's rates same by 1961. Promotion prospects; opportunities to compete for established posts.—Forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London. S.W.1, quoting A.206/9A. [8552

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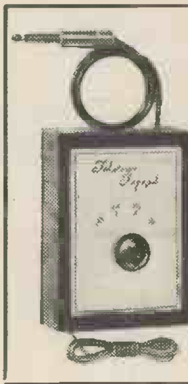

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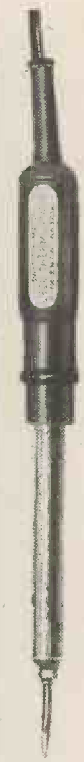

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