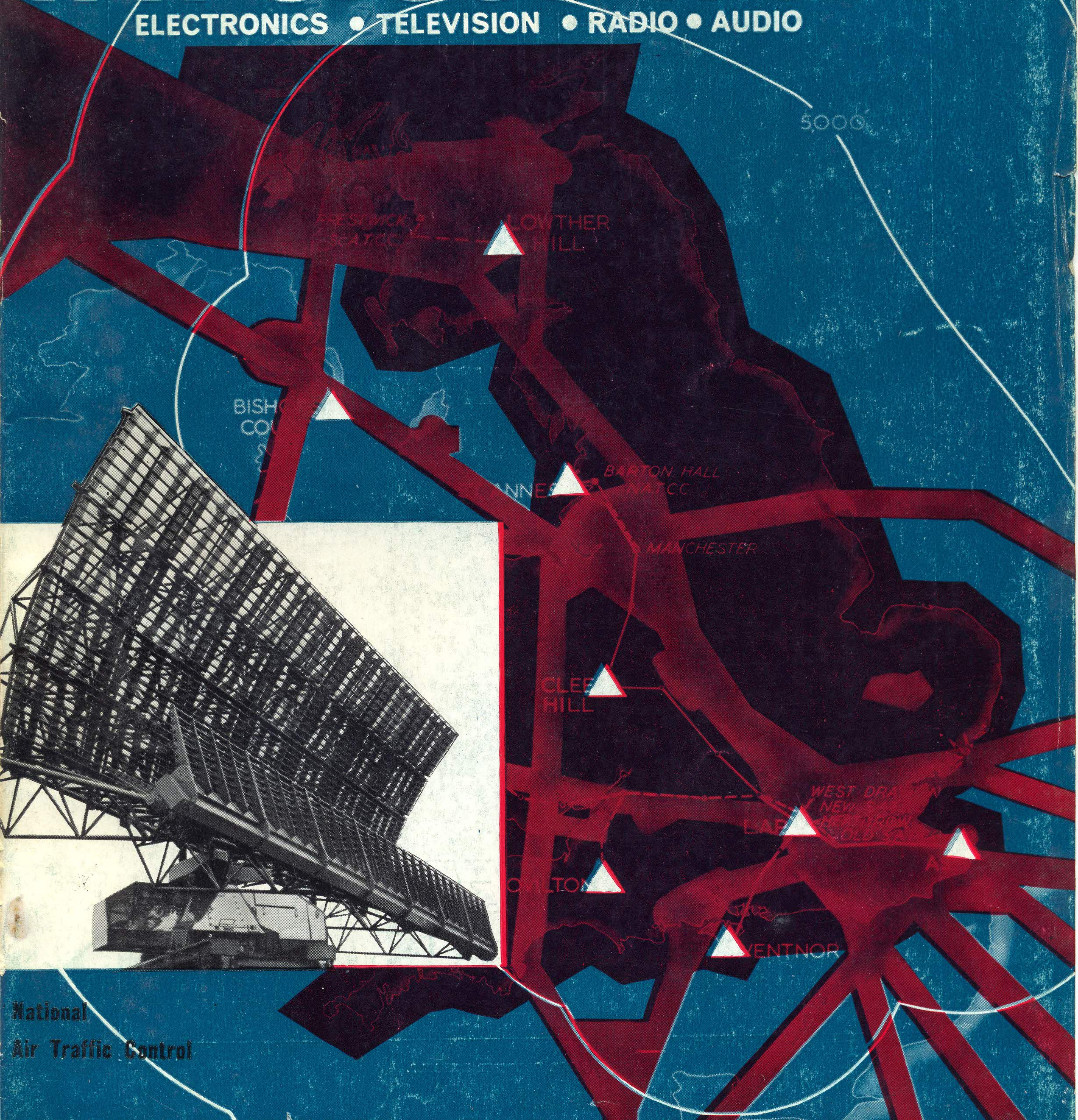
SEPTEMBER 1965
Three Shillings

SIMPLE PULSE-COUNTING F.M. TUNER

Wireless World

ELECTRONICS • TELEVISION • RADIO • AUDIO



National
Air Traffic Control

"Wireless World"
Iliffe Electrical Publications Ltd.,
Dorset House, Stamford Street,
London, S.E.1

VOLUME 71 No. 8
PRICE: 3s.

FIFTY-FIFTH YEAR
OF PUBLICATION

Wireless World

ELECTRONICS, TELEVISION, RADIO, AUDIO

SEPTEMBER 1965

PUBLISHED MONTHLY (4th Monday of preceding month). *Telephone:* Waterloo 3333 (70 lines). *Telegrams/Telex:* Wiworld Iliffepres 25137 London. *Cables:* "Ethaworld, London, S.E.1." *Annual Subscriptions: Home* £2 6s 0d. *Overseas:* £2 15s 0d. *Canada and U.S.A.* $8.00. Second-class mail privileges authorised at New York N.Y. BRANCH OFFICES: *BIRMINGHAM:* King Edward House, New Street, 2. *Telephone:* Midland 7191. *BRISTOL:* 11, Marsh Street, 1. *Telephone:* Bristol 21491/2. *COVENTRY:* 8-10, Corporation Street, *Telephone:* Coventry 25210. *GLASGOW:* 123, Hope Street, C.2. *Telephone:* Central 1265-6. *MANCHESTER:* 620, Deansgate, 3. *Telephone:* Blackfriars 4412. NEW YORK OFFICE U.S.A.: 111 Broadway, 6. *Telephone:* Digby 9-1197.

By foreseeing the needs of the public; by anticipating the practical requirements of setmakers; by helping to solve the problems of service engineers and dealers; by building reliability and performance into every product they make, **MULLARD** have created a unique business philosophy....in a word **INTRINSICALITY.**

Mullard

WW—114 FOR FURTHER DETAILS.

Wireless World

ELECTRONICS, TELEVISION, RADIO, AUDIO

Who Designs Systems — and How Well?

APPOINTMENTS and situations-vacant advertisements, some in large display panels, are making us aware of a new breed of specialist called a systems engineer. Sometimes he is given a specific "discipline"—telephone, computer, avionics—but often just as a "systems engineer." From the blurb in the advertisement it appears that the wanted engineer is mainly an electronics man, although he is not to be concerned with the detailed design of specific pieces of equipment. He apparently has to build up existing pieces of equipment or known techniques into systems primarily for the transmission, processing and presentation of information. On his work may depend the safety of human lives—as for example in the new National Air Traffic Control Scheme described in this issue, and a plane's automatic landing system—or the operation of vast industrial plants.

Where do these systems engineers come from? How are they trained and how do they get their experience? These questions ought to be examined, as it does not appear that there is any established machinery for training them. One might go so far as to say that they are virtually amateurs, picking up expertise as they go along.

An important aspect of systems engineers' work is reliability. In electronics and communications we tend to think of reliability mainly in terms of immunity from breaking down of components or equipment, and of circuit designs having good safety factors, etc. These things are all necessary of course in the individual parts of systems, but are not enough in themselves to ensure system reliability.

For example, a system can fail even though all the electronics are working perfectly. In an information processing system a situation could arise where more digits are being fed into a store than it will actually hold: the capacity of the store is exceeded and there is consequently a loss of accuracy or a complete breakdown.

Redundancy, therefore, plays a vital rôle in achieving reliability in the design of systems, as indeed is the case with animal nervous systems so that part of the "hardware" can be damaged and yet the overall system carries on. An example of a system achieving reliability through redundancy is the automatic landing system being designed for the Trident and other aircraft. This is a triplicated system with a majority vote scheme for ensuring correct operation. If two out of the three autopilots give the same output it can be assumed that that output is the correct one. If only two autopilots were installed, and they gave different outputs, how would one know which was correct?

Redundancy design techniques are a complex of economics, logic, statistics (including probability theory), information theory, etc., and the systems engineer, while being at heart an electronics man, must, it would seem, be a "generalist" rather than a "specialist."

VOL 71 NO 9
SEPTEMBER 1965

A Simple Transistor F.M. Tuner

DESIGN USING A PULSE DISCRIMINATOR AND AN LC-TUNED LOCAL OSCILLATOR

By J. C. HOPKINS,* B.Sc., Grad.I.E.E., A.Inst.P

FOLLOWING the publication of the "*Wireless World* F.M. Tuner" (July 1964) some interest seems to have been aroused again in the pulse counting type of receiver. P. J. Baxandall[1] has also pointed out that a simplified version using an LC-tuned local oscillator, and employing valves, had been designed and built by him some years ago. The following is a description of a transistor tuner designed along similar lines.

R.F. and mixer stages

These are shown in Fig. 1. The aerial is coupled *via* a coaxial cable to the emitter of Tr_1 which acts as a common-base amplifier. The operating current of the stage is set at about 0.7 mA and this yields an input impedance which approximately matches the input cable. Since this impedance is somewhat inductive at 90 Mc/s, it can be rendered resistive by simply adding the tuning capacitor C_2.

The r.f. stage is capacitatively coupled to the base of Tr_2 which acts as a self-oscillating mixer. As suggested by Baxandall, a 45 Mc/s local oscillator frequency was tried, the second harmonic of this beating with the signal to produce the required i.f. (at about 200 kc/s.). However this was found to produce a high level of second harmonic signal at the aerial terminals and so it was decided to employ a 30 Mc/s oscillator and tolerate the lower value of conversion gain produced. As a result, the gain of the r.f. stage slightly more than compensates for the loss incurred in the mixer! Nevertheless an overall sensitivity of the order of 100 μV is achieved.

The oscillator configuration employed is a modified Clapp type, the transistor operating in common-base mode so far as this action is concerned. The base is connected to earth *via* L_3 and C_7 which is broadly series resonant near 30 Mc/s. This reduces the fundamental component of the local oscillator signal fed back over the r.f. stage. A rejector circuit (L_2, C_6) for 60 Mc/s is also included. At the same time, these components are chosen so that at 90 Mc/s they balance the capacitative part of the input impedance of Tr_2, thus assisting the signal transfer from the r.f. stage. The oscillator frequency is stabilized against ambient temperature changes by using a resistive biasing network which renders the change in collector current with temperature quite small and the final compensation is achieved by giving the capacitor C_{11} a negative temperature coefficient. This is achieved by the parallel combination of a high-stability capacitor with a ceramic type having a coefficient of -750 p.p.m. per °C.

Intermediate frequency signals are taken at low impedance from the emitter of Tr_2 *via* R_{10} and the low pass filter L_5, C_{16}, L_6. The latter gives a fairly level response up to about 350 kc/s but attenuates at higher frequencies quite sharply, the mutual inductance of the two windings series resonating at about 2 Mc/s with C_{16}. This gives good rejection of the adjacent f.m. channels which produce beat frequencies in a region where the gain of the i.f. amplifier is still significant. It was found that a standard 470 kc/s i.f. transformer could be used to produce this filter, the usual winding inductances (without

*Bristol College of Science and Technology.

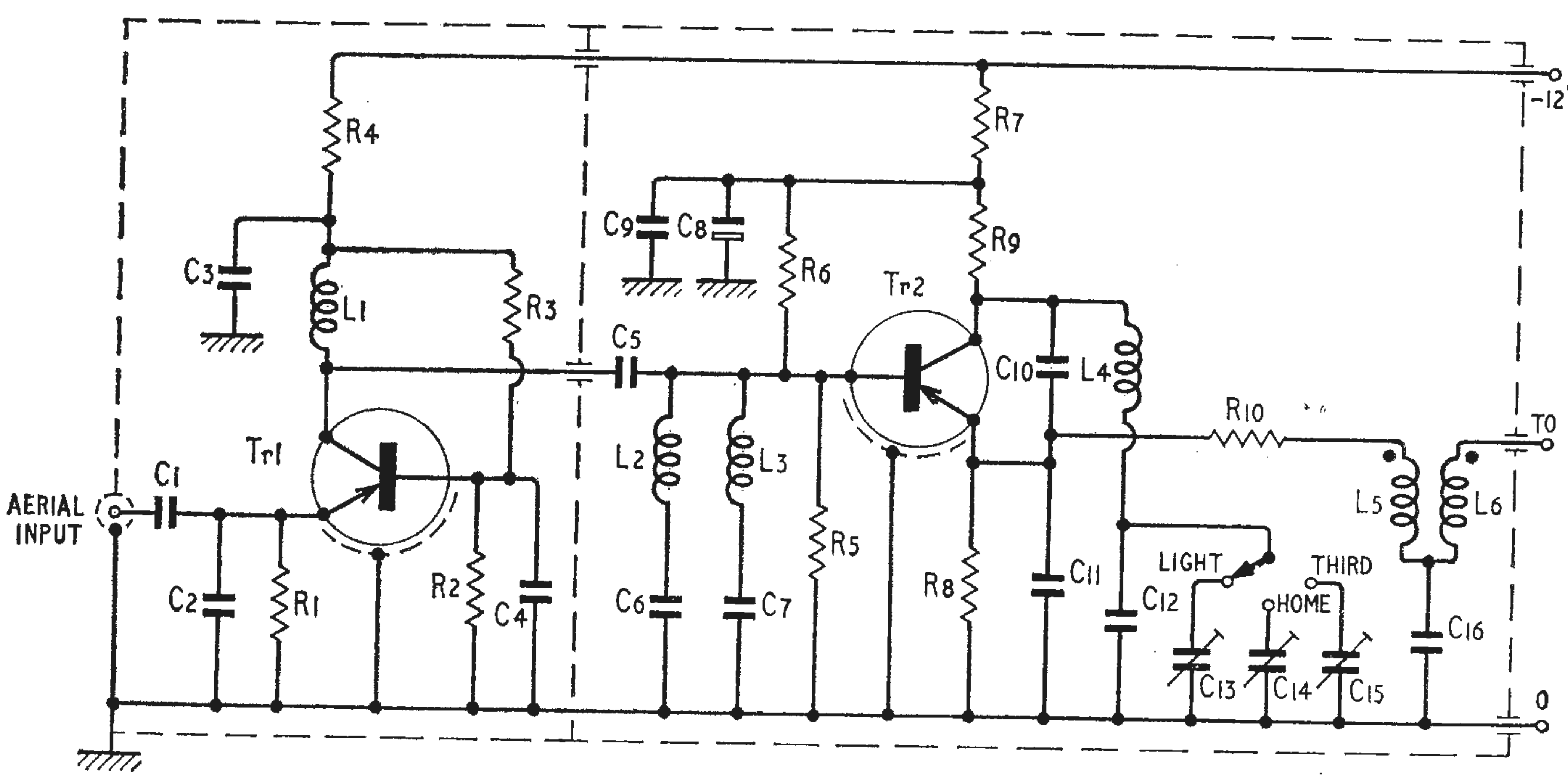


Fig. 1. R.F. and mixer stages.

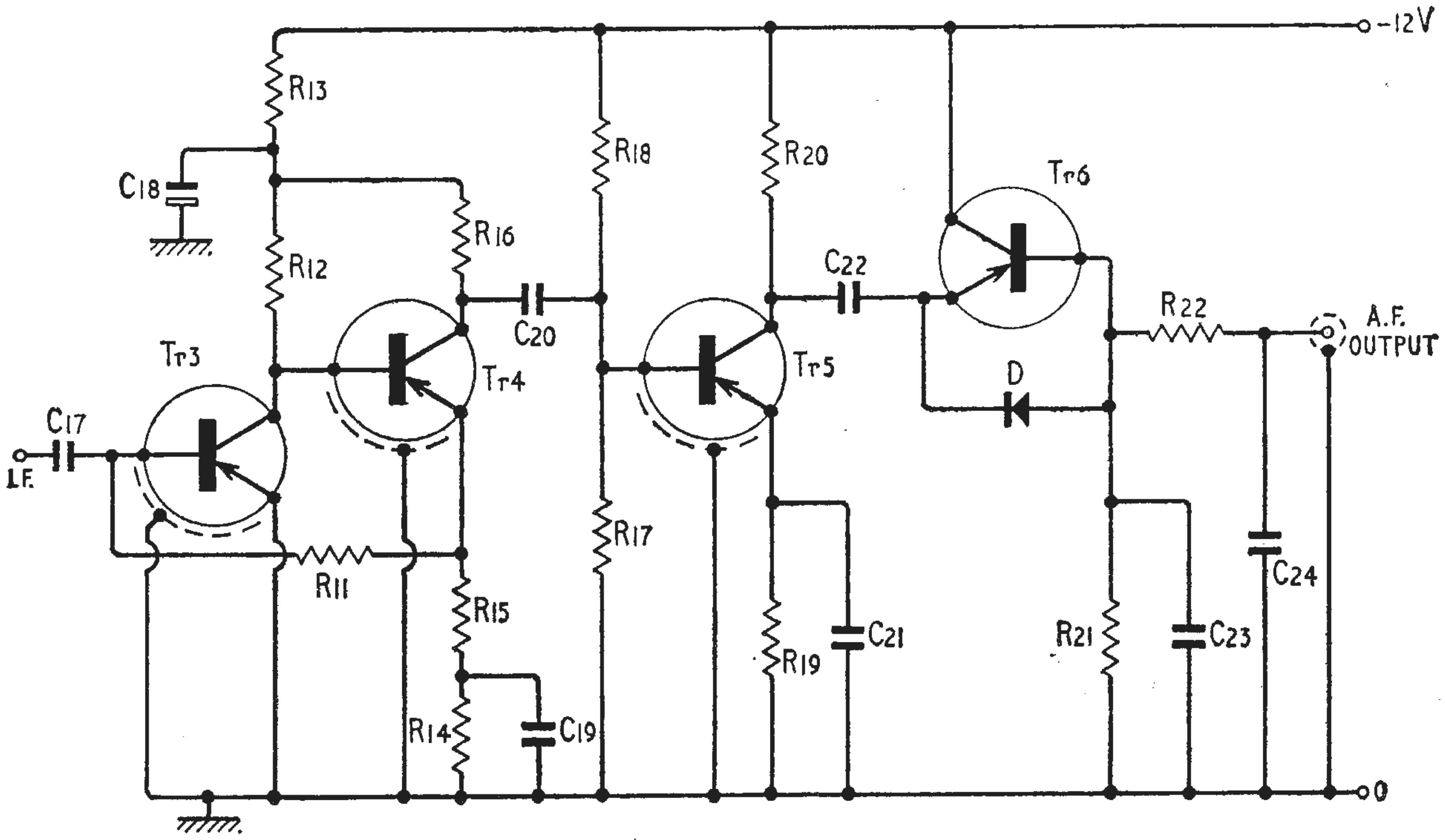


Fig. 2. I.F. and discriminator stages.

the normal tuning capacitors) and the coupling between windings being quite suitable for the job in hand.

I.F. and discriminator sections

These are shown in Fig. 2. Tr_3 and Tr_4 form a directly coupled pair with feedback both at d.c. (to achieve temperature stabilization) and at signal frequency where it usefully levels the frequency response and reduces gain changes produced by the different samples of OC171.

Tr_5 acts as final amplifier stage and is over-driven to produce a limiting action. A rectangular wave of approximately 11V pk-pk appears at the collector, the limiting

LIST OF COMPONENTS

Resistors

R_1	1kΩ	R_{12}	10kΩ
R_2	1kΩ	R_{13}	1kΩ
R_3	10kΩ	R_{14}	680Ω
R_4	1kΩ	R_{15}	100Ω
R_5	3.9kΩ	R_{16}	6.8kΩ
R_6	10kΩ	R_{17}	3.3kΩ
R_7	1kΩ	R_{18}	27kΩ
R_8	2.2kΩ	R_{19}	470Ω
R_9	2.2kΩ	R_{20}	2.7kΩ
R_{10}	2.2kΩ	R_{21}	3.9kΩ
R_{11}	39kΩ	R_{22}	15kΩ (± 5%)

All resistors ½ W, ± 10%, carbon, unless otherwise stated.

Capacitors

C_1 0.001μF, disc ceramic.
C_2 4.7pF ± 10%, ceramic.
C_3 0.001μF, disc ceramic.
C_4 0.001μF, disc ceramic.
C_5 3.3pF ± 10%, ceramic.
C_6 10pF ± 1%, silvered mica.
C_7 25pF ± 1%, silvered mica.
C_8 10μF, 15V sub-miniature electrolytic.
C_9 0.001μF, disc ceramic.
C_{10} 220pF ± 1%, silvered mica.
C_{11} 218pF: 68 pF ± 1%, silvered mica, in parallel with 150pF ± 10%, ceramic.
C_{12} 68pF ± 1%, silvered mica.
C_{13}, C_{14}, C_{15} } 3-30pF concentric trimmer.
C_{16} 624pF: 68pF in parallel with 556pF, both ± 1%, silvered mica.
C_{17} 0.01μF ± 20%, 250V polyester.
C_{18} 1μF, 15V sub-miniature electrolyte
C_{19} 0.1μF ± 20%, 250V polyester.
C_{20} 0.01μF ± 20%, 250V, polyester.
C_{21} 0.1μF ± 20%, 250V polyester.
C_{22} 68pF ± 1%, silvered mica.
C_{23} 2700pF ± 1%, silvered mica.
C_{24} 3600pF ± 1%, silvered mica.

Inductors

L_1 6 turns 22 swg (enamel) ½in dia., spaced to about ½in long (self supporting).
L_2 13 turns 26 swg (enamel), close wound on 1W carbon resistor of high value (7/32in dia.).
L_3 19 turns 26 swg (enamel), close wound as for L_2.
L_4 8 turns 18 swg (enamel) ½in dia. close wound (self supporting).
L_5, L_6 Standard 470 kc/s i.f. transformer (Radiospares) with dust cores removed.
Connect " start " ends of windings together.

Switch

Single pole, 3-way wafer switch (Radiospares).

Semiconductor devices

Tr_1-Tr_5 OC171.
Tr_6 OC41.
D OA10.

Notes

(a) Total consumption: about 8mA at 12V.
(b) The supply voltage should preferably be held to about 12 ± 1V. This could most conveniently be derived from the mains and roughly stabilised with a Zener diode to achieve the value required.
(c) R_{14} (nominally 680Ω) may require adjustment with some transistor pairs (Tr_3, Tr_4). A value should be chosen which sets the collector voltage of Tr_4 at between 5 and 7V negative w.r.t. earth.
(d) A modification of the discriminator circuit values will enable the tuner to feed about 1V a.f. into loads of 1MΩ or greater. This is done by adopting the following component values:—
R_{21} 39kΩ, ½W, ± 10% carbon.
R_{22} 150kΩ, ½W, ± 5% carbon.
C_{23} 270pF, ± 1% silvered mica.
C_{24} 330pF, ± 1% silvered mica.
The modification is useful for feeding some valve power amplifiers without the need for an intermediate pre amplifier.

action being sufficiently good up to 350 kc/s to achieve excellent discriminator action.

The discriminator itself is a transistor pump[2]. This is a modified version of the familiar diode pump which gives improved linearity at the higher output levels. The audio output is finally taken *via* R_{22} and C_{24} which provide the required de-emphasis characteristic. An audio output of about 100 mV (r.m.s.) for a deviation of ± 75 kc/s, can be delivered into loads of 100 kΩ or greater. Where this is done with a coaxial cable, care should be taken to see that the length does not exceed about 10ft.

Construction

This is not unduly critical but the whole must of course be enclosed in a screened aluminium box and the r.f., mixer and i.f. sections screened from each other.

The discriminator and i.f. stages are assembled on an insulating board using conventional wiring techniques. (A printed wiring board would probably also be suitable). The r.f. and mixer stages are most conveniently assembled on paxolin insulated tag strips screwed to the aluminium housing, the most suitable place for the low-pass filter seems to be within the mixer compartment, the normal screening can of the i.f. transformer being removed and the coil former mounted directly on the chassis.

Setting up

Aerial.—The tuner should preferably be fed from a dipole aerial proportioned for Band II operation. This should yield an adequate signal for correct operation for field strengths down to 250 μV/m, if care is taken with the aerial installation. In areas of very low field strength a multi-element array will be necessary.

Oscillator.—The main adjustment required is that of setting the local oscillator frequency. This is most conveniently done by feeding in 90 Mc/s signals from a signal generator (say about 500 μV r.m.s.) into the aerial terminals and adjusting the self supporting coil L_4 until the whole range can be tuned with the trimmers C_{13}, C_{14}, C_{15}. L_1 should also be adjusted to peak at about mid-band, i.e. 94 Mc/s. Final oscillator frequency adjustment can easily be done on a signal, if a high-resistance voltmeter is arranged to read the mean d.c. signal appearing at the a.f. output socket. The appropriate trimmer is first adjusted to give a low intermediate frequency—as indicated by a "null" reading on the voltmeter—and then the oscillator frequency is moved to one side of this setting, to produce a voltmeter reading of 0.4 V. This will give a mean i.f. of about 180 kc/s.

Acknowledgement

I wish to thank Professor S. H. Ayliffe for permission to publish this article and for the use of the facilities of his department.

REFERENCES

1. " Transistor FM Tuner " : P. J. Baxandall (Correspondence) *Wireless World*, September 1964, p. 460.
2. " Elements of Transistor Pulse Circuits " : T. D. Towers, *Wireless World*, August 1964, p. 403.

Books Received

Topology and Matrices in the Solution of Networks, by F. E. Rogers. An initial detailed explanation of the rudiments of topology is used as a basis for introduction to the matrix concept. The combined principles are extended progressively to the solution of network equations and then applied to fundamental theorems and four-terminal networks. Worked examples, given at the end of each chapter, link theory with practical application. Pp. 204; Figs. 100. Price 45s. Iliffe Books Ltd., Dorset House, Stamford Street, London, S.E.1.

Dynamic Circuit Theory, by H. K. Messerle. Written as an introductory course on electromechanical energy conversion and electromechanical systems, the book uses dynamic circuit theory as a basis for the formulation of the principles of electrodynamics. Particular attention is given to the derivation and analysis of lumped parameters and their use for representation of electromechanical devices. Double storage transducers, commutator machines, two- and three-phase machines, and multiphase systems are dealt with in detail. Worked examples are included. Pp. 657; nearly 330 Figs. Price £5. Pergamon Press Ltd., 4 & 5 Fitzroy Square, London, W.1.

The Invention of the Traveling-wave Tube, by Rudolf Kompfner. An interesting, lucid account of the research by the author which led to the invention of the travelling-wave tube. Parts of the text which recount particularly difficult stages of the work are tempered with humour and will act as a stimulant to others engaged in the arduous field of research. Pp. 30; Figs. 18. Price 10s 8d. W. Heffer & Sons Ltd., 3-4 Petty Curry, Cambridge.

Handbook of Electron Tube and Vacuum Techniques, by F. Rosebury. A new version of the Tube Laboratory Manual produced by the Research Laboratory of Electronics at the Massachusetts Institute of Technology. The introductory sections deal with procedures and techniques in the manufacture of thermionic valves and other evacuated devices. The rest of the book contains a glossary of terms comprising a detailed and comprehensive compilation of definitions, materials, processes, etc., presented in graphical and tabulated form together with explanatory diagrams. Pp. 597; Figs. 154. Price £6 12s. Addison-Wesley Publishing Company, Inc., 10-15 Chitty Street, London, W.1.

The Electron in Electronics—Modern Scientific Concepts for Electronic Engineers, by M. G. Scroggie. Couched in the inimitable style for which the author is so well known, the book fulfils the need of students and engineers requiring a lucid explanation of the physics of the electron in modern electronics. Energy levels, work functions and valency bonds are dealt with in the introductory chapters which lead to the quantum theory and photons. The controversy of electromagnetic radiation—wave theory versus photon theory—is discussed in detail and includes the effects of polarization, diffraction and interference. Continued expansion of the text then covers semiconductors and aspects of atomic theory such as magnetogyric ratio, electron spin, nuclear spin and magnetic resonance. The final chapter is devoted to relativity. Throughout the text, the standard of mathematics and general physics does not exceed G.C.E. "A" level. Pp. 276; Figs. 132. Price 45s. Iliffe Books Ltd., Dorset House, Stamford Street, London, S.E.1.

Principles of Transistor Circuits (Third Edition), by S. W. Amos. First published in 1959, the contents have been expanded in successive editions to deal with later developments of the transistor. In this edition the general arrangement of the subject matter of the book remains the same—the physics of semi-conductors, design of transistors, receivers, oscillators and generators. Additions to the text include d.c. stabilization of amplifiers by direct coupled feedback, phase shift and Wien-bridge oscillators, blocking oscillators and transistor sawtooth generators. Two appendices give details of the manufacture of transistors and an explanation of transistor parameters. Pp. 293; Figs. 172. Price 35s (stiff cover), 25s (limp cover). Iliffe Books Ltd.

Medical Instrumentation

A Way of Speeding Up the Application of New Techniques to Medical Practice

By VLADIMIR K. ZWORYKIN*, Ph.D., D.Sc.

As an introduction to the two forthcoming conferences on medical electronics, in Tokyo (29th August) and Brighton (28th September), Dr. V. K. Zworykin, who is an international leader in this field, gives his views on a problem which concerns him greatly—the excessive delay that occurs between the introduction of new instrumentation techniques and their application to medical practice.
Recently Dr. Zworykin, who is 76, was awarded the I.E.E.'s Faraday Medal for his notable scientific and industrial achievements, including the invention of the iconoscope, and his work in medical electronics.

FOR many years I have advocated the establishment of a chain of specialized institutions devoted to the advancement of medical instrumentation throughout the world, linked by our International Institute for Medical Electronics and Biological Engineering in Paris. While institutions of this nature have existed for a long time in several of the Eastern countries, in particular the U.S.S.R. and Czechoslovakia, I have found it relatively difficult, until recently, to develop the enthusiasm needed for their launching in the West and in the United States in particular. However, there are many signs that the climate is becoming more favourable for such ventures. Many influential voices have been added to my own, urging the creation of Institutes of Medical Electronics and Biological Engineering in various localities. This makes it desirable that we should examine what the structure and the functions of such an Institute might properly be. While my suggestions are necessarily tinged by my experience in the United States, the basic problems and conditions are sufficiently similar in other countries to make such an examination of general interest.

Our past experience with various national interdisciplinary professional societies, as well as with the International Federation of Medical Electronics and Biological Engineering, has emphasized the benefits to be derived from closer contact between the medical and engineering professions. The co-operation promoted by these groups has already proved exceedingly fruitful. At the same time it has thrown into clear relief a gap in the application of engineering knowledge to medical problems.

This gap exists primarily in the development of new devices for large-scale use in clinical practice. It may be attributed to the long period of testing and evaluation which, in medicine, must intervene between the construction of an engineering model and the large-scale distribution of the final device. The resulting expense and delay in marketing, which finds no counterpart in other branches of industry, discourages private enterprise from ventures in the development of medical instrumentation. A primary objective of the Institute should be, I submit, to remove this impediment. In this manner the flow of promising ideas in the field of medical electronics and biological engineering, greatly augmented in the past years through interdisciplinary co-operation, would be directed most effectively to the advancement of medical practice and, with it, to the improvement of general health and well-being. The orientation of the Institute would thus be primarily practical, since the practical application of engineering methods in medicine has, so far, tended to lag far behind their application in scientific research in the life sciences.

It should be recognized that, in principle, any new group could undertake the launching of an Institute of the type here considered. However, it is vital for its success that it should benefit from close association, from the very beginning, with organizations in the field of medical electronics and biological engineering which have been built up in the past decade. This imposes, in my opinion, a special responsibility for this undertaking on those of us who have been intimately associated with the development of the above organizations.

With this preface, what might the structure and functions of the Institute be?

Let us first consider the structure of the Institute, which would be a non-profit organization. The control of the Institute would rest in the hands of a board of directors, consisting of persons deeply convinced of the importance of the mission of the Institute and ready to maintain a financially sound basis for its operations. It would be supported by a group of eminent technical advisers drawn from the engineering and medical professions. The board would appoint a Director of the Institute who, with his secretarial assistants, would constitute the initial permanent staff of the Institute. The Director, in addition to his other duties, would be charged with establishing rosters of specialists in the medical and engineering fields who could be drawn upon to carry through technical projects in their area of competence which have been undertaken by the Institute. These specialists might be persons retired from industrial and other organizations with a prescribed retirement age who are eager to contribute their skills to the humanitarian purposes served by the Institute. While placement on the roster would not imply remuneration of any kind, travelling and *per diem* expenses incurred in the service of the Institute would be reimbursed. The establishment of the rosters may be regarded as a device for circumventing the large initial expenditure inherent in setting up a well-rounded paid professional staff and, at

*Vice-President and Technical Consultant, Radio Corporation of America.

the same time, utilizing an important available source of talent.

The activities of the Institute might include:—

1. Keeping informed concerning problems and ideas encountered in international medical practice and research and submitting them to members of the roster for evaluation with respect to importance and feasibility of further development.

2. Arranging for follow-up activity if the evaluation recommends further work; this could be carried on within the Institute or with the aid of outside organizations, always with the collaboration of the orginator of the problem and of members of the evaluating panel.

3. Carrying on such evaluation and follow-up activities for other organizations under contract.

4. Application for grants for the construction of working models and further development by an appropriate organization if this appears justified.

5. Organization of working groups from the Institute roster to supervise work carried forward under such grants and to arrange for the publication of the results in the technical journals.

6. Making arrangements for patent protection and negotiating licensing agreements under patent rights acquired by the Institute, if, under the conditions prevailing in the country, this were consistent with obtaining support from other sources.

7. Seeking financial support for the Institute from industry, foundations, and other sources, making use of professional assistance as needed.

We can envisage the function and growth of the Institute taking the following course. To begin with, the staff would make known, through appropriate professional channels, that it was available for consultation on medical engineering problems encountering obstacles of a technical, financial or some other nature. The consultation might result in a referral to a commercial or scientific organization with interests in the same field or experience in solving problems of a similar nature, or it might point out published work with a bearing on the subject. Just by serving as a focus at which medical and engineering scientists would be together, the Institute would frequently provide the starting point for collaborative investigations. If a specific project required financing, the staff might put the applicant in touch with possible sources of support after a favourable evaluation of the project by members of the advisory panel.

The Institute would not concern itself with basic research investigations which are already well supported by other agencies, but would deal primarily with the design and application of medical instrumentation. In due time, as engineering designs perfected and tested with the assistance of the Institute became widely accepted in hospitals, the demand for them would increase to a level sufficient to yield a financial return to the electronic and mechanical industries which had made the original collaborative effort. As the Institute became more widely known and a greater range of problems was presented to it, the need for laboratory facilities would become evident. Thus, in response to demand, it might gradually develop into a larger-scale research institute of medical electronics and biological engineering. The necessary "*in vivo*" experiments, which initially would be carried out in co-operating hospitals and other institutions, might then be transferred to its own facilities. Thus the Institute might grow, from relatively modest beginnings, into an establishment fully equivalent to the extensive institutes for medical instrumentation set up in Russia and other countries of Eastern Europe.

I estimate that an Institute of the type here contemplated might be launched, under the conditions prevailing in the United States, with an initial annual budget of $100,000 or less. This would just suffice to pay the Director and his assistants and provide the minimal office space and equipment required. Its growth would be determined by its recognized usefulness to industry and the medical and engineering professions. The favourable response I have received so far assures me that the growth of the Institute would be rapid and that it would come to provide an important service to the patient, the physician, and the research scientist alike.

We should lose no time in calling such Institutes into being. They would do much to close the gap between theoretical understanding and practical utilization in the application of engineering knowledge to medicine.

Chartered Engineers

THE granting of a Royal Charter to the Council of Engineering Institutions, formerly known as the Engineering Institutions Joint Council, has brought a step nearer the day when the titled "chartered engineer" (C.Eng.), without reference to a particular discipline, will be used by members of the 13 constituent institutions.* To this end it is proposed to introduce a common Part I examination which will benefit "cross-fertilization" between the different disciplines. It will not be easy to reconcile the varying requirements of the different institutions, each representing a specialized branch of science and technology.

In the Rules of the C.E.I. it is specified that there shall be "an examination in the principles of engineering which shall be set by the Council . . . and shall be of a standard at least equivalent to that of a degree in engineering currently awarded by a university. The Council will accept certain qualifications as exemption from this examination.

The Institution of Electronic & Radio Engineers has issued a policy statement regarding the proposed common examination. "It has been clear," it says, "from the outset that this will preclude the degree of specialization which characterizes engineering studies today, particularly in the universities, where departments, chairs, and new courses in electronics have slowly but steadily appeared since the war."

It is pointed out that through the proposed regulations governing the examination the C.E.I. "will exert a powerful influence on the structure and content of courses of study in colleges of technology and even the universities. Proposals which are in sharp contrast with accepted practice in engineering education deserve for that very reason, more thorough and prolonged discussion."

The I.E.R.E. warns against the possibility of the Council foundering "on the uncharted rocks of educational policy, many of which are not yet discernible," and adds "A liberal conception of the specialist requirements of the individual engineering professions is most necessary if we are to avoid the mistakes of the past in restricting development of new technologies."

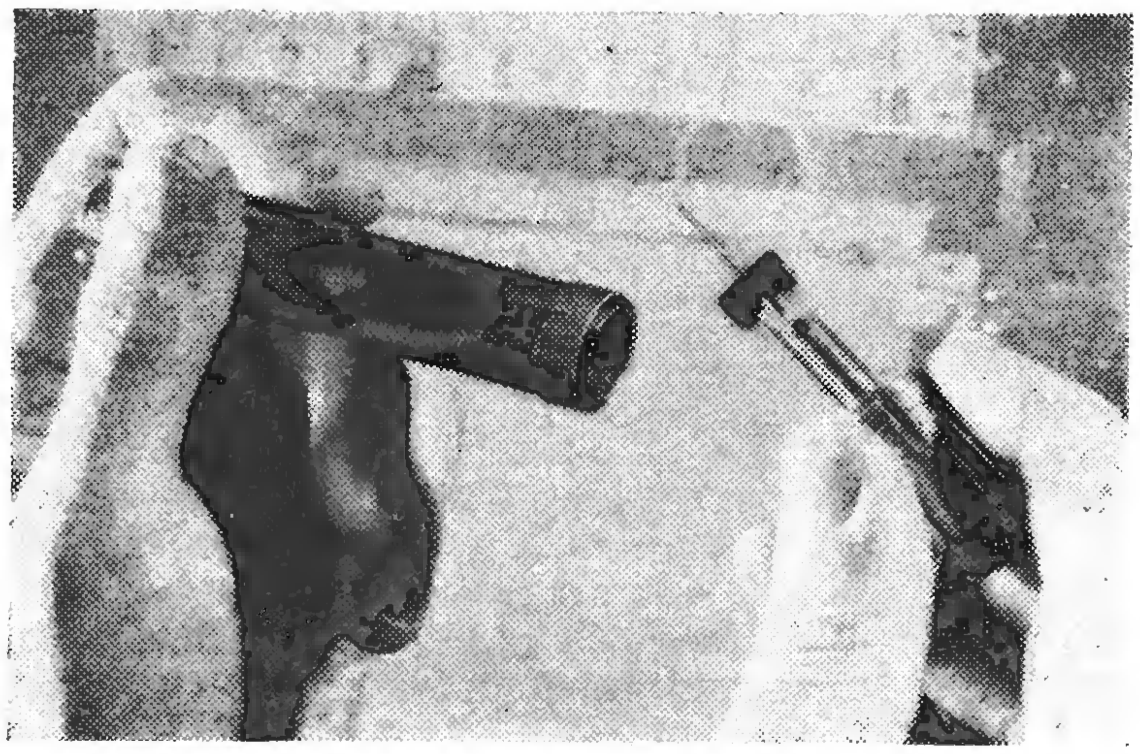
The proposed Pt. I syllabus comprises papers in the following subjects:—mathematics, properties of materials, principles of electrical engineering, applied mathematics, fluid mechanics and thermodynamics.

While giving support to the principle of a common examination the I.E.R.E. feels that it cannot agree that this demands a Part I exam with no optional papers. It therefore proposes an examination based on a core of four compulsory papers of a broader basic coverage (such as mathematics, engineering science, principles of both mechanical and electrical engineering) plus at least one optional paper to cater for the requirements of individual institutions.

*Royal Aeronautical Society; Institution of Chemical Engineers; Institution of Civil Engineers; Institution of Electrical Engineers; Institution of Electronic and Radio Engineers; Institution of Gas Engineers; Institute of Marine Engineers; Institution of Mechanical Engineers; Institution of Mining Engineers; Institution of Mining and Metallurgy; Institution of Municipal Engineers; Institution of Production Engineers; and Institution of Structural Engineers.

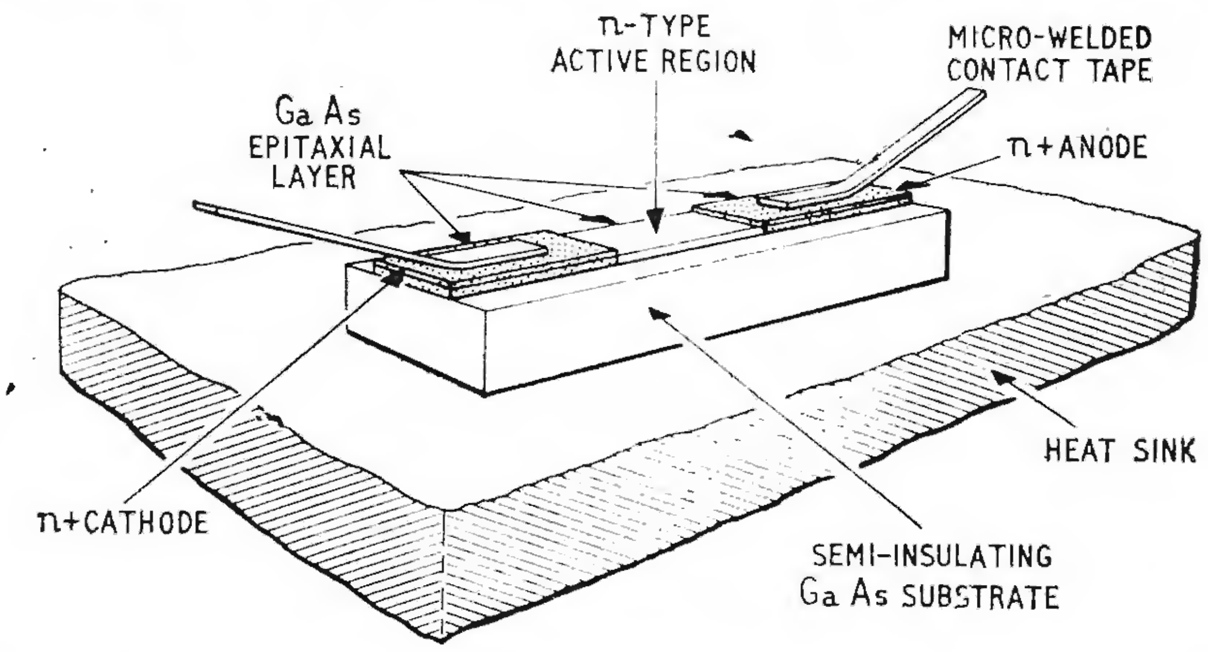
EPITAXIAL GUNN-EFFECT DEVICE

AN epitaxial version of the Gunn-effect device has been developed as an experimental microwave oscillator by Standard Telecommunication Laboratories (see "The Gunn-Effect," *Wireless World*, August 1965, p. 416). It has a volume of 0.1 in^3 and is said to produce several milliwatts of power at 1 Gc/s. S.T.L. explain that the epitaxial construction enables the frequency and the threshold power



of the device to be determined independently of the resistivity of the active region or the mechanical and thermal properties.

On a substrate of semi-insulating gallium arsenide about 100 μm thick is grown a 15 μm layer of gallium arsenide whose properties are optimum for the active region of the device. The effective cross-sectional area for the current path is detrmined by removing part of this layer to form a narrow track 100 μm wide. The anode and cathode are formed by converting two parts of the track to n+ regions,



leaving a gap of the original n-type material between them, the length of which determines the self-oscillating frequency. The semi-insulating substrate is bonded to a heat sink and electrical connections to the anode and cathode are made by micro-welding tapes to metal contacts on the top surface of the n+ regions.

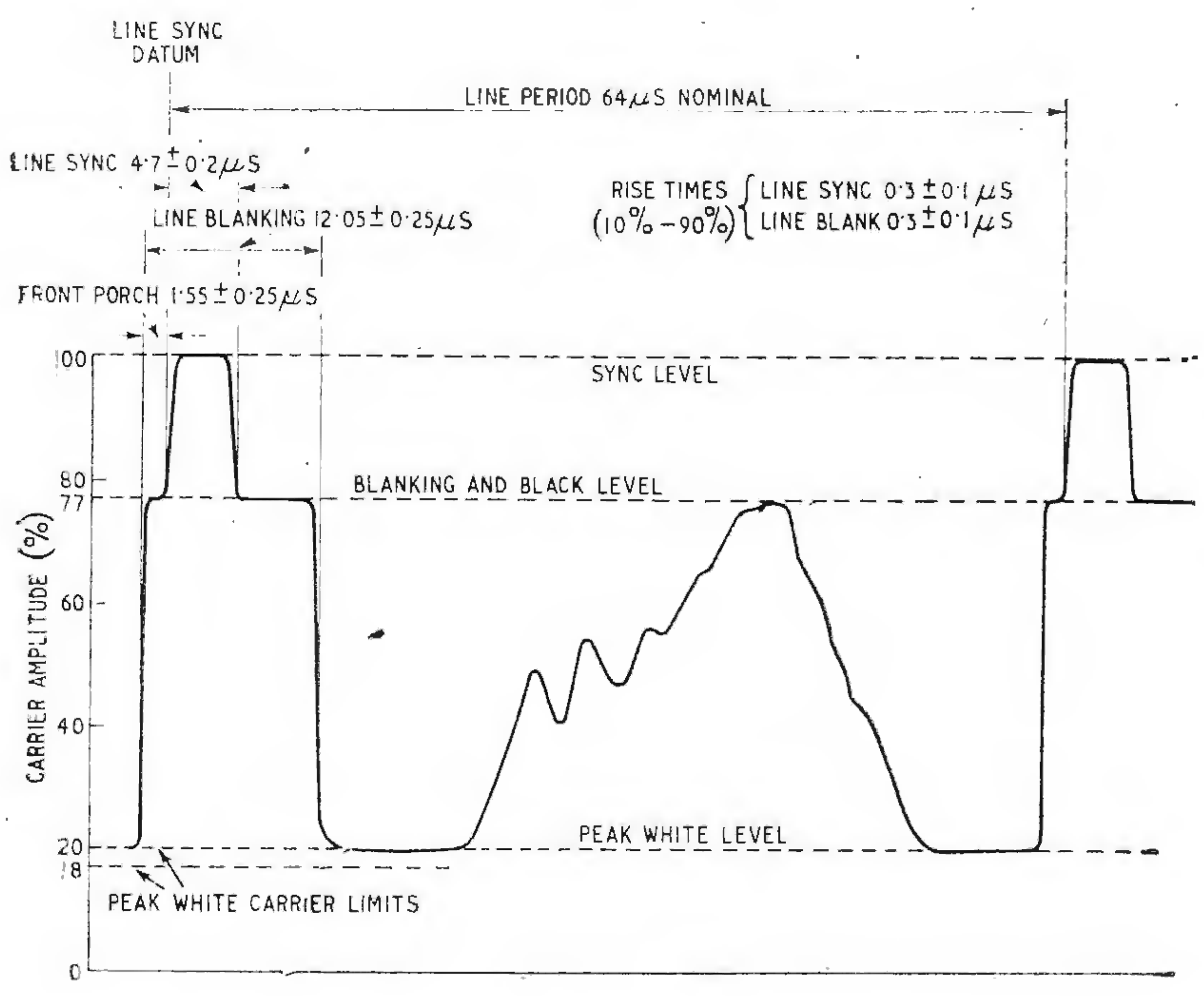
The shape of the substrate controls the mechanical and thermal properties of the device. The electrical properties, determined by the dimensions of the epitaxial n-type track, can be varied independently of the shape of the substrate. It is stated that the configuration is suitable for mass production, using precision masking techniques similar to those employed in the manufacture of semiconductor integrated circuits.

S.T.L. are also looking into the idea of three-terminal Gunn-effect devices in which domain formation can be influenced by the potential of an isolated gate electrode similar to that in a metal oxide semiconductor transistor—the cathode and anode being in the positions of the source and drain of the M.O.S.T. respectively.

625-LINE TELEVISION WAVEFORM

LATEST change to the B.B.C.'s 625-line vision signal waveform is the addition of a test signal for use in automatic test equipment at unattended transmitting stations. This signal is inserted on lines 17 and 330, and consists of a 12.5 μs bar, a sine-squared pulse (half-amplitude duration 0.2 μs) and a five-step staircase. The first four steps of the staircase have a duration of 5.3 μs and the final step a duration of approximately 4.0 μs, all steps being of equal height.

The B.B.C. has also published tolerances on the figures in the 625-line vision and sound signal specification, and for the benefit of readers who may not possess up-to-date information we give here the current specification together with the idealized carrier amplitude waveform.



Channel bandwidth	8 Mc/s
Spacing between unmodulated sound and vision carriers	6 Mc/s ± 1,000 c/s
Vision modulation	a.m. negative
Upper sideband	5.5 Mc/s
Lower sideband	1.25 Mc/s
Synchronizing level (as percentage of peak vision carrier)	100%
Blanking level (as percentage of peak vision carrier)	76% ± 1%
Difference between black level and blanking level (as percentage of peak vision carrier)	0%
Peak white level (as percentage of peak vision carrier)	19% ± 1%
Sound modulation	f.m.
Peak deviation	50 kc/s
Pre-emphasis	50µs
Ratio of peak vision carrier power to sound power	5 : 1
Lines per picture	625
Interlace	2 : 1
Field frequency	50 c/s
Line frequency	15,625 ± 0.15 c/s
Approximate gamma of picture signal	0.5
Nominal video bandwidth	5.5 Mc/s
Aspect ratio	4 : 3

Transmissions are normally asynchronous, i.e. the sync signals are derived from a stable oscillator and are not locked to the mains.

Electronics for "Mediator"

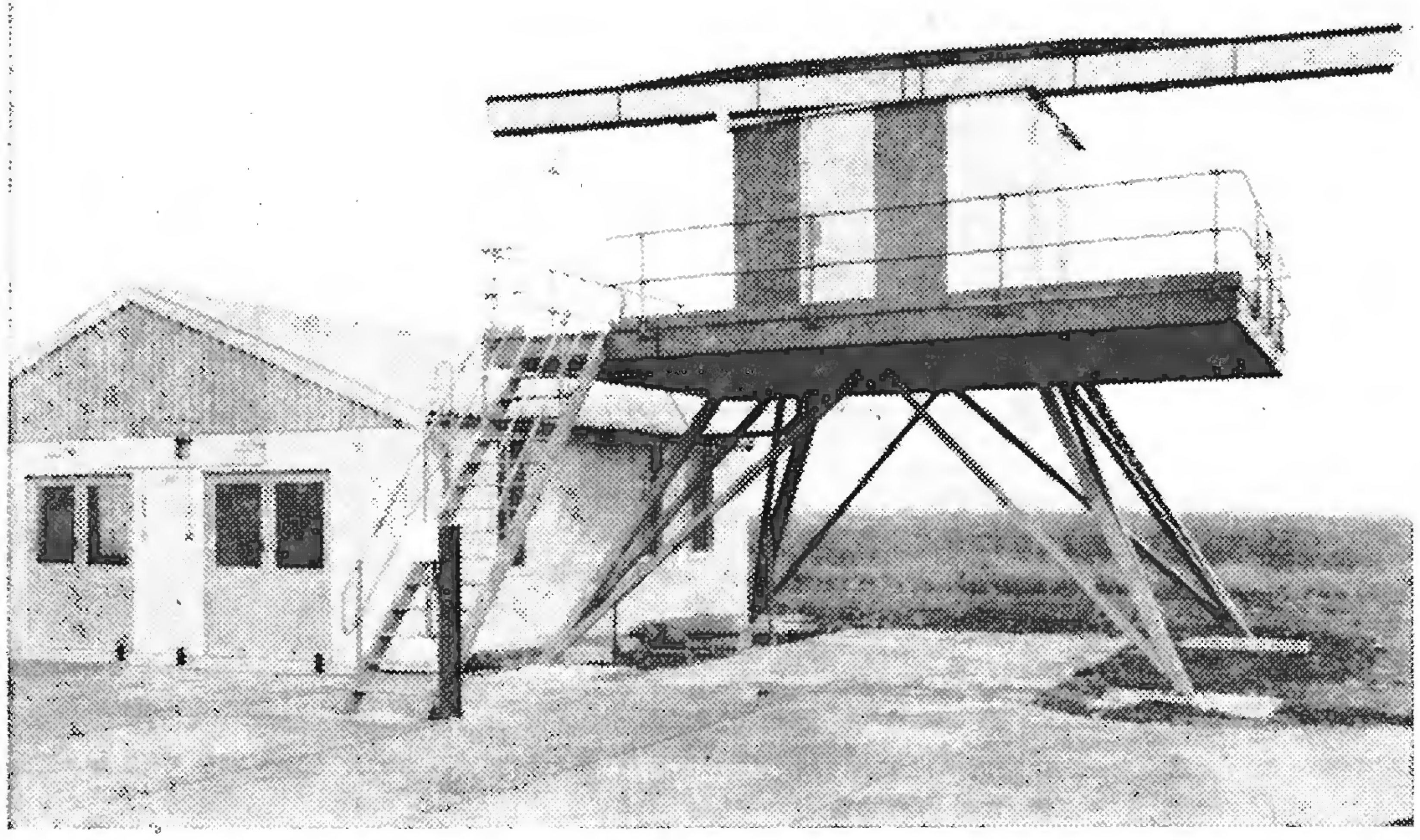
Comprehensive air traffic control scheme designed to cope with the rapidly increasing density and speed of air traffic over the United Kingdom

EXTENDED radar coverage and automatic data processing are the two electronic cornerstones of a comprehensive air traffic control scheme now gradually being introduced in the U.K. under the code name "Mediator". The radar surveillance will eventually cover the whole of the U.K. Flight Information Region below 57°N, from a height of 5,000 ft upwards. It is being provided initially by primary radar stations, but these will gradually be supplemented by co-located secondary radars which will assist in identifying aircraft and provide accurate information on their heights. The automatic data processing equipment, based on electronic digital computers, will not only reduce the controllers' normal work-load by maintaining an up-to-date store of information on the intention and progress of all aircraft, performing automatically all the necessary analysis and correlation of different information sources, but will also make possible the rapid prediction of conflicting flight paths.

Government N.A.T.C.S.

The new scheme is being put into operation by the National Air Traffic Control Services. This is a Government body which was formed in 1962 for the express purpose of setting up a comprehensive a.t.c. system and which is responsible to both the Ministry of Aviation (for civil aircraft control) and the Ministry of Defence (for military aircraft control). "Mediator" is comprehensive because it will serve all users of British airspace—airlines, charter companies, military aviation, research and development flying, private business users and so on, right down to gliding clubs. The impetus for the scheme has come from the rapidly increasing density and speed of air traffic. From 1957 to 1964, for example, civil air transport movements in the U.K. airspace increased by nearly 50%, while the top speed of civil aircraft rose during this period from about 300 knots to about 600 knots. This has demanded a corresponding increase in the information handling capacity of the air traffic control loop (information gathering—decision making—transmission of instructions), an increase which could not be provided by the existing facilities nor by a straightforward multiplication of the existing equipment and personnel.

Hitherto air traffic control has been based on the so-called "procedural" method (in which pilots report their positions to controllers by R/T), while radar has served mainly in a monitoring or backing-up role. With the increasing density and speed of air traffic, the information gathering part of procedural control is now beginning to show limitations (e.g., errors can occur in reading aircraft instruments and in air/ground voice communication). These limitations restrict the volume of air traffic that can be handled because the standards of separation between aircraft have to be sufficiently large to allow for the errors in time and space that can occur. This is a particularly serious problem in and around the London Terminal Area. Radar, however, which requires no co-operation from the pilot, is inherently faster and more accurate as a means of position finding, and is consequently beginning to assume a more important role in control operations—especially now that secondary radar is being adopted more widely. Be-



Cossor SSR.5G secondary surveillance radar installation at London Airport. Interrogator/responsers and servo equipment are housed in the building.

cause of this, aircraft separation standards for radar control are smaller than for procedural control. These, then, are the basic reasons why the existing a.t.c. radar coverage is being extended in the new scheme.

There are similar reasons for the introduction of automatic data processing in place of conventional a.t.c. methods of handling information. Here the main problem is to process the increasing volume of information at sufficiently high speed to allow effective control. Each controller can cope with only a limited number of air-

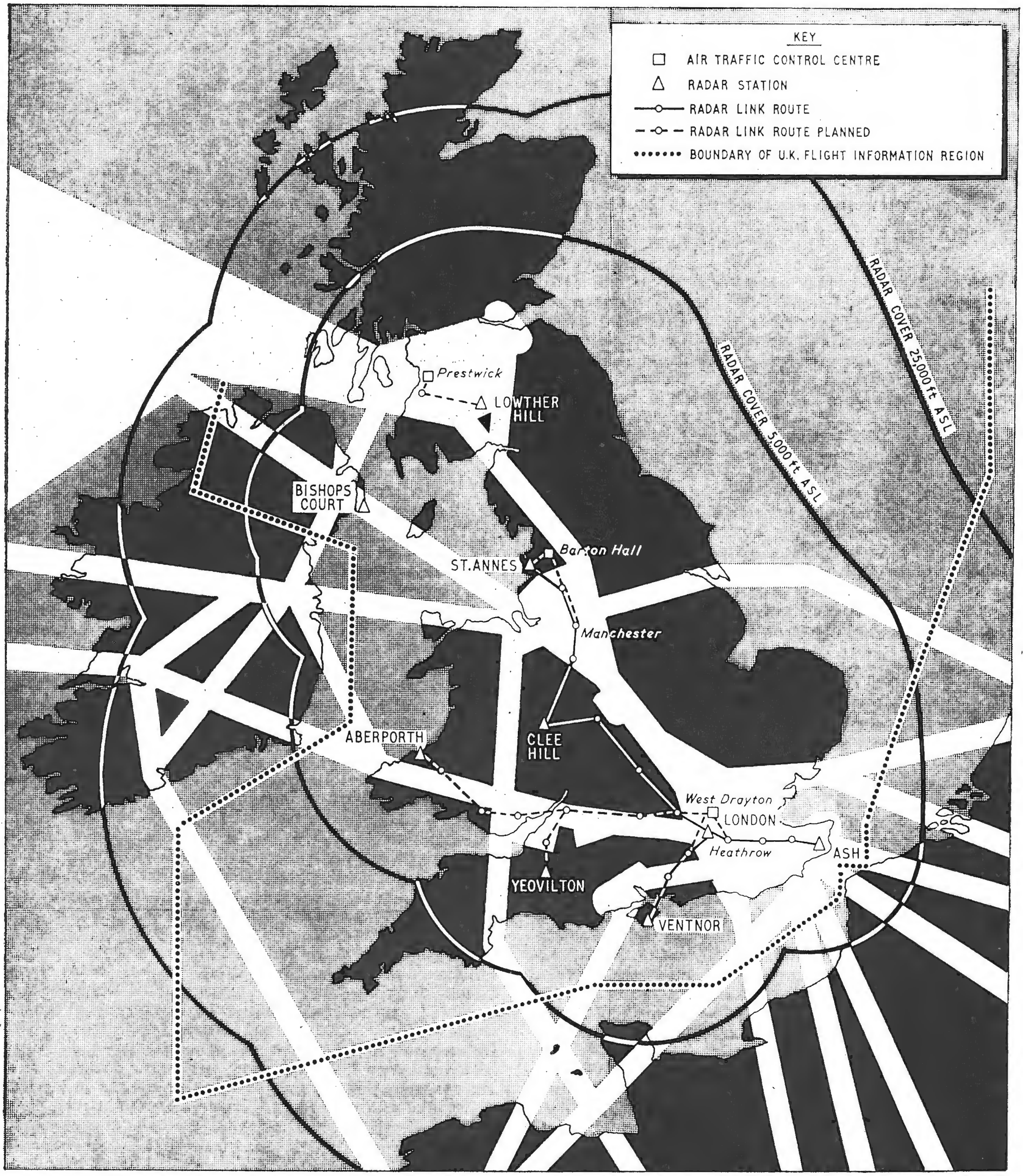


Fig. 1. Radar network to be completed by 1969, showing main airways and other controlled airspace, new air traffic control centres, and radar coverage at 5,000 ft and 25,000 ft. The boundary of the U.K. Flight Information Region is indicated.

craft. Under the present method of working an increase in air traffic calls for an increase in the number of controllers—but this means that more time must be spent in communicating between controllers. Furthermore, the increase in traffic density results in control problems of greater complexity, which take correspondingly longer to solve by human mental processes. The use of automatic data processing equipment will enable these delays to be reduced considerably, so that they no longer present a serious time lag in the control of high speed aircraft; it will also facilitate predictive operations such as calculating times of arrivals and possible conflicts between flight paths.

In the new scheme the airspace of the U.K. Flight Information Region, Fig. 1, will be divided up horizontally by the existing airways (which are defined by radio navigational aids and mainly used by airlines) and vertically into the following sections: upper airspace (above 25,000 ft), middle airspace (above 5,000 ft and below 25,000 ft), controlled airspace (the airways part of the middle airspace in which positive control is exercised) and lower airspace (below 5,000 ft). The degree of control exercised will vary throughout this total airspace in a complex pattern determined by the forecasted increase of aircraft movements in the horizontal and vertical divisions, and will range from a minimum of control in the upper airspace in the north of Scotland to maximum control in the controlled airspace above the London Flight Information Region. Two types of information will be required from all aircraft moving through this total airspace. The first is flight plan data —a statement of intention which must be filed by every aircraft entering the system and which is subsequently fed into the data processing equipment by keyboards. The second is flight progress data—mainly the output of the primary and secondary radars, giving aircraft identification, position and height—which is fed directly into the data processing system (in the later stages of the project without human intervention).

Progressive introduction of the scheme

How far has the new scheme progressed? The radar network is the most advanced part. New primary radars at London and Manchester serve the controlled airspace, and the cover they now provide will be greatly extended by the progressive introduction into service of new radars at Ash (Kent), St. Annes (Lancs), Clee Hill (Shropshire), Ventnor (I.o.W.) and Lowther Hill (Lanarks) and by the addition of existing radars at Yeovilton (Somerset) and Aberporth (Cardigan). Ash and St. Annes should be operational this September, Clee Hill and Ventnor before the end of this year and Lowther Hill in 1967, and Yeovilton and Aberporth will be added to the system in 1968. All radar stations have been, or are being, linked to the air traffic control centres they serve by wide-band microwave links. Secondary surveillance radar (s.s.r.) is being progressively added to all the radar stations—the installation at London is complete and others are in progress at Ash and Ventnor.

All primary radars mentioned are Marconi S264A equipments, with the exception of Aberporth (Marconi S300) and Clee Hill (Plessey DASR-1). London, Ash and Ventnor s.s.rs. are Cossor SSR5G equipments. Radio link equipment connecting St. Annes, Ash, Ventnor and Clee Hill to their air traffic control centres is of Marconi manufacture.

For the upper airspace, new equipment is being installed at joint civil/military a.t.c. radar units at Bishops Court (N. Ireland), Sopley (Hants), Boulmer (Northumberland) and Hack Green (Cheshire), while two new military radar units at Lindholme (Yorks) and Watton (Norfolk) will be fully operational by July 1966. The middle airspace will be served by the units at Lindholme and Watton, and also by a new unit at North Luffenham (Rutland), which will provide general radar surveillance in the Vale of York, East Anglia and the Midlands. Information from the London, Ash and Ventnor radars will also be used to give an improved radar control service to aircraft flying in the London Flight Information Region, crossing the airways and in the London Terminal Area.

Data processing and display

As for the information processing and display operations, these will be divided between three air traffic control centres: a Scottish centre at Prestwick airport, a Northern centre at Barton Hall (Preston) and a Southern centre at West Drayton, near London (Heathrow) Airport. The Scottish centre, controlling all airspace north of 57° N and the middle airspace north of the Clyde-Forth valley, will use raw radar information and no automatic data processing. The Northern joint centre, dealing with the middle and controlled airspace in the north-west area, will not have automatic data processing equipment installed but will be able to make use of information processed at West Drayton. The Southern centre, which will be responsible for all the rest of the controlled and middle airspace and for all the upper airspace south of 57° N, will be the largest of all three centres and will house the automatic data processing equipment for the whole scheme. The building at West Drayton has been completed, the procedural control element of the existing S.A.T.C.C. at Heathrow is being transferred into it and the first stage of electronic information handling is expected to be working in 1966.

Fig. 2 shows in broad outline the equipment to be installed at the West Drayton S.A.T.C.C. Positional information from remote primary and secondary radar stations is received via 7-Gc/s broad-band radio links and from the local radars at London (Heathrow) Airport via G.P.O. coaxial cables. Signals available at the radio link terminal are primary and secondary video, trigger pulses and aerial turning information. These signals are distributed to various destinations—to raw radar displays on controllers' consoles in the operations room, to extraction equipment and to secondary radar decoding equipment. In the extraction equipment the analogue positional information is converted into digital form, and is then fed into the radar data processing equipment where it is converted into Cartesian co-ordinates and stored.

The function of the radar data processing equipment is to maintain track records of all aircraft (these being continuously up-dated by fresh positional information), to detect possible track conflicts (by prediction of future radar responses) and to read out this track information for marking of raw radar and synthetic radar displays. The secondary radar decoding equipment provides aircraft identity and position information for the extraction equipment and also gives identity and height read-outs at controllers' consoles and s.s.r. marking of raw radar displays.

In procedural control the principal document for recording aircraft information—identification, destination, estimated time of arrival, etc.—is the flight progress strip. Information needed by controllers is taken

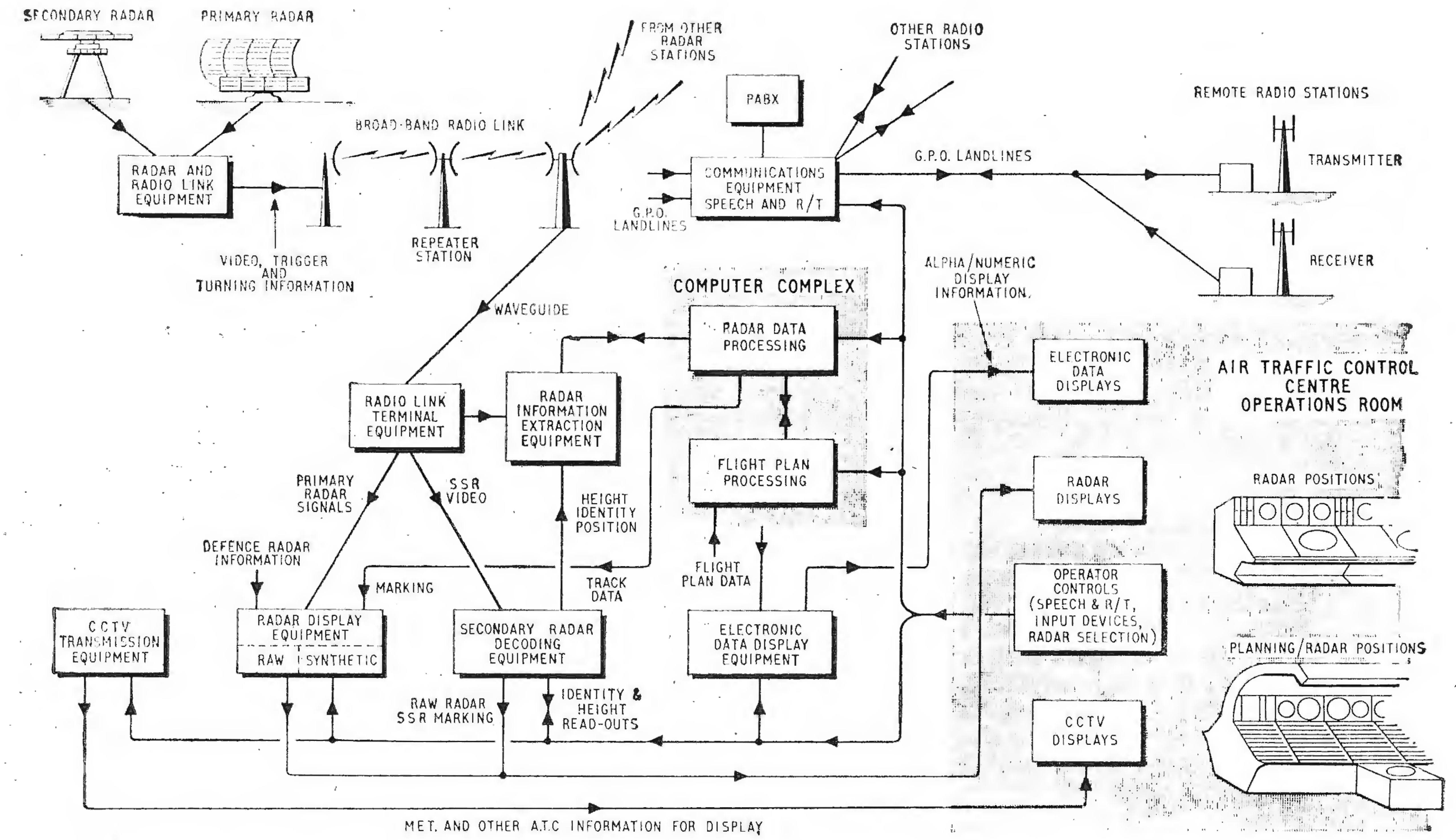


Fig. 2. Outline of information processing and display equipment at the new West Drayton air traffic control centre, showing remote radar and radio stations and the local operations room.

from the pilots' flight plans and is normally written by hand on these progress strips. As a first step in the evolutionary development of an automatized a.t.c. system, a Ferranti Hermes computer and associated peripheral equipment (not shown on Fig. 2) will be used to print the strips automatically. Flight plan data will be fed into the computer, and the flight progress strips printed, by IBM input/output writers. Two of the IBM printers will be at Heathrow, where the strips will be used in ground movement planning and at the "air control" positions.

Continuously up-dated information

The next stage will be the introduction of a flight plan processing system, and this is indicated in Fig. 2 by the second block of data processing equipment within the computer complex. This equipment receives manually inserted data on the planned movements of aircraft and, after checking them for acceptability, performs flight path calculations (using also the processed radar data) and finally provides output selections of the inserted and calculated data. These selections are made by the controllers in the operations room, by operating switches which send demands for the required information to the computer complex. Data called up in this way are displayed to the controllers in alpha-numeric tabular form on c.r.t. displays, the data format being determined by the computer system.

Communication with aircraft is effected in the normal way through the existing v.h.f. multi-carrier radio network, the speech signals between West Drayton and the remote transmitters and receivers being conveyed by G.P.O. landlines. At each remote radio station the transmitting and receiving installations are separated by a mile or more to avoid inter-action between signals on closely spaced frequencies and the consequent generation of spurious signals.

Two types of controller are catered for in the design of the operations room consoles—the procedural controller, who will act mainly in a planning capacity, and the radar controller, who will be more of an executive controller. One type of console will be purely for radar control functions in the middle air space, while the other will allow planning and radar control functions to be carried out together for the controlled airspace. The design of the consoles has not yet been fully settled but the radar (m.a.s.) console is a double unit, for an a.t.c. officer and an assistant, and incorporates either one or two radar viewing units, up to three alpha-numeric data displays, a closed circuit television display, controls for the flight plan data processing system and channel-selection units for the air/ground radio communications system.

Thus, in the operations room the air traffic controllers will have presented to them, on a variety of displays, continuously up-dated information on aircraft identification, intention, actual and predicted position and height, flight path conflicts and flight plan deviations. The computer complex will be able to allocate tasks to controllers on a sector or workload basis, indicate the priorities of these tasks, detect and give warning of actual and planning flight path conflicts, provide rapid automatic routing of communications between controllers, and transfer control as necessary. As a result the controllers will be able to make decisions on the basis of a common fund of information which will be as complete and up-to-date as is possible to achieve with electronic engineering techniques and equipment which are both modern and reliable.

SWITCHED THYRISTOR VOLTAGE REGULATOR

By F. BUTLER, O.B.E., B.Sc., M.I.E.E., M.I.E.R.E.

THE most efficient way of producing a constant load-voltage from an unregulated d.c. source is to use a switched thyristor as a control element between source and load. When it is conducting, the voltage drop across it is between 1 and 1·5 V, and with a load current up to 10 A the loss will not exceed 15 W. When blocked (non-conducting), the energy loss in the thyristor is zero.

Two switching modes are possible. In one, the average switching rate is held constant but the proportion of the total time during which the switch remains closed is variable. The method is commonly described as time-ratio control and it may be exercised manually or automatically. A second method of control is to switch on the thyristor and then turn it off after a fixed period of time. In this case regulation is effected by varying the repetition frequency of the fixed-duration pulses. The second method is rather simpler to engineer and its only disadvantage is that on light load the pulse recurrence frequency may fall so low that filtering becomes difficult. In practice this effect is only troublesome in variable-voltage supplies which are required to operate at maximum load current with a very low output voltage setting.

Thyristor turn-off methods

A controlled rectifier can be turned on by a low-level short-duration positive pulse into the gate electrode. The problem is to turn it off. Six or seven methods of doing this have been proposed, most of them having some objectionable features, notably cost or complexity. All involve the same basis principle, which is to charge up a capacitor to a high voltage and then to discharge it through the thyristor in a direction opposite to that of the normal load current. The controlled rectifier will block if the load current is reduced to zero for about 60 microseconds or if a reverse voltage can be maintained across it for at least 20 microseconds.

One of the simplest and most reliable turn-off circuits was suggested by R. E. Morgan of the (American) G.E. Company. It is shown in Fig. 1. In the steady state,

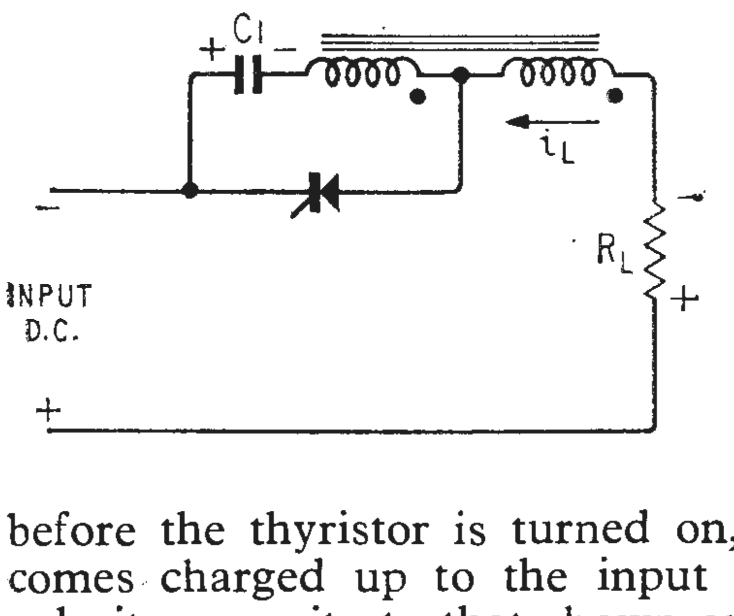
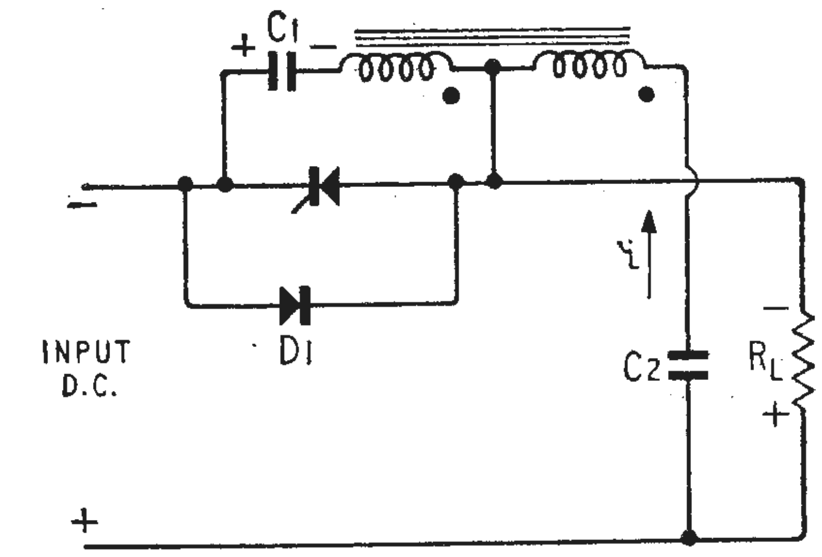


Fig. 1. Thyristor turn-off circuit due to R. E. Morgan.

before the thyristor is turned on, the capacitor C_1 becomes charged up to the input direct voltage, with a polarity opposite to that shown on the diagram. There is no flux in the auto-transformer core, no voltage across either of its windings and the load voltage is zero. On firing the controlled rectifier, a current shown as i_L, passes through one winding of the transformer and through the load. The induced voltage in the other winding charges up the capacitor with the polarity shown, which is opposite in sense to the initial charge. At first the charging current into the capacitor is such as to produce an ampere—turn balance with the current in the primary or load section of the winding. The core remains unsaturated. When the capacitor becomes fully charged the current into it sinks to zero but load current continues to flow in the primary winding. In consequence the core material (nickel-iron or permalloy), becomes saturated and both winding impedances become very small. In effect the capacitor is then connected directly across the thyristor but with a polarity in the correct sense to turn it off.

The circuit has some good features. For example, an increase of load current will cause more complete magnetic saturation of the core of the transformer and also the capacitor becomes charged to a higher peak voltage.

Fig. 2. Modified version of the Morgan circuit.



Both effects co-operate to give a more positive and abrupt turn-off of the thyristor. The turn-off mechanism is inoperative on no load and a dummy load must be used to cope with this condition. A second, more minor disadvantage is that the turn-off pulse characteristics tend to vary with the load current.

The writer has found that a modified version of Morgan's circuit can be made to give reliable turn-off under a wide range of load conditions, provided only that, as is also necessary with Fig. 1, the input voltage is considerably higher than the required maximum load voltage. It need hardly be remarked that this does not imply a reduced conversion efficiency in either circuit. The new arrangement is shown in Fig. 2. One feature is that the auto-transformer has been taken out of the main load circuit. When the thyristor is turned on by means of a positive gate pulse the forward voltage drop across it sinks to about 1 V and load current flows in R_L. At the same time a current pulse is passed by C_2, which is initially uncharged. This current pulse in the primary winding of the transformer induces a high voltage in the other winding, charging up C_1 with the polarity shown. This is in the correct sense to turn off the thyristor as in the Morgan circuit. The diode D_1 is not strictly necessary but it serves two useful purposes. Provided that it is of the fast recovery type (low hole-storage time), it protects the thyristor from exposure to high peak inverse voltages. It also serves to discharge C_1 in the shortest possible time. Clearly the action of this turn-off circuit is independent of the magnitude of the load current. However, there is a point which must not be overlooked; C_1 must become completely discharged between consecutive firing pulses. It does so by supplying current to the load. On open circuit it would never discharge and no subsequent turn-off pulse could be developed. A relatively small permanent load will draw sufficient current to discharge C_2 in a fraction of one millisecond.

As before, the auto-transformer core should be of magnetically soft material such as permalloy, mumetal, H.C.R. alloy or some similar grade. Details of the core and windings are given later.

It remains now to provide a suitable pulse generator of variable recurrence frequency to fire the thyristor. A control circuit must also be devised to regulate the output voltage developed across the load and to set it at the desired level. Suitable filter circuits are required and the related question of response time of the regulator must be considered. All these points are best brought out by reference to an actual design example.

Practical voltage-regulated power supply

Fig. 3 gives the complete circuit diagram of a stabilized power supply with suggested component values. It accepts an unregulated and roughly filtered d.c. input at about 40 V and delivers a regulated output between 10 and 24 V at a maximum load current dictated by the thyristor rating. Thyristors are available from Westinghouse, A.E.I., Mullard and Texas Instruments. A suitable rating is 400 V, 4.7 A. Though prices are steadily falling, thyristors with a high voltage-rating are still expensive. It is thus worth noting that from time to time, supplies become available cheaply on the surplus market. At the time of writing, G. W. Smith (Radio) of 3-34 Lisle Street, London, W.C.2, have a few in stock and further deliveries are expected. At a conservative rating they may be used singly to give a 2 A d.c. output or they may be paralleled to give any desired output provided that suitable arrangements are made for simultaneous firing. Minor component changes in Fig. 3 will allow for inputs up to at least 200 V and regulated outputs up to 100 V, figures well beyond the economic range of transistor regulators.

The auto-transformer T makes use of an H.C.R. toroidal core, outside diameter $2\frac{3}{8}$ in, inside diameter $1\frac{3}{8}$ in, depth $\frac{5}{8}$ in. The winding W_2 is a single layer of 20 or 21 s.w.g. enamelled wire, 75 turns in all. Wound over this and insulated from it is W_1, with 25 turns of 18 or 19 s.w.g., spaced evenly round the core. It may be found easier to use twin strands of 20 s.w.g. for W_1 in order to avoid the risk of damage to the core bobbin or to W_2. The two windings are connected series-aiding. The inductance of the smaller winding, measured on a 1000 c/s impedance bridge, is 160 μH. That of the other is 2.5 mH and of the pair in series 3.4 mH total. The number of turns on each coil, the turns ratio and the inductances are in no sense critical and it is quite possible that a smaller and cheaper core could be used, certainly at the lower power levels.

The 2 μF and 4 μF capacitors associated with the auto transformer must be high grade components, rated at 1000 V working to give a good margin of safety since it is disastrous if they fail. They should be of the extended-foil, low-inductance construction, rated to carry large pulse currents. Their actual capacitance values do not matter very much. A choke-input filter is used consisting of the inductance L (0.5 ohm, 100-250 mH at full rated current), followed by the large capacitor C_3.

The function of the diode D_1 has already been mentioned. It is rated at 6 A d.c. with a peak inverse voltage rating of 200 V. The free-wheel diode D_2, with a similar rating, maintains load current while the thyristor is blocked. Without this the energy $\frac{1}{2}Li^2$ in the choke would cause back e.m.f.s which would interfere with commutation of the thyristor. The 5-ohm 20 W resistor in series with D_1 dissipates the excess commutation power and damps out possible oscillations which might make it difficult to turn off the thyristor.

Diodes D_1, D_2 and the thyristor can all share the same heat sink if one diode has stud-to-cathode and one stud-to-anode. Such different types need to be specially ordered but at least D_1 and the thyristor can use the same heat sink if the 5-ohm resistor is moved to the other side of the diode.

The firing pulse generator makes use of a unijunction transistor (American General Electric Type 2N1671A). A similar device is also available from Texas Instru-

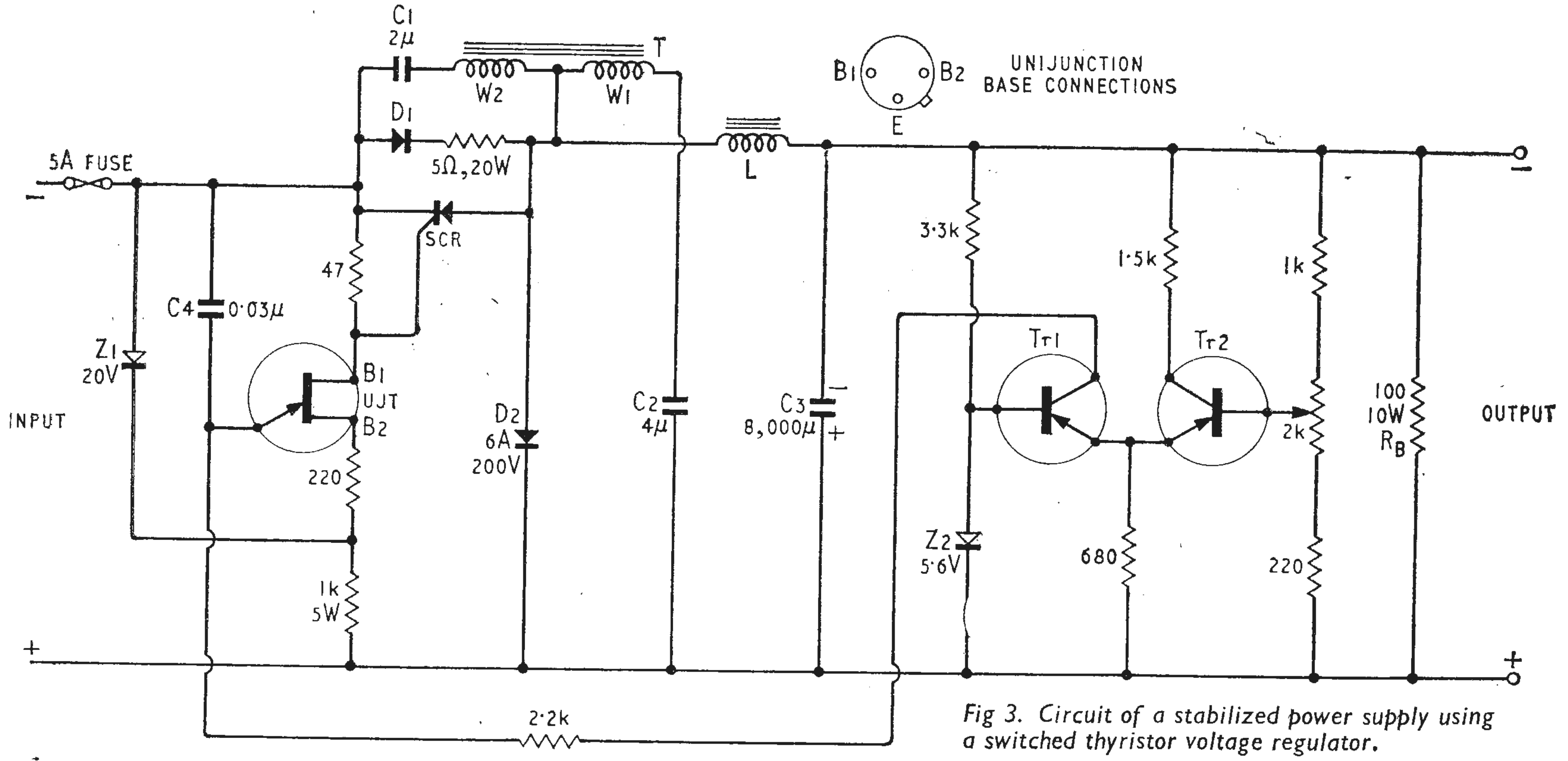


Fig 3. Circuit of a stabilized power supply using a switched thyristor voltage regulator.

ments. The construction and mode of operation of the unijunction device have been described by the writer in an earlier paper.* Briefly, it forms a relaxation oscillator which produces a saw-tooth waveform across a capacitor which is periodically discharged to produce a short duration pulse for firing the thyristor. The repetition rate can be varied by changing the capacitor size or by varying the charging current.

In Fig. 3, the charging current is determined by an output voltage sensing arrangement of two transistors Tr1 and Tr2; the transistors (high gain low power p-n-p types) form a differential amplifier. The base of one of them is supplied with a constant reference voltage from a 5.6 V Zener diode. The base of the other is taken to the slider of a potentiometer connected across the output terminals of the power supply. A rise of output voltage increases the base current of Tr2 and causes a greater voltage drop across the common emitter resistance. This in turn reduces the collector current of Tr1 which constitutes the capacitor charging current. The reduced charging current lowers the recurrence frequency of the firing pulse train and restores the output to its original voltage.

At full load the p.r.f. is about 3 kc/s. Load current pulses of this frequency are easily filtered with moderate values of inductance and shunt capacitance. The remaining component, not so far discussed, is a 100-ohm 10 W resistor, permanently connected across the output terminals. It ensures positive turn-off of the thyristor under external no-load conditions.

Performance

The percentage voltage regulation depends mainly on the gain of the error-signal amplifier. With high gain transistors Tr1, Tr2 the regulation against load current changes is within 1 or 2 per cent from zero to full load.

* "Controlled Rectifiers in Stabilized Power Supplies," by F. Butler, *Wireless World,* October 1963, p. 480.

The precise figure depends on the output voltage setting. Against supply voltage changes the performance is even better. An input voltage change of 100 per cent has an almost imperceptible effect on the output voltage. The 20 V Zener diode which regulates the working voltage of the unijunction transistor contributes to this result.

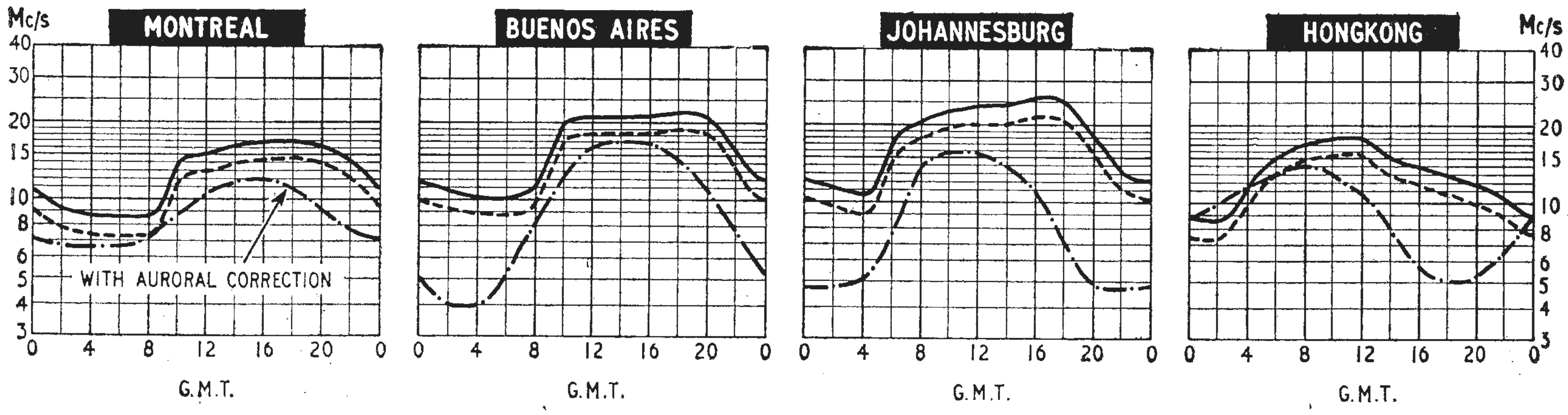
The response time to step changes of load current is set mainly by the time constant of the main filter circuit. It cannot be less than the reciprocal of the low-pass cut-off frequency. In other words, the better the filtering the longer is the response time. Preferably, all the smoothing should be accomplished in a single stage and by using a high firing-pulse frequency this amount of filtering will be found satisfactory and the transient response is good enough for most applications.

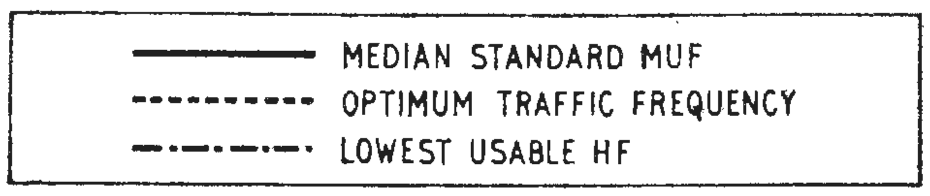
Circuit losses are quite small. If p.n.p. silicon transistors are used for Tr1 and Tr2 the equipment will work well over the temperature range −20 to at least 80°C.

A fast-acting fuse in the input circuit will give acceptable protection against overloads though it would fail to safeguard a transistor regulator. Still better protection, almost instantaneous in action, can be given by shunting a transistor or silicon controlled switch across the charging capacitor of the unijunction oscillator and arranging for the voltage drop across a sensing resistor, under overload conditions, to bias the shunt element into conduction, thus inhibiting firing pulses.

The only real disadvantage of power supplies of this type springs from the very perfection of the thyristor as an electronic switch. It can be turned on and off in a matter of microseconds and these switching transients are quite difficult to suppress, reminding one of the difficulties at one time experienced with vibrator power supplies. The effect is most troublesome if the regulator is used to supply radio receivers, low-level digital circuits or high-gain broad band amplifiers. However the most useful applications of thyristor stabilized supplies are in the high voltage, high power field where efficiency and reliability are of much greater consequence than a noise-free output.

H. F. PREDICTIONS—SEPTEMBER





The MUFs are beginning to show the effect of the slowly rising Ionospheric Index. The predicted Index has risen from 12 in June to 22 for this month. Comparisons with the predictions for previous years show that the MUFs are about 1 Mc/s higher than in 1964 or 1963, and comparable with those of 1962.

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

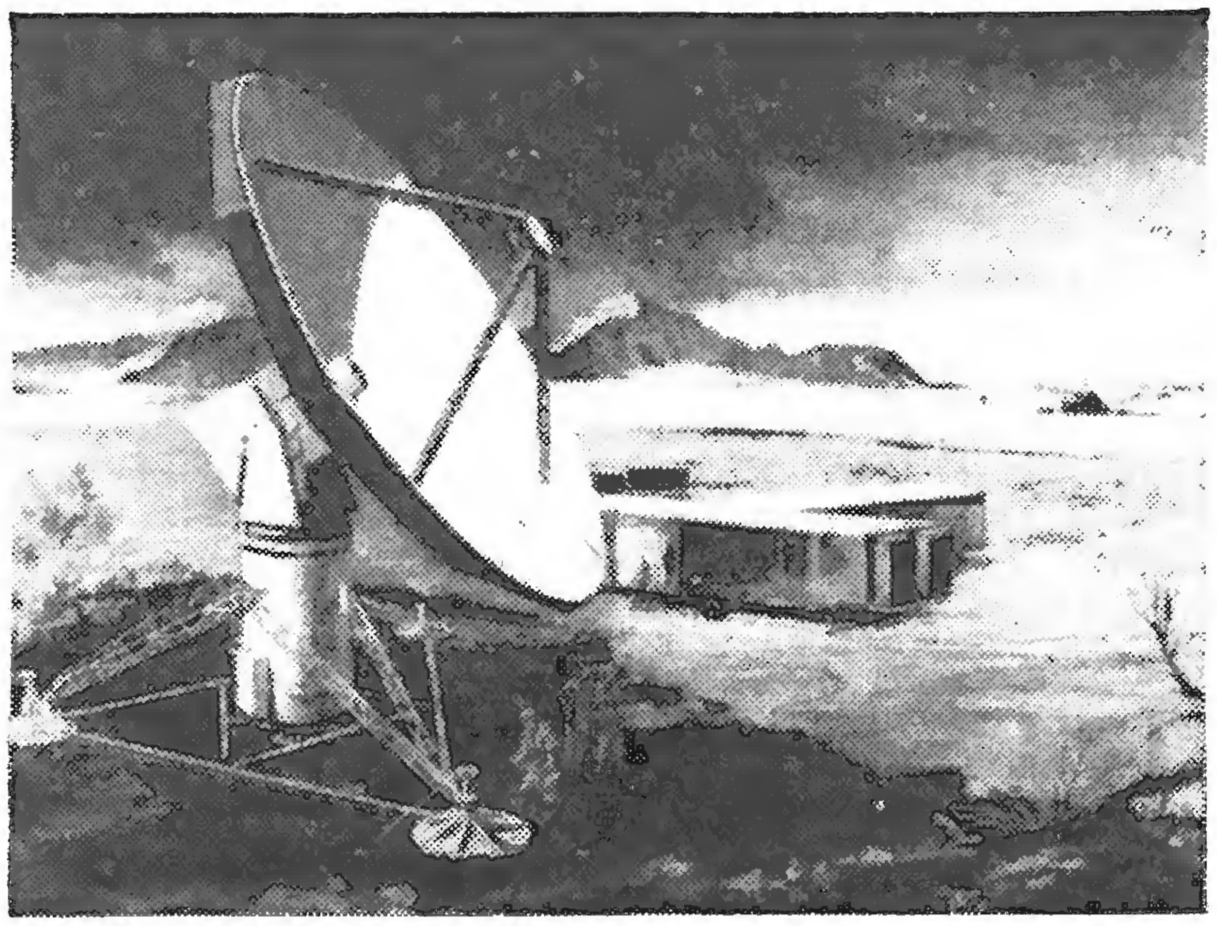
WORLD OF WIRELESS

Subscription Television

THE Postmaster General, the Rt. Hon. Anthony Wedgwood Benn, has announced that the Government intends to continue with the subscription television experiment despite the withdrawal of all but one company from the pilot scheme.

Last year the P.M.G. announced the names of five organizations which were offered licences to enable them to participate in the experiment—the licence to be valid for three years from the date of commencement of service. Subsequently, licences were issued to three, Pay-TV Ltd., Choiceview Ltd. and Telemeter Programmes Ltd. Of these three only Pay-TV intends to continue and the areas in which it is licensed to operate are Sheffield and London (initially the Boroughs of Westminster and Southwark). Programmes are to be the responsibility of the operator and will be fed via relay networks to subscribers who will pay for viewing time by means of coin boxes fitted to their receivers.

The decision regarding the introduction of a permanent service will depend upon the analysis of results based upon economic and social factors involved. For example, one of the many factors to be considered is that of the effect on cinema attendances, and the Board of Trade is being consulted to arrange for protection of the legitimate interests of cinema exhibitors in the areas in which the pilot scheme will operate.



***Mobile ground station links** for satellite communications are being designed and built by the communications division of Hughes Aircraft Company to enable existing and future satellites to be linked in a worldwide communications network. Each mobile station consists of three power units, three equipment vans and a 40ft diameter paraboloid as shown in the illustration. Four voice and five teleprinter messages can be received, amplified and transmitted simultaneously via synchronous or medium altitude active satellites.*

I.T.U. Plenipotentiary Conference

MORE than 500 delegates from most of the 127 member countries will be participating in the Plenipotentiary Conference of the International Telecommunication Union (I.T.U.) which opens in Montreux, Switzerland, on September 14th.

The Plenipotentiary Conference is the I.T.U.'s supreme authority although this year's conference, which takes place in the Union's centenary year, is only the ninth to be held. The founding conference met in Paris in May 1865 and succeeding conferences took place in Vienna in 1868, Rome 1871, St. Petersburg 1875, Madrid 1932, Atlantic City 1947, Buenos Aires 1952 and Geneva 1959.

The main purpose of the Plenipotentiary Conference is to revise the I.T.U. Convention—the Union's basic charter.

The U.K. delegation will be led by W. A. Wolverson, C.B., deputy director of the G.P.O.

Broadcast Receiving Licences.—During the first six months of this year the number of combined television and sound receiving licences in the U.K. increased by 203,321 bringing the total to 13,358,003. Sound-only licences fell by 92,959 to 2,766,874; this figure includes 638,642 for sets in cars representing an increase of 22,342. On August 1st, the combined television and sound licence fee was increased from £4 to £5 and the sound-only licence from £1 to £1 5s.

Confederation of British Industry.—The Federation of British Industries (F.B.I.), the National Association of British Manufacturers (N.A.B.M.) and the British Employers' Confederation (B.E.C.) have amalgamated to form the C.B.I. which was established by a supplementary Royal Charter effective on July 30th. The charter supersedes the original charter granted to the F.B.I. All communications should now be addressed to the Confederation of British Industry, 21 Tothill Street, London, S.W.1 (Tel.: WHItehall 6711).

The first **I.E.E./I.E.R.E. joint meetings** of the 1965/6 session will be held on September 29th. The Institutions' Computer Groups are holding a one-day conference on airborne computers at the School of Hygiene & Tropical Medicine, Keppel St., London, W.C.1, from 10.30 a.m. In the evening at 6.0 at the I.E.R.E., 9, Bedford Square, W.C.1, the Medical Electronics Group have arranged a meeting at which Dr. P. E. McGuff will present a paper on "Treatment of Experimental Animal and Human Malignant Tumours by Laser Radiation." Tickets obtainable from the I.E.R.E., are required for both meetings.

European A.T.C.—A computer-controlled system for the identification and tracking of civil aircraft is to be installed at the Eurocontrol Experimental Centre at Bretigny, France. The prime contractor is Elliott-Automation and the work will be carried out in conjunction with Standard Elektrik Lorenz (W. Germany), Ateliers de Construction Electronique de Charleroi (Belgium) and Cossor Electronics. The new A.T.C. scheme for the U.K. described elsewhere in this issue may well form part of the overall Eurocontrol in the not-too-distant future. By July 1st next year it will be compulsory for aircraft to carry transponders for use with the secondary radar system.

Radio Interference in America.—Authority to prohibit the production of electronic or electrical devices which might cause radio interference has been requested by the Federal Communications Commission, but the Electronic Industries Association has asked the Senate Communications Subcommittee to delay legislation until the F.C.C. and representatives from industry can discuss alternative methods of solving radiation-interference problems.

Frequency Tolerance of Aircraft Transmitters.—The I.T.U. Radio Regulations (Geneva) 1959 require that, as from January 1st, 1966, the carrier frequencies of all aircraft transmitters operating in the band 118 to 136 Mc/s be maintained to within 50 parts in a million of the selected channel. However, an analysis made by the Ministry of Aviation reveals that the number of transmitters operating outside the stipulated tolerance is insignificant and equipment with a frequency tolerance of 100 parts in a million may remain in use until further notice. Should a particular type or types of equipment consistently fail to meet the I.T.U. requirements, remedial action will be called for.

Guide to Electronic Equipment.—The Industrial Control and Electronics Division of B.E.A.M.A. has issued the first edition of a "Guide to the Specification and Purchase of Electronic Equipment for Industrial Systems." In the past, lack of general specifications for industrial electronics equipment has sometimes resulted in the use of specifications which may be inappropriate or unnecessarily costly. The guide will assist both customers and manufacturers by specifying standard types of equipment to meet the requirements for various applications and discusses other factors which need to be considered by both contracting parties. Priced at one guinea, the guide is available from the British Electrical & Allied Manufacturers' Association, 8 Leicester Street, Leicester Square, London, W.C.2.

Requirements for R.F. Connectors.—Part 1 of the International Electrotechnical Commission Publication 169, "Radio-frequency connectors," has recently been issued. Relating to connectors for r.f. transmission lines for use with electronic equipment, the publication establishes uniform requirements for electrical, climatic and mechanical properties, test methods, interchangeability and compatibility of connectors and connectors with cables. Price £3 from British Standards Institution, Sales Branch, 2 Park Street, London, W.1.

U.K. Kompass, a detailed register of British industry, is available in three volumes (£15 15s the set) from Kompass Register Ltd., R.A.C. House, Lansdowne Road, Croydon, Surrey. Two volumes list suppliers of more than 33,000 products manufactured in the U.K. The third volume details the location, products, share capital, directors, number of employees and other information of over 24,000 manufacturing companies.

Sound and Vibration Research.—The Science Research Council has made a grant of £228,200 to the University of Southampton towards the cost of research in sound and vibration under the direction of Professor E. J. Richards, director of the Institute of Sound and Vibration Research. Part of the grant relates to the provision of acoustic chambers and an audiology laboratory.

The Hungarian Society for Optics, Acoustics and Film-techniques is organizing a second conference on **Magnetic Recording** to be held in Budapest between October 11th and 15th, 1966. Papers on the subjects of static magnetic memories and recording on moving magnetic media are invited for inclusion in the conference programme. Further details can be obtained from the society—Optikai, Akusztikai és Filmtechnikai Egyesület, V, Szabadság tér 17, Budapest.

R.T.E.B.—The Radio Trades Examination Board this year celebrates its 21st anniversary. During the 21 years it has examined over 22,000 candidates for its certificates in radio and television servicing.

The series of articles, **Elements of Transistor Pulse Circuits,** by T. D. Towers, which appeared in *Wireless World* during 1964, has been used as a basis for a book of the same title published by Iliffe Books Ltd., price 35s.

Two Years in Space.—July 26th marked the second year in space of Syncom II, the world's first synchronous communications satellite. Hughes Aircraft Company who designed and built the satellite report that Syncom II stationed above the Indian Ocean has received and transmitted voice and teleprinter messages for an average of 13 hours a day. It has been in use for a total of 9,508 hours and has travelled more than 119 million miles in orbit.

Ghana's television service, comprising three transmitting stations at Accra, Kumasi and Sekondi-Takoradi, was officially opened by President Nkrumah on July 31st. The three stations, which serve approximately one quarter of the country, have central studios in the capital. The service, which operates in Band I on 625 lines (7 Mc/s channels) with f.m. sound, was a "turnkey" project of the Marconi Company. Ghana's external sound services have been extended by the installation of two Marconi 250-kW h.f. transmitters at Ejura where there are also six 10-kW h.f. transmitters for internal sound broadcasting.

American production of **colour TV receivers** in April this year was nearly double that of April 1964. The figures are 179,321 compared to 92,318, an increase of 94%. Although April output was down on the March figure of 205,577 the total production for the first four months of this year was 682,178 compared to 378,545 for the same period last year, an increase of 78%.

Air Defence for Three NATO Countries.—To control the air defences of Belgium, the Netherlands and West Germany the individual governments have selected the Tactical Air Weapons Control System (T.A.W.C.S.) designed by the Hughes Aircraft Company of Fullerton, California. In order to obtain NATO council approval for modernization of their air defence control system, the three countries formed an international planning group. The system provides the countries with not only collective air defence but also individual facilities for the rapid detection, identification and tracking of potential enemy air threats. Ground installation equipment supplied with the system includes communications, electronic displays, computers and data processing units.

New Colour Film from C.O.I.—Aspects of the technology of microelectronics are dealt with in the film "Thin-film Microcircuits" released by the Central Office of Information. The progress of a circuit is followed in this Mullard film from the design stage to the finished product, together with a description of evaluation and final testing. Running time 15 minutes; available on free loan from Central Film Library, Government Building, Bromyard Avenue, Acton, London, W.3.

1966 I.E.A. Exhibition.—The next International Instruments, Electronics and Automation Exhibition will be held at Olympia from May 23rd to 28th, 1966. Bookings are 15 per cent up on the 1964 exhibition in which 148 exhibitors out of 729 came from overseas.

German Radio Show Stamp.—30 million copies of a special stamp are to be printed featuring the German Radio Show which will be held in Stuttgart from August 27th to September 5th. The design depicts the Stuttgart TV tower surrounded by symbolic radiations.

The ninth B.R.E.M.A. exhibition of **cabinet styling accessories** will be held at the Hotel Russell, London, W.C.1, from September 28th-30th. It will be open each day from 2 to 6 p.m. and admittance is by invitation or business card. There will be 48 exhibitors.

The **Council of Engineering Institutions,** formerly the Engineering Institutions Joint Council, has moved to 2 Little Smith Street, Westminster, London, S.W.1. (Tel. SULlivan 3912-4.)

PERSONALITIES

G. D. Speake, M.A. (Cantab), A.M.I.E.E., appointed Director of Research for the Marconi Company, has since 1962 been chief of research at the Great Baddow Research Laboratories

G. D. Speake

and Development manager for the Radar Division. Mr. Speake, who is 45, took his degree in physics at St. Catharine's College, Cambridge. He joined the Marconi Company in 1950 and was engaged in radar systems research until 1954 when he was appointed chief of the vacuum physics section of the Research Division. Two years later he became chief of the microwave physics section. Before joining Marconi, Mr. Speake was a Flight Lieutenant in the Technical Branch of the R.A.F. and later, instrument manager at the Plastics Division of I.C.I.

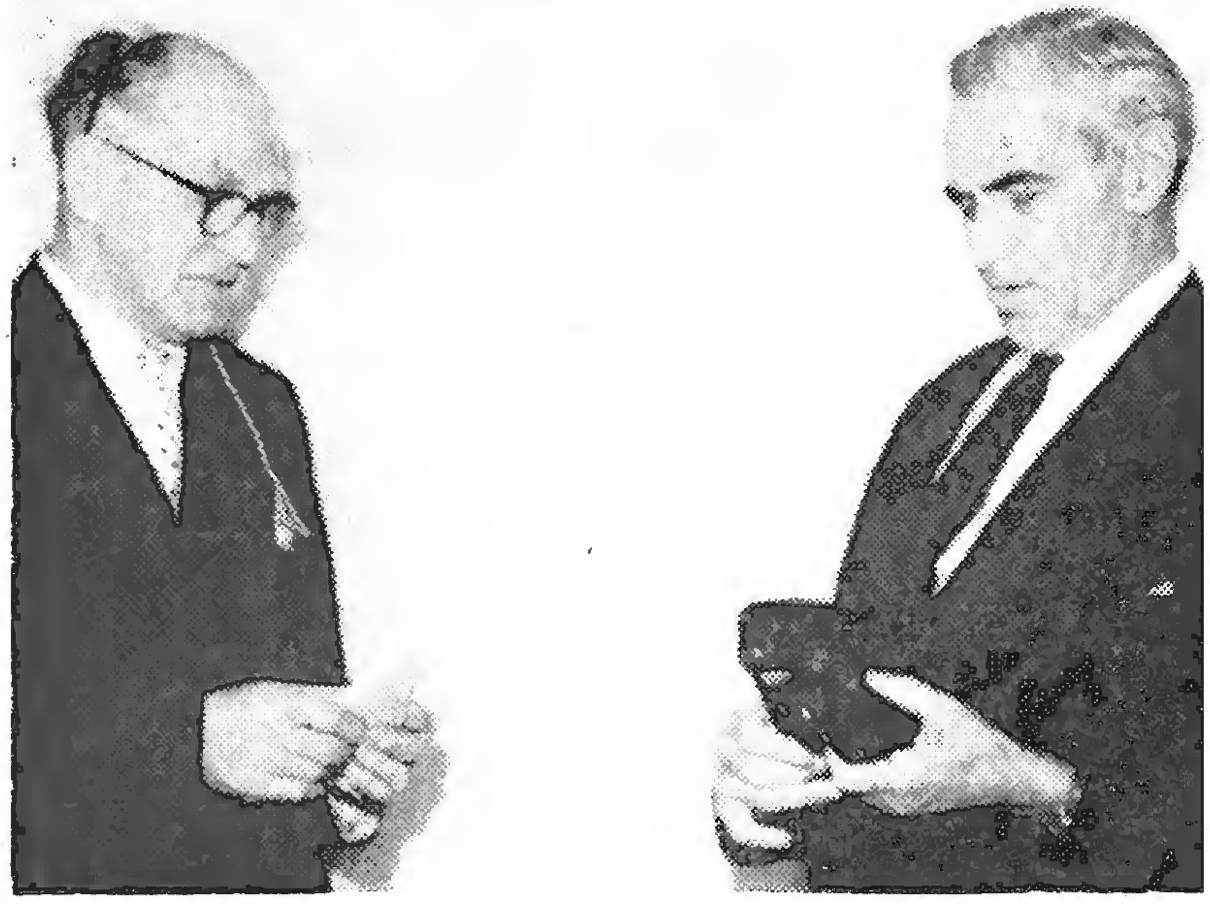
Following the acquisition by Marconi Instruments of W. H. Sanders (Electronics) Ltd., **Professor H. M. Barlow,** F.R.S., and **Dr. E. Eastwood,** C.B.E., have been appointed to Sanders' board. Dr. Barlow is Pender Professor of Electrical Engineering at University College, London, where, except for war service, he has been on the academic staff since 1925. During the early part of the war he worked on the development of radar at the Telecommunications Research Establishment and in 1943 was appointed superintendent of the Radio Department at the Royal Aircraft Establishment, Farnborough. Dr. Eastwood joined the English Electric Group at the Nelson Research Laboratory, Stafford, in 1946, where he was in charge of radiation studies. Two years later he was appointed deputy chief of research with Marconi's at Chelmsford, and subsequently became Director of Research. Dr. Eastwood has been primarily engaged in research in the field of molecular constitution and in the application of radar techniques to the investigation of celestial noise and the detection of meteors.

Harold Peterson, who has been in Australia since 1960 as managing director of both British Automatic Telephone & Electric Co. Ltd., and Communication Systems of Australia Pty. Ltd., as well as a director of other Australasian companies, has been appointed chief executive of the Plessey Company's South African Region. Plessey's interests in the region include the Instrument Manufacturing Corp. of South Africa which produces the Tellurometer radar surveying instrument. Mr. Peterson, who is 46, began his career with the G.P.O., was in Royal Signals throughout the war, then with Cable & Wireless for eight years before joining A.T. & E. which is now part of Plessey.

F. W. Stoneham, M.B.E., Ph.D., B.Sc.(Eng.), A.M.I.E.E., who recently joined Creed & Company (makers of teleprinting and data processing equipment) as managing director has also been appointed a director of ITT Europe Inc. Dr. Stoneham is a graduate of University College Nottingham and was in the Royal Corps of Signals from 1939 until 1954 when he retired with the rank of Lt. Colonel. He was then with Smiths Aircraft Instruments until 1959 when he joined Ultra as chief engineer. He was managing director of Ultra Electronics when he left in May this year.

Geoffrey F. Meakes, who has been with the Racal Organization in the U.K. since 1951 and was responsible for a large part of the development of the famous Racal RA.17 communications receiver, has become chief engineer of Racal Communications Inc., of Silver Spring, Maryland, U.S.A. He was intimately associated with setting up Racal Communications Inc., and Racal (Canada), Ltd.

W. R. Parkinson, founder of the original Radio Gramophone Development Company has retired. When the R.G.D. factory at Bridgnorth became A. T. & E. (Bridgnorth) Ltd. he became technical director and he is here shown (left) being presented with a pair of binoculars by E. J. Bartlett, manager of A. T. & E. (Bridgnorth)



Dudley Saward, O.B.E., managing director of Rank-Bush Murphy for the past four years, has been appointed general manager of the consumer products division of Standard Telephones & Cables in succession to **Gibson B. Kennedy,** who is returning to the United States. In his new position, Mr. Saward is responsible for the K.B., R.G.D., Regentone, Ace and Argosy brands of domestic sound and television equipment manufactured at Footscray (where he has his headquarters), Hastings and Rhyl. Mr. Saward, who was at one time managing director of Texas Instruments Ltd., is a member of the P.M.G.'s Television Advisory Committee.

D. Saward

E. C. J. Jezierski has been appointed chief engineer of Radio Communications Co., of Crewkerne, Somerset. Previously he was research director with Derritron Research Development Ltd., where he was concerned with the design of telecommunications, telemetery and missile control equipment.

Air Cdre. Lionel H. Greenman, C.B.E., who has been senior air staff officer, R.A.F. Signals Command since May last year, has been transferred to technical operations at the Maintenance Command H.Q. Air Cdre. Greenman, who is 50, was a Post Office engineer before joining the R.A.F.V.R. in 1936. In 1943 he went to America and became deputy director of technical requirements with the R.A.F. Mission in Washington. For two years from 1959 he was commanding No. 30 Maintenance Unit, R.A.F. Sealand, Cheshire. He is succeeded as senior air staff officer at Signals Command by **Air Cdre. John Goodman,** M.I.E.R.E., who joined the R.A.F. in 1932 as an aircraft apprentice at No. 1 Electrical and Wireless School, Cranwell. During and since the war he has served at various bases at home and overseas and at the Air Ministry. In 1962 he took command of the Radio Engineering Unit at R.A.F. Henlow and since 1963 has been commandant of the Central Signals Establishment.

J. R. Humphreys has become general manager of A. C. Cossor's Industrial Products Group. He will be responsible for the operations of the Cossor Instrument Co., Cossor Communications Co., Best Electrics and Cossor Valve Co. He succeeds **J. F. Eldredge,** who, after spending over three years at Cossor, is returning to Raytheon in the United States. Mr. Humphreys was, until recently, divisional manager of the Telecommunications Division of Elliott Bros. (London) Ltd., prior to which he was for a number of years chief engineer of Pye Telecommunications.

J. R. Humphreys

"The Indefatigable Dr. Eccles"

90TH BIRTHDAY OF A LAST CENTURY PIONEER

A NAME to conjure with in the more elevated radio-technical circles during the first quarter of the present century was that of Dr. W. H. Eccles, F.R.S., who recently celebrated his 90th birthday. His name recurred constantly in *Wireless World* during its early years.

William Henry Eccles was born at Ulveston, Lancs., on 23rd August, 1875. It would hardly be too much to say he became the first of the radio physicists, though he has to his credit many contributions to the technology of the art. He came near to being a founder member of the world's first wireless company, the Wireless Telegraph and Signal Co., eventually to become the Marconi Co., which he joined in 1899—during Queen Victoria's reign! That was a year after the firm started at the Chelmsford works. Armed with an Honours B.Sc. in physics, gained the year before from the Royal College of Science, he started work on the design of oscillation transformers or "jiggers," as they were called, for the new tuned sets that were just coming in. He also started a study of the coherer, the only detector of the period, which led to a better understanding of the action of that temperamental device. Then, after a short spell as editorial assistant on *The Electrician,* he changed over to teaching electrical engineering, physics and mathematics. Whenever opportunity offered he did radio research.

What was probably Dr. Eccles's most significant work was on a subject at the very heart of our affairs—on radio wave propagation. In 1911 he published a Royal Society paper explaining and expanding the theory put forward by Oliver Heaviside some ten years earlier and since then largely forgotten or ignored. Heaviside had tentatively said "there may possibly be a sufficiently conducting layer in the upper air. . ." Eccles now suggested that the ionizing effect of sunlight might account for observed differences between day-time and night-time transmissions. The subject, which was treated in greater detail later, aroused quite violent controversy but, by the end of 1912, when some support for his ideas came from observations made during a partial solar eclipse, the Eccles theory was widely accepted and solid foundations were laid for subsequent work by Appleton and others.

It would hardly be too fanciful to put forward Dr. Eccles as the grandfather of the transistor. In 1909 he demonstrated oscillating crystal detector circuits and developed the general theory "that under certain conditions a rectifying detector could become a generator of oscillations and conversely a generator of oscillations could be used as a rectifier."

One of his minor contributions was the proposal in 1919 of what has since become the universal valve nomenclature—diode, triode, heptode, etc. *Wireless World* may well blush with shame for having stigmatized that proposal of "the indefatigable Dr. Eccles" as being "too academic" for general acceptance. He was often ahead of his times.

When, just after the first World War, the project for a British "Imperial Chain" of long-wave stations was revived Dr. Eccles was appointed vice-chairman under Lord Milner of a Government committee to plan the details. Before the scheme came to fruition the "short-wave bombshell" was exploded but the long-wave Rugby station eventually started operation.

During his distinguished career he occupied many important posts and has accumulated an impressive list of honorifics. He is Past-President of the Physical Society; of the Institute of Physics; of the Institution of Electrical Engineers; of the Radio Society of Great Britain and *President d'Honneur* of the International Radio Scientific Union (U.R.S.I.) of which he was a member almost from its beginnings.

Dr. Eccles recently talked about some of his little-known activities during the first World War. In 1915 he was invited to advise the War Office on radio matters and devised a short-wave transmitter with valves in push-pull capable of oscillating at the then unheard-of high frequency of 60 Mc/s. Sets to this design were tried by the French army for short-distance work, but the signals were heard as far away as Syria. That was the first indication that short waves had possibilities for long-distance working. At about the same time he devised a valve-maintained tuning fork for frequency control.

In 1917, when Professor of Electrical Engineering and Applied Physics at the City and Guilds Institute, he was appointed to the anti-submarine committee and the college laboratory was taken over by the Admiralty. Many applications of valves to underwater signalling and detection were developed.

After 1924, when Dr. Eccles suffered a severe illness, he was forced to confine his activities to private consultancy. He now lives in retirement on the South Coast. Happily, his health is now remarkably good except for failing eyesight and his memory exceptionally clear. In boyhood he spent some months in a Quaker community near the birthplace of Michael Faraday (whom he greatly admires) and there absorbed the faith to which he has since adhered. By reason of his beliefs, he has been reluctant to patent his inventions.

H. F. S.

Demonstration of Oscillatory Action

By T. PALMER,* B.A., Grad.I.E.E., Assoc.I.E.R.E.

IN a previous article[1], a description was given of a method for demonstrating the phase difference of currents flowing in a parallel arrangement of L, C and R. The signal source was an oscillator with a frequency of 5 cycles per minute and phase difference was demonstrated by the pointer movements of moving-coil centre-zero meters. By using a double-beam cathode ray oscilloscope and an a.f. signal generator our demonstrations can be extended to display oscillatory action.

* Acton Technical College.

1 "Demonstrating A.C. Theory," by T. Palmer, *Wireless World*, October 1963, p. 515.

Parallel resonance can be demonstrated by the circuit of Fig. 1. Suitable values are 30mH for the coil and 0.5μF for the capacitor. The A2 trace of the oscilloscope displays the generator voltage, and the A1 trace displays the voltage across the tuned circuit. By varying the frequency of the signal generator above and below the resonant frequency the effect of resonance can be displayed. At resonance the two traces are in phase and the voltage across the tuned circuit has maximum amplitude.

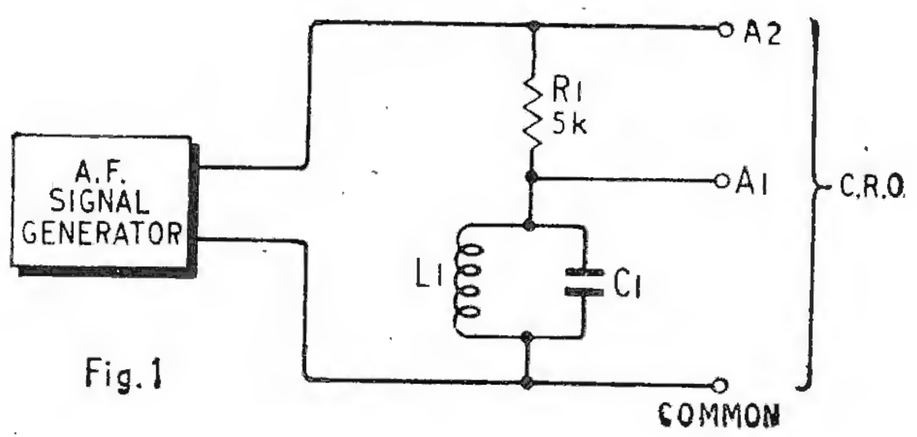
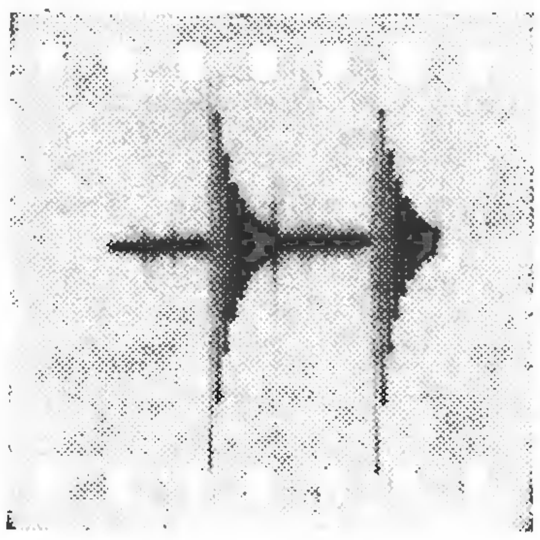


Fig. 1

We now take the circuit of Fig. 1 and modify it to that of Fig. 2. A change-over switch, S1, is operated by a Carpenter relay working at 50c/s. In one position of the switch, a 2-volt accumulator charges C1 through R1; in the other position, C1 discharges through L1 and R2, a variable resistor of 0-50Ω. The waveform of the voltage across the coil is shown in Oscillogram A, with R2=0Ω. With R2=30Ω, the waveform is as shown in Oscillogram B. Having shown this waveform we reduce R2 to zero.



A

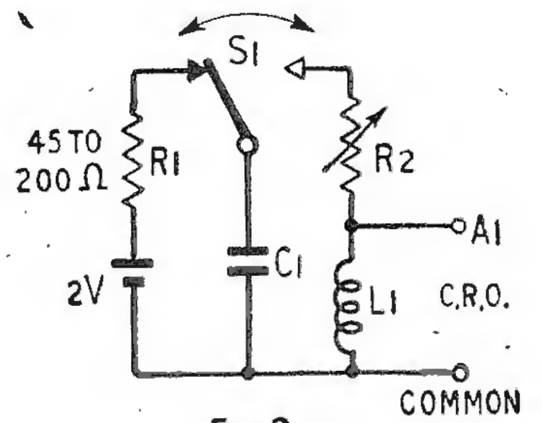
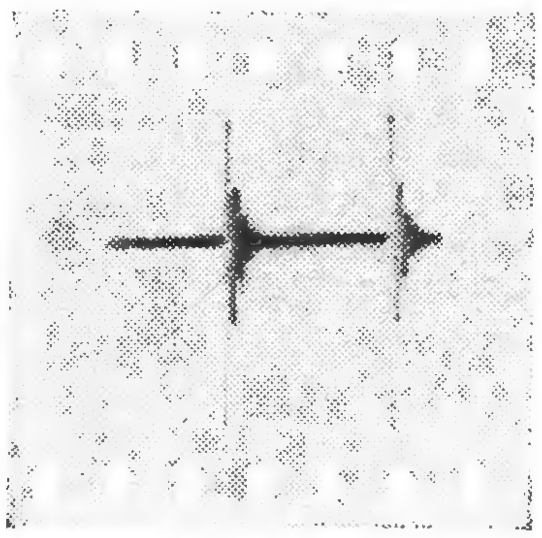
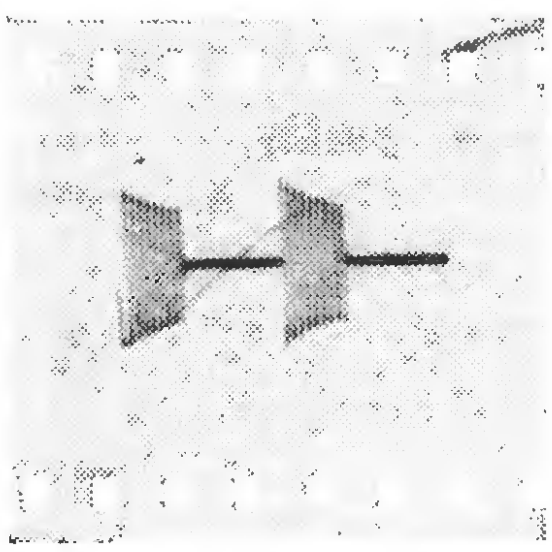


Fig. 2



B

In Fig. 3, the coil L1 is connected in the input of a very simple transistor amplifier which has a coil, L2, of 30mH in the collector circuit. First, this coil is remote from L1, and, when the amplifier is switched on, there is no difference in Oscillogram A. However, as the collector coil L2 is advanced towards L1, the trace on the scope is seen to die away either more rapidly (as if the resistance R2 in Fig. 2 had been increased—negative feedback) or less rapidly (positive feedback). Whether we have the first effect or the second depends, of course, on the way L2 is connected. Both effects should be shown in turn. With positive feedback, as L2 is advanced towards L1, the oscillation dies away less and less rapidly (as in Oscillogram C). With L2 still closer to L1, oscillations are seen to grow, as in Oscillogram D.



C

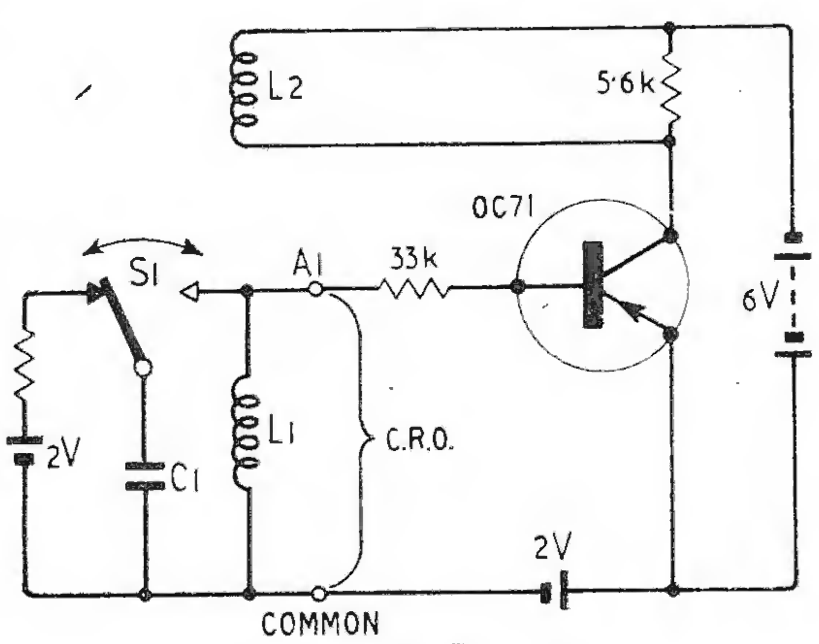
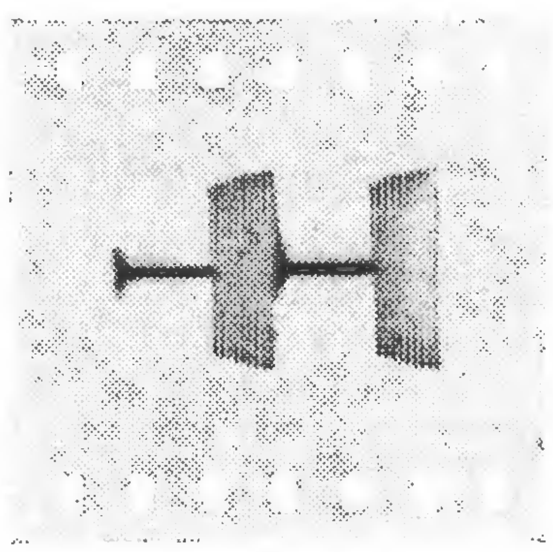
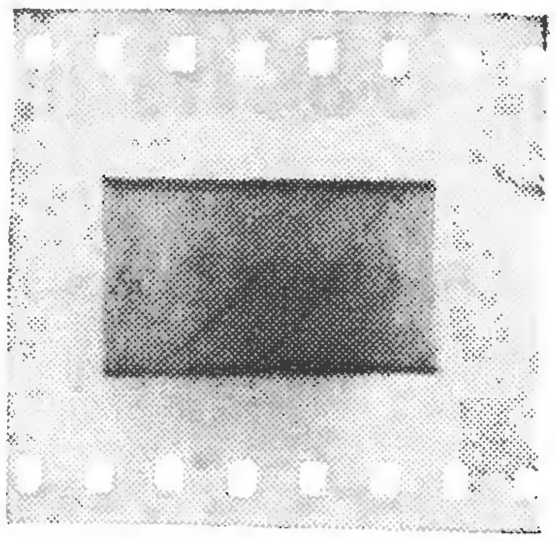


Fig. 3



D

L2 is left in the position which produces increasing amplitude of oscillation, the Carpenter relay is disconnected and the coil is strapped permanently to the capacitor as shown in Fig. 4. Sustained oscillations are seen as in Oscillograme E and F (for F the time-base has been speeded up) showing that the parallel circuit of Fig. 1 has become part of an oscillator.



E

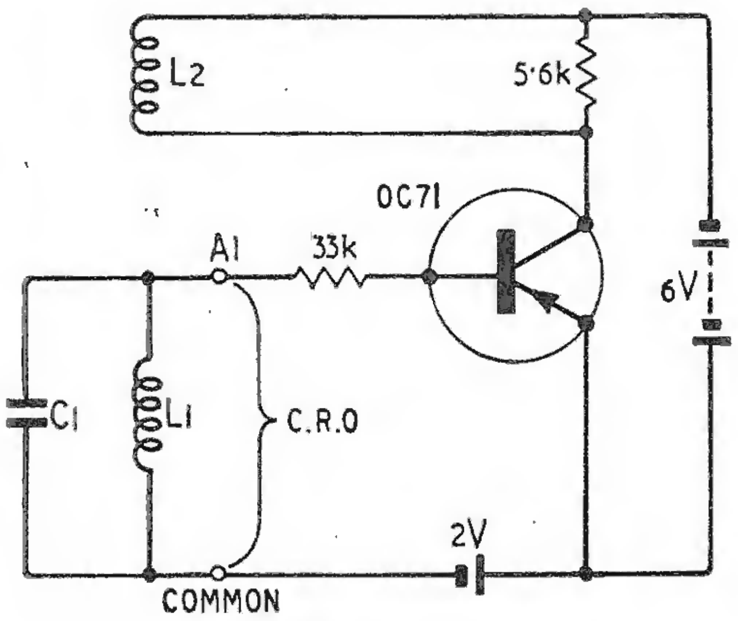
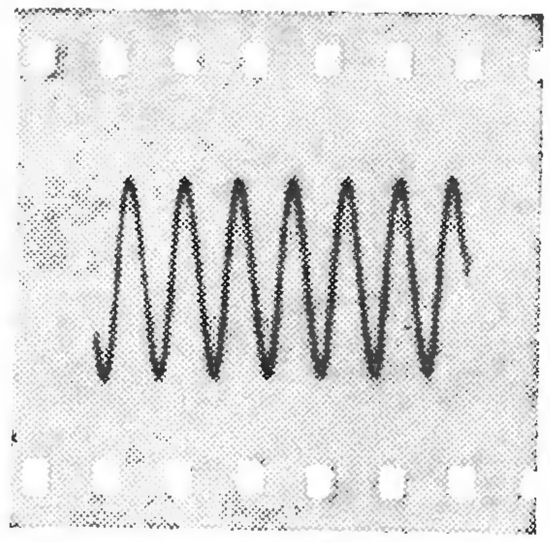


Fig.4



F

It scarcely needs to be stressed that these demonstrations are intended only for elementary students although the last demonstration may help those who wish to study the action of super-regenerative circuits. With conditions corresponding to those of Oscillogram D, try charging C1 from batteries of different voltages.

September Conferences and Exhibitions

Further details are available from addresses in parentheses

LONDON
Sept. 13-17. — Olympia
Engineering Materials & Design Exhibition
(Industrial Trade Fairs, 1-19 New Oxford St., W.C.1)

Sept. 13-17 — Savoy Place
Microwave Behaviour of Ferrimagnetics & Plasmas
(I.E.E., Savoy Place, W.C.2)

Sept. 20-24 — Savoy Place
Thermionic Electrical Power Generation
(I.E.E., Savoy Place, W.C.2)

BRIGHTON
Sept. 28-Oct. 1 — Hotel Metropole
European Medical Electronics Symposium & Show
(Symposium Secretary, 4 Mill Street, London, W.1)

CAMBRIDGE
Sept. 1-7
British Association Meeting
(British Assoc., 3 Sanctuary Bldgs., Great Smith St., S.W.1)

CRANFIELD
Sept. 20-24 — College of Aeronautics
Network Theory Symposium
(S. R. Deards, College of Aeronautics, Cranfield, Beds.)

LIVERPOOL
Sept. 15-17 — The University
Nuclear and Particle Physics
(Inst. Phys. & Phys. Soc., 47 Belgrave Sq., London, S.W.1)

MANCHESTER
Sept. 6-10 — Col. of Science & Tech.
Materials & Environmental Testing
(Inst. Mech. Engrs., Birdcage Walk, London, S.W.1)

Sept. 7-9 — The University
Internal Friction in Solids
(Inst. Phys. & Phys. Soc., 47 Belgrave Sq., London, S.W.1)

Sept. 28-Oct. 2 — Belle Vue
Electronics, Instruments & Components Show & Convention
(Institution of Electronics, 78 Shaw Rd., Rochdale, Lancs.)

OXFORD
Sept. 5-11
Electromagnetic Distance Measurement
(Royal Society, 6 Cornwall Terrace, London, N.W.1)

SOUTHAMPTON
Sept. 21-23 — The University
Applications of Microelectronics
(I.E.E. Symposium, The University, Southampton)

SWANSEA
Sept. 21-23 — University College
Physics of Semiconducting Compounds
(Inst. Phys. & Phys. Soc., 47 Belgrave Sq., London, S.W.1)

OVERSEAS
Sept. 4-12 — Milan
Italian Radio & TV Show
International Electronic Components Show
(A.N.I.E., via Luciano Manara 1, Milan)

Sept. 6-9 — Paris
Opto-Electronic Components & Devices
(M. Coulmy, D.R.M.E., 7 rue de la Chaise, Paris, 8)

Sept. 6-11 — Delft
Electromagnetic Wave Theory
(Dr. R. Timman, c/o Technological University, Julianalaan 132, Delft)

Sept. 7-11 — Basle
INEL—Industrial Electronics Exhibition
(Swiss Industries Fair, Postfach, Basle 21)

Sept. 7-14 — Liège
International Congress on Acoustics
(5e Congrès International d'Acoustique, 35 rue Saint-Gilles, Liège, Belgium)

Sept. 9-11 — Philadelphia
Industrial Electronics & Control Instrumentation
(L. Winner, 152 W42nd St., New York 52)

Sept. 9-19 — Paris
International Radio & TV Salon
(F.N.I.E., 16 rue de Presles, Paris 15)

Sept. 14-Nov. 12 — Montreux
I.T.U. Plenipotentiary Conference
(International Telecom. Union, Place des Nations, Geneva)

Sept. 17-19 — Knokke
International Ham Convention
(L. Vervarcke, Lippenslaan 284, Knokke, Belgium)

Sept. 17-26 — Amsterdam
Firato Electronics Exhibition
(RIA, Europaplein 8, Amsterdam)

Sept. 17-Oct. 3 — Tokyo
British Exhibition
(British Overseas Fairs, 21 Tothill St., London, S.W.1)

Sept. 21-23 — Vienna
Conference on Magnetism
(Verein Deutscher Eisenhüttenleute, Breite Str. 27, Düsseldorf)

Sept. 22-24 — Washington
Military Electronics Convention
(I.E.E.E., Box A, Lenox Hill Station, New York 21, N.Y.)

LETTERS TO THE EDITOR

The Editor does not necessarily endorse opinions expressed by his correspondents

Transistor Cascade Crystal Oscillator

IN my article in the July issue there is a mis-statement in the paragraph under the heading " The Bootstrap Cascade Circuit ". The offending sentence reads: " Both transistors are used in the common-base connection, though this may not be apparent from the circuit diagram." The wording should read: " Tr_2 is used in the common base connection while Tr_1 is a common collector stage which acts as the collector load impedance of Tr_2".

My attention was drawn to this slip by a young reader, Mr. C. Marcus, of Ashtead, Surrey, who pointed out in a well-reasoned letter that there is no alternating potential on the collector of Tr_1. He went on to justify his comments by re-drawing the circuit to illustrate the a.c. conditions more clearly and finally he built circuits and obtained both sinusoidal and relaxation oscillations at will.

My description of the functions of Tr_1 was perhaps too brief but the point had been more fully covered in an earlier article on " Transistor Wide-Band Cascade Amplifiers " (March 1965). Some further explanation is required. If in Fig. 4 of my July article the quartz crystal, the feedback diodes and their associated capacitors are removed, we are left with two series-connected transistors and their bias networks. If an alternating signal voltage is applied to the emitter of Tr_2 it acts as an earthed-base amplifier. Its complex collector load is formed by Tr_1, R_1 R_2, R_5 and C. If C is large, or if its reactance is low at the signal frequency, the alternating output voltage of Tr_2 appears at the base of Tr_1, across R_1. If the output is taken from the emitter of Tr_1, it is at low impedance since this transistor is acting as an emitter follower. At the same time Tr_1 and its associated components simulate a very high-impedance collector load for Tr_2, giving a large voltage gain, without calling for an excessive supply voltage. A limit to the load impedance is in fact set by R_1 which (with large C), is effectively in parallel with the load presented by Tr_1 and R_5 in series. High gain thus calls for a high value of R_1, with proper selection of R_2, R_3 and R_4 to maintain the correct operating bias. To sum up, Tr_1 acts simultaneously as a high-impedance load as seen from Tr_2 and also as an output stage of low impedance to any load connected to its emitter terminal.

Finally, I mentioned the possibility that the new crystal oscillator might be suitable for development into a high-grade frequency standard. Readers interested in this topic are referred to a recent paper by P. J. Baxandall, " Transistor Crystal Oscillators and the Design of a 1 Mc/s Oscillator Circuit of Good Frequency Stability", *Radio and Electronic Engineer* (I.E.R.E.), Vol. 29, No. 4, April 1965, p.229. It takes a new look at some well-established oscillator circuits, re-drawing them to suggest a fresh analytical approach, makes a critical comparison of the Pierce and Miller circuits and finally gives details of a new series resonance oscillator of high performance.

Although many designs for stable crystal oscillators have been published, some actually going into details like component values, nearly all have the weakness that no reasons are given for the choice of the techniques actually used. In this respect Peter Baxandall's paper is outstanding. It provides a wealth of unique information to the designer of such equipment, for whom it is not too much to say that the paper is indispensable.

Cheltenham, Glos. F. BUTLER

Units

MR. GIBBS writing again on this subject at considerable length in the August issue, dismisses my first three points (April issue, p.196) as matters merely of convenience rather than principle. Is convenience not then important? Yet paradoxically he himself raises a point of convenience in conjuring up a fanciful picture of SI advocates trying to persuade semiconductor specialists to measure the volume of germanium in cubic metres. Does he really suppose that I or anyone else would spend our time campaigning for the statement of inter-electrode capacitances in farads? The SI system does not exclude the well-known set of mutiples and submultiples. Incidentally, I disposed of this argument in my original article.

Mr. Gibbs is just as wrong in his closing sentence suggesting, on no evidence at all, that I wish to enforce any system of units by legislation. He must be running short of arguments to have to invent Aunt Sallies to hit out at. He also ignores my point (6), which is a matter of principle.

The first argument in his letter seems to be based on the premise that what a lot of people have done must be right. Are there no such things as enlightenment and progress?

I do not intend to waste space by arguing the essential difference between H and B, when it has been done by writers of much greater authority whose works are on record for Mr. Gibbs or others sufficiently interested.*

Mr. Gibbs undermines his own case against electrical charge being basically one quantity, whether reckoned in e.m. or e.s. c.g.s. units, by his arguments for the identity of H and B. If he can believe that electric charge is fundamentally two quantities at the same time as believing H and B are fundamentally one quantity he can believe anything. And then he goes on " From the atomic point of view, then, a distinction between the units of B and H is a considerable inconvenience," when he has already dismissed convenience as too unimportant to discuss compared with principle! Incidentally, I have recently written a book on atomic electronics without being conscious of the inconvenience mentioned. Neither, apparently, were the physicists Bleaney and Bleaney in their very successful textbook on electricity and magnetism from the modern point of view (now in its second edition), written throughout in m.k.s.a. units.

I do seem to have based my appeal to Maxwell on an incomplete reading of the context, and am obliged by Mr. Gibbs to conclude that on this matter he has been proved wrong, as he admittedly has been with regard to his Art.501 which states that magnetic force acts on the conductor, not the current.

I am fairly sure that arguments in favour of the c.g.s.

* E.g.: C.W.O.H., " *Wireless Engineer* ", Feb. 1933 p. 61; Apr. 1933, p. 179 Dec. 1949, p. 383; etc.
Sir J. J. Thomson, "*Elements of Electricity and Magnetism*" 5th edn., (1921), Art. 153.
O. Heaviside, "*Electromagnetic Theory,*" Vol. 1, Arts. 20-23.

systems made now will look rather quaint to our successors in the not very remote future.

"CATHODE RAY"

Radiation from Class D Amplifiers

IN the July issue of *Wireless World* Mr. F. Butler pointed to the problem of radiation caused by class D amplifiers. The radio frequency interference produced by the carrier and its harmonics can indeed be quite objectionable if no special precautions, such as low-pass filters or screened and twisted loudspeaker leads, are used. The design of such filters, however, is particularly difficult as the introduction of linear frequency-dependent circuits may cause non-linear distortion of a different nature than already discussed for purely inductive loads. To understand this phenomenon it is necessary to know more about the high-frequency components of p.w.m.

The rectangular waveform shown in Fig. 1, having a

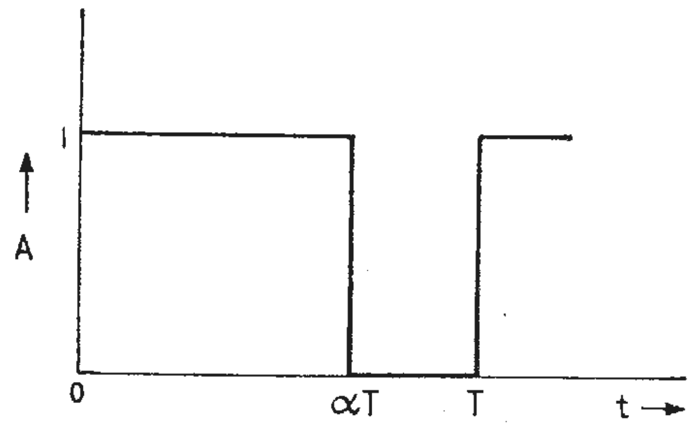


Fig. 1

variable mark-space ratio denoted by α, can be represented by:

$$F(s) = \frac{1}{s}\,\frac{1-e^{-\alpha sT}}{1-e^{-sT}}$$

where T is the duration of one period. Apart from the low-frequency component which is intended to flow through the load it can be shown that the high-frequency components (first and higher order harmonics) are given by:

$$F_h(t) = \frac{1}{\pi}\sum_{1}^{n=\infty}\frac{1}{n}\left\{\sin(n\omega t - 2\pi n\alpha) - \sin n\omega t\right\}$$

$$\text{or } F_h(t) = \sum_{1}^{n=\infty}\frac{\sin n\pi\alpha}{n}\cos(n\omega t - n\pi\alpha)$$

where ω is the angular velocity of the p.w.m. repetition rate (first harmonic) and n is the order of each harmonic. This formula shows that each component is phase modulated and that the modulation index for each component is proportional to its order. Further the amplitude of each component is inversely proportional to n, and varies with the mark-space ratio α as given in Fig. 2.

Thus, when the pulse width is modulated, simultaneous amplitude and phase modulation of each component occurs in such a fashion that the pulse width corresponds uniquely to the amplitude and phase relationship given by the formula. When this relationship is distorted by a low-pass filter having an improperly designed amplitude and phase characteristic, the pulse width at the output will be altered with respect to the p.w.m. at the input. Although generally this distortion will be non-linear (depending on the characteristics of the filter) it is of no consequence as long as the load is a purely linear element. This is because the high-frequency components contain no d.c. or l.f. component and will average out in a normal loudspeaker.

The situation is different when part of the energy at the input of the filter is reflected back into the output stage. In the properly designed filter the prescribed relationship between the harmonics is maintained and only loss of efficiency may occur. However, if this is not the case, a superposition of two signals, only related by the filter characteristics, is presented to the highly non-linear output stage and gives rise to modulation effects. The result is not only non-linear distortion of the audio signal (depending on the transistor switch characteristics as already discussed in these pages) but also beat products between the high-frequency components themselves. This last effect is particularly objectionable, since the beat product of the harmonics of the 2nd and 3rd order then not only produces a non-linearly distorted audio signal but may again beat against the first harmonic, producing more distortion. This type of distortion is unique to the class D amplifier and cannot be compared to that produced by the more conventional classes

As transistor switches are not the ideal generators to match filters to, it is advisable that the group delay of the filter is constant over a sufficiently large range to ensure that the energy of reflected harmonics is low enough when the prescribed relationship between them is lost. This is not true for all types of loudspeaker, so one should be careful in selecting a suitable reproducer.

Much has been said in these pages on the subject of p.w.m., but it seems less known that a class D amplifier driven by a f.m. signal is equally capable of producing audio amplification. The only difference between the two methods is that f.m. differentiates the modulating signal if the modulation index is independent of the frequency of the modulating signal, whereas p.w.m. does not. In a properly designed f.m. audio amplifier the audio signal should therefore be integrated before modulation. This effect explains why, in the case of, e.g., the closed loop p.w.m. amplifier, the distortion introduced by the limited p.w.m. can be compensated by frequency modulation of the p.w.m. repetition rate—or, as Mr. K. C. Johnson put it in the May issue: "might not the feedback . . . 'know' that a judicious amount of f.m. can actually reduce the troublesome l.f. sidebands ?" However, it will be clear that a suitable filter for f.m. is even more difficult to design than for a fixed repetition rate.

Finally, it seems surprising that the more conventional circuits for producing p.w.m. as used in telemetry, etc., have not been discussed. As so many readers are vividly interested in the subject, a fairly simple circuit is given in Fig. 3 which needs little explanation. A symmetrical driver feeds a flip flop modulator (2N1304), which in turn drives directly the symmetrical output stage. The transistors in this last stage are driven hard so that extra

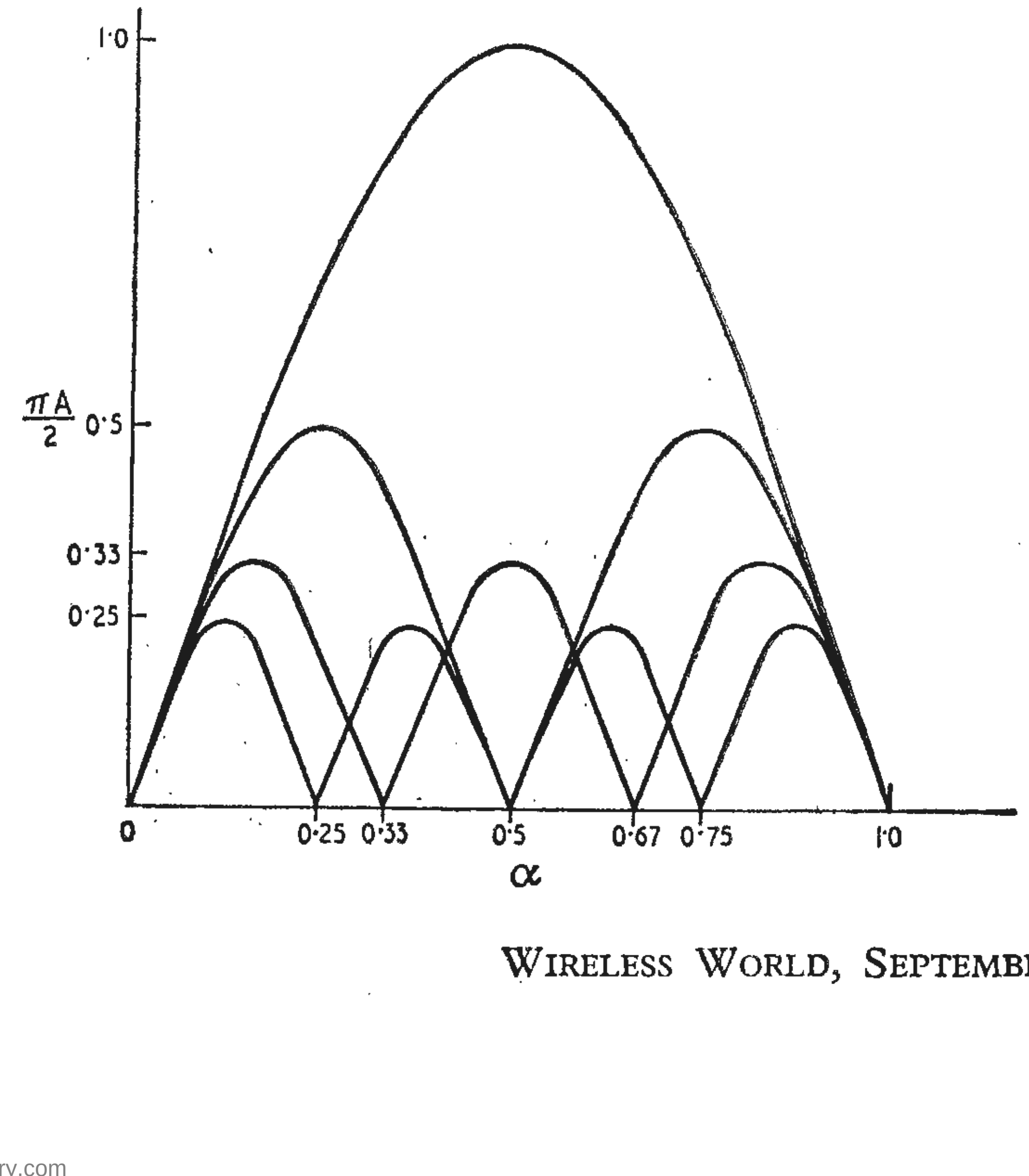


Fig. 2

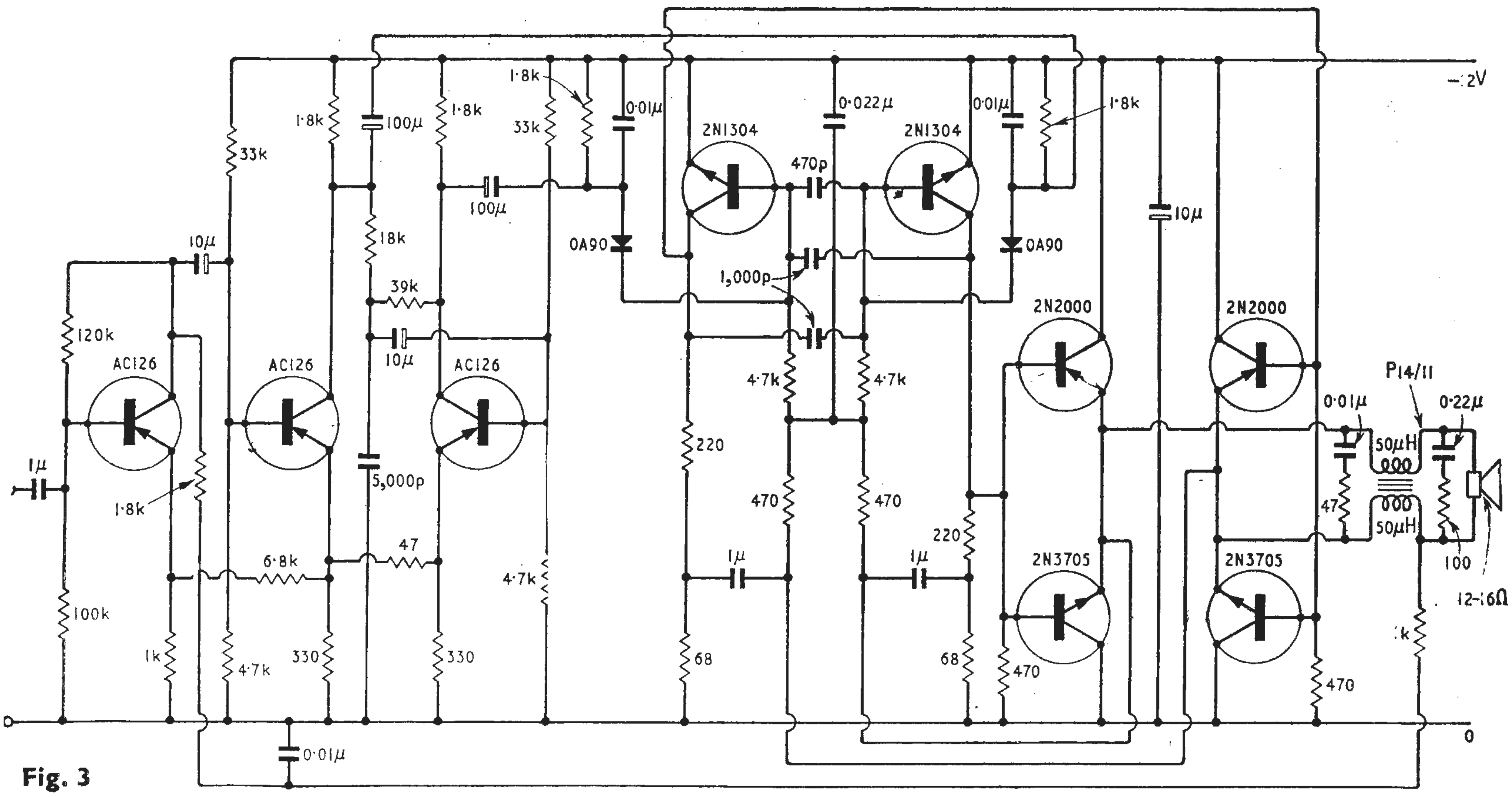


Fig. 3

diodes to provide alternative paths are not necessary. Furthermore, the simple (but by no means optimum) filter is damped to reduce the reflected energy.

Amsterdam. D. BOSMAN

Satellites & TV Standards

YOUR editorial in the August issue has, rightly, raised the problem of television standards and the use of synchronous satellites. May I suggest that a possible solution offers itself, if we have the courage to accept the fact that the new u.h.f. television service for the U.K. is obsolete before it has got off the launching pad?

The plan for the u.h.f. service is, by now, well known. The country is to be covered by a number of high-powered transmitters, with a number of low-powered "fill-in" stations to cater for the low-lying and badly shadowed regions. A capital expenditure of some £100 million will be involved.

It has recently been announced that a satellite housing a high-powered transmitter can be put into orbit and it is, surely, more practical (and very much cheaper) to use such a satellite to broadcast the country's television service. The satellite could be commissioned and put into orbit for, probably, less than £20 million, and maybe it could be simplified by being engineered for this exclusive use. Existing problems of co-channel and similar interference would not arise, neither would those due to propagation over the earth's surface.

The satellite signal frequencies would, of course, need to be very much higher than the u.h.f. band in order that a high-gain aerial of modest dimensions could be used at the receiver. Existing receivers need not, however, be made obsolete; a frequency converter could be fitted either as part of the aerial installation, or at the receiver.

If we used such a system it would, of course, provide "free" television programmes to a large proportion of the earth's surface. Herein lies a particularly attractive aspect of the system. We could "go-it-alone" with the reasonable assurance that viewers in other countries will wish to see these "free" programmes. It is probably too much to hope that such a venture could be a combined European operation in its early stages.

Is it too late to re-cast the country's television service into a sophisticated system that could be far in advance of any other? It could give receiver manufacturers the "shot-in-the-arm" they so desperately need.

R. S. ROBERTS

The Northern Polytechnic,
London, N.7.

FURTHER EDUCATION

THE following courses to be held at various centres during the forthcoming academic year have been selected from information received as being of particular interest to *Wireless World* readers.

Twickenham College of Technology.—In addition to part-time courses leading to the O.N.C. and H.N.C. with endorsements for the graduateship examinations of I.E.E. and I.E.R.E., special lecture courses are available on fundamentals of semiconductor devices, transistor circuit design, basic electronics, network analysis and basic principles of systems analysis.

Full-time and part-time post-graduate courses in electrical engineering leading to the internal M.Sc.(Eng.) degree of the University of London commence on September 27th at **West Ham College of Technology,** London, E.15. Evening courses for post-graduates include semiconductor device design, semiconductor circuit design theory and linear network theory.

Among the subjects dealt with by special evening lecture courses at **Hendon College of Technology** are an introduction to microwaves, introduction to automatic computing techniques in industrial applications, transistors and transistor circuit design, and high-fidelity sound reproduction.

The prospectus from the **Northern Polytechnic,** London, N.7, gives details of full-time and part-time degree courses together with a professional course leading to a diploma exempting students from the graduateship examination of the I.E.R.E.

Bristol Technical College is offering a two-year full-time course in aircraft radio and electronics as well as courses for the P.M.G.'s certificates for marine radio officers.

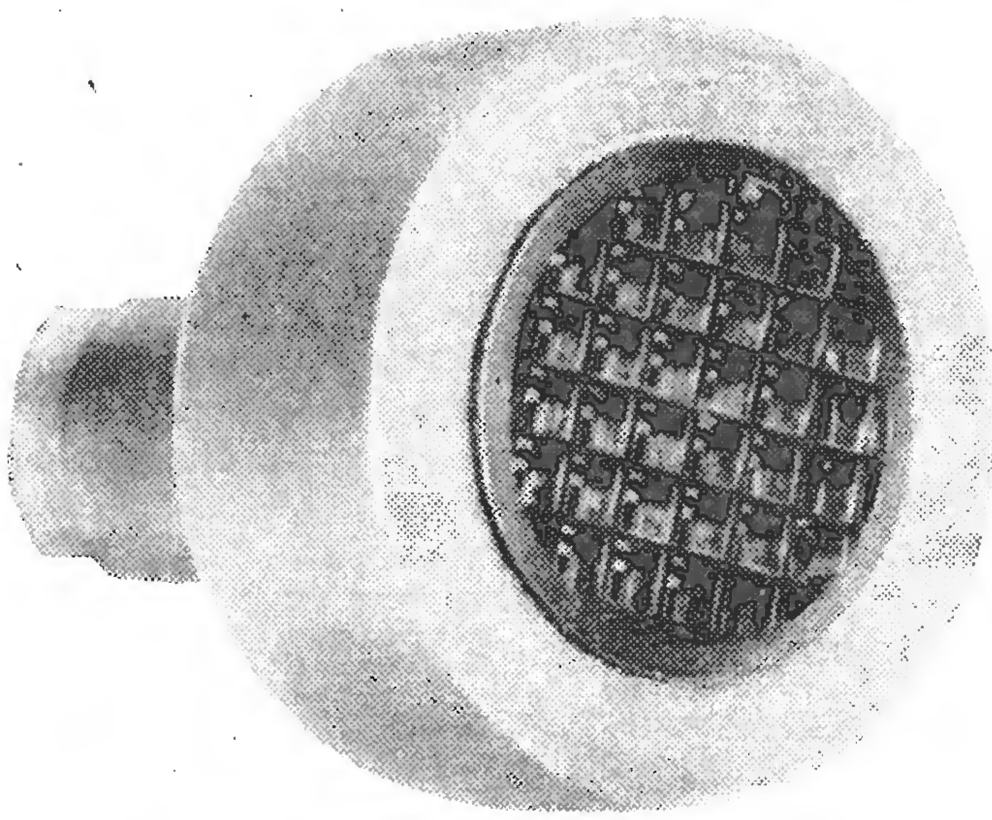
Brighton Technical College.—Part-time courses and block release courses for technicians are outlined in the Engineering Department's prospectus "A."

Post-graduate laboratory courses at **Portsmouth College of Technology** include a ten-evening course on the analysis and simulation of control systems and another on microwave measurements.

Semiconductor Detectors for Nuclear Radiation

By J. B. DANCE, M.Sc.

IF α, β or γ-radiation is absorbed by matter, the energy is dissipated in the formation of ions and excited atoms. With application of a suitable electric field, the ions may be collected at the electrodes and the resulting pulse used to operate a scaler or ratemeter. In some forms of detector (ionization chambers, proportional and Geiger-Müller counters) the ions are formed in a gas, but during the past few years much effort has been expended on solid-state ionization chambers, partly because a solid absorbs energy from penetrating radiation far more effectively than a gas. A particle which will travel 1 metre in air can be absorbed by about 1 mm of silicon. Particles are absorbed in a solid in scintillation counters, but the process by which the energy of the particles is converted first into photons and then into photo-electrons at the cathode of a photomultiplier tube is very inefficient.



A silicon surface-barrier detector with a detachable collimator (Elliott S.R.D.I.).

For any specific material the fraction of the total energy used in ion formation is almost independent of the initial energy of the radiation and of the type of incident particle. Thus a particle of 2 MeV energy will produce about twice as many ions as a 1 MeV particle absorbed in the same medium, but the ions formed by the 2 MeV particle will be distributed over a greater path length. In many types of detector the number of ions collected (and therefore the output pulse amplitude) is proportional to the energy absorbed from the particle. The energy required to form each ion pair in a gas varies from about 22 to 37 eV according to the nature of the gas.

The ionization produced by a charged particle is a result of the electrostatic forces between the particle and the electrons of the matter through which it is passing. The energy of γ-radiation is dissipated indirectly in three main ways. In the photoelectric effect the whole of the energy of a γ-photon is used to eject an electron from an atom; the fast electron then behaves as a β-particle and produces ions. In Compton scattering the energy of a γ-ray is shared with an electron; the electron is given a high velocity and a γ-ray of lower energy is formed. The γ-ray may undergo further Compton scattering, but is more likely to escape unless the volume of the absorber is large. Radiation exceeding 1.02 MeV can cause electron-positron pair production. The positron will meet another electron and the two will be annihilated, two γ-rays (about 0.51 MeV) being formed.

In Compton scattering and pair production it is likely that a large fraction of the energy of the γ-ray will escape the absorbing material. If a γ-photon is absorbed by the photoelectric process, however, the whole of the energy of the photon is absorbed. Thus if a detector is used which produces output pulses of an amplitude proportional to the energy absorbed, the amplitude of these pulses will be proportional to the energy of the incident γ-radiation only if the absorption occurs by the photoelectric process.

The photoelectric absorption coefficient is proportional to the fifth power of the atomic number of the absorber. Thus if it is necessary to determine the energy spectrum of γ-photons, it is desirable that the absorbing material should have a high atomic number.

Resolution of detectors

If a detector is being used for energy spectrometry, the output pulses will not have exactly the same amplitude even if the energy absorbed by the detector from each particle is identical. One reason for this is that the presence of noise pulses may increase or decrease the amplitude of the detector output pulses. In addition, the exact fraction of the energy of the incident particle used to create ions is determined by probability. A similar effect occurs in scintillation counters where the exact fraction of the energy used to create photons (and hence electrons at the photo-multiplier cathode) shows a statistical variation around an average value. Thus if the output pulse amplitude of any detection system is converted into an energy spectrum by means of a pulse height analyser, the spectrum for monoenergetic particles will be of the form shown in Fig. 1. In a spectrum of radiation containing a number of peaks, two of the peaks may be so close together that they cannot be distinguished from a single peak. The width of a single peak at half the

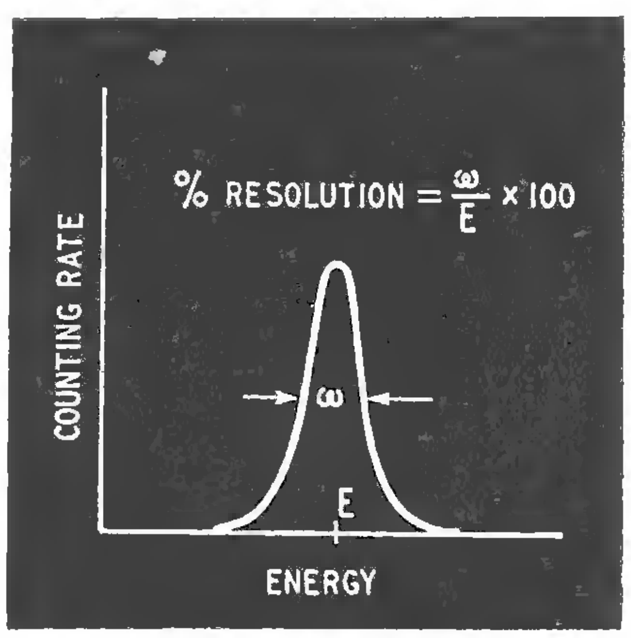


Fig. 1. A typical energy spectrum of monoenergetic radiation.

maximum height may be used as a measure of the energy resolution of the system.

SEMICONDUCTOR DETECTORS

In order that the statistical spread of each energy peak shall be as small as possible, the material of the detector should be chosen so that as many ions as possible are formed for each MeV of energy absorbed from incident radiation. Not only will this reduce the statistical spread in the number of ions formed, but it will also increase the signal amplitude and therefore reduce the effect of any noise pulses.

Each ion pair formed in a semiconductor material requires an energy of about 2-4 eV; this is only about one tenth of that required by gaseous absorbers. It is also very much smaller than the energy required to produce one photoelectron in a scintillation counter (which varies from about 200 eV in a thallium-activated sodium iodide crystal to over 1 keV in organic phosphors). Semiconductor detectors can therefore show excellent energy resolution.

If the maximum resolution is limited by the noise level, it might be expected that semiconductor detectors would show an improvement of about ten times when compared with gas filled detectors. If, however, the statistical spread in the fraction of the energy which is used to create ions is limiting the resolution obtainable, it would be expected that the use of a semiconductor detector would improve the resolution by a factor of $\sqrt{10}$. In practice noise often limits the resolution, but other factors must be taken into account, particularly the noise introduced by the first stage of the amplifier used.

The number of ions formed in a semiconductor material per MeV of absorbed energy is inversely proportional to the gap in the energy band of the material used. It will be shown, however, that other factors are more important than this in the choice of the semiconductor material.

Homogeneous detectors

Semiconductor detectors may be divided into two main types, the homogeneous detectors and the junction detectors. Homogeneous detectors consist of a piece of semiconductor material sandwiched between two electrodes. They can be used for individual particle counting only if the temperature is very low, but certain types of homogeneous detector can be used for integrated flux measurement at normal temperatures. Junction detectors can be used for counting individual particles both at room and low temperatures, but have the disadvantage that their sensitive volume is severely limited. In order to appreciate how these types of detector have been developed and why they have certain limitations, it is necessary to consider the properties of the semiconductor materials used.

The material to be used in a solid-state ionization chamber designed for counting individual particles must have a fairly low specific conductivity, or statistical fluctuations in the steady current passing between the electrodes (i.e. noise) will provide pulses of the same order of amplitude as the pulses caused by the radiation being detected. As in a gas-filled detector, the number of charge carriers present in unit volume of the material in the absence of radiation must be relatively small, although it is desirable that their mobility shall be large in order to obtain short pulse rise times for fast counting. This requirement seems to indicate that a high-purity semiconductor material with a fairly large energy gap should be chosen so that the number of thermally generated charge carriers will be comparatively small.

A second requirement is that the mean free carrier lifetime should be reasonably high. Impurity atoms, dislocations, etc., in the crystal lattice form local energy bands within the forbidden region. These bands act as traps at which free charges may be temporarily or permanently held, since the probability of recombination with a charge of the opposite sign is fairly small at these trap levels. The trap density should be low (as in a gas-filled detector) or a partial loss of the signals will occur together with a change in the properties of the material as the electron population of the traps is altered (" polarization "). The energy resolution will then be impaired.

It is most unfortunate that materials which have the required energy band gaps have carrier lifetimes which are too low. The energy gaps of germanium and silicon are not large enough to enable a homogeneous block of either of these materials to be used as a detector at room temperature, although the trap density is low. Gallium arsenide has a suitable energy gap, but the carrier lifetimes in this material are too low; in addition it can show oscillations at high field strengths. Diamond was one of the first materials used in a solid-state detector, but apart from the prohibitive price of large crystals of this material, it has a number of other disadvantages including high trap density. Considerable effort is being made to find new materials which will be suitable for homogeneous detectors, but even if such materials are found, it is likely that there will be considerable difficulties attached to the fabrication of single crystals of the materials of the required uniformity.

Flux measuring detectors.—Integrating instruments do not provide a separate pulse as each particle strikes the detector, but are merely used to give an indication of the particle flux at the detector. In this type of instrument traps which lengthen the response time may not matter, since it is only necessary to measure the mean current passing through the detector.

Semiconductor flux detectors take the form of a crystal of the semiconductor material between two electrodes. As the radiation flux (often gamma) increases, the resistance of the crystal decreases. Cadmium sulphide is commonly used in flux detectors, but other group II-VI compounds can be used, such as cadmium selenide and telluride. Sometimes insulators (polythene, p.t.f.e. etc.) are used for dosimetry, since they have a density of approximately unity; however, they are not as sensitive as cadmium sulphide.

Charge amplification.—Cadmium sulphide and selenide are materials of large energy gaps and high trap densities. However, the traps may be used to obtain a charge amplification of perhaps 10,000. If ions are formed by a particle of nuclear radiation striking a cadmium sulphide crystal, the electrons are quickly swept to the anode, but many of the holes are trapped. If suitable electrodes are employed, the field due to the trapped holes will cause electrons to enter the crystal from the cathode. A small proportion of these electrons will neutralise trapped holes, but most of them will pass to the anode. Further electrons will be injected from the cathode until eventually all of the trapped holes will be neutralized.

If the time for an electron to pass across the crystal is t_r and τ is the mean lifetime of an electron, the total charge which passes through the crystal per incident particle will be $n\tau/t_r$ where n is the charge formed by an incident particle. The ratio τ/t_r may be called the amplification of the device. A high gain will be obtained if τ is fairly large and if t_r is kept small by choosing a thin crystal with a high electron mobility. In practice the electron lifetimes are modified by crystal imperfections which act as electron traps. A high concentration of such traps will reduce the sensitivity and increase the response time. The crystals are fine needles about 1 cm long with indium electrodes attached to them. They are sealed in a glass tube. The most suitable crystals must be selected from a batch which have been grown from the vapour phase.

Cadmium sulphide and selenide detectors are available with sensitivities of 0.1 to 50 μA rad^{-1}hr^{-1}; generally the cadmium sulphide types are the more sensitive. A linear response over many orders of magnitude up to at least 10^8 rad hr^{-1} can be obtained. These detectors have the advantages that they are small and cheap (less than £5) and the associated instrumentation could hardly be simpler. It is only necessary to connect a cadmium sulphide detector in series with a moving coil micro-ammeter and a battery to make an inexpensive portable γ-ray monitor. These detectors are not damaged by high radiation intensities.

One of the main disadvantages of the cadmium sulphide detector is the long response time for moderate radiation intensities ($\sim$1 sec.). When a cadmium sulphide detector is placed in a radiation field of moderate intensity, the current passing increases fairly slowly to a maximum value in a time which is of the same order as the lifetime of the trapped carriers. A similar slow decrease occurs when the detector is removed from the field. The response time is short at high intensities (where the traps are quickly filled), but it is generally so large at intensities of the order of the recommended human tolerance levels that it seems doubtful whether these detectors in their present form will be useful for health monitoring at low intensities.

The response time of a cadmium sulphide cell which has been kept away from radiation for some time is greater than that of a cell which has been irradiated during the previous few hours. In order to avoid this effect, some cadmium sulphide cells incorporate a radioisotope in the semiconductor material so that some of the deeper traps are kept filled. Such crystals pass a small current even in the absence of an external field and this current must be "backed off" in the instrument.

It has been found that cadmium sulphide detectors giving current gain can produce single pulses of several volts amplitude when they absorb α-particles(2). Although the energy resolution and maximum counting rate are very limited, such low cost α-counting systems may be useful when a large number of the detectors are required.

Junction detectors

In a p–n junction holes from the p-type semiconductor initially diffuse across the junction into the n-type and electrons from the n-type diffuse into the p-type. Equilibrium is established when the potential developed across the junction by this carrier diffusion prevents further diffusion from taking place. The junction potential repels free charges away from the junction. The junction region contains no free charge carriers and is therefore referred to as the depletion region. The application of a negative bias potential to the p-type material will increase the depth of the depletion layer (and hence decrease the junction capacitance) by drawing mobile charges further from the junction.

Although the number of free charge carriers in a homogeneous sample of silicon is too great for it to be employed as a solid-state ionisation chamber at room temperature, silicon p-n junctions can be made in which the depletion region is used as the active part of a solid-state detector at room temperature.

Silicon junction detectors are the most commonly used form of semiconductor detector. The depth of the depletion layer is, however, severely limited and is dependent on the applied reverse bias potential. Germanium junction detectors must be cooled to liquid nitrogen temperatures.

Depletion depth.—The depth of the sensitive depletion region of a junction detector is controlled by the applied bias voltage; optimum bias voltages range from a few volts to over a kilovolt. The depletion depth, d, is given by the following approximate equations:—

$$d \approx 5\sqrt{\rho V} \times 10^{-5} \text{ cm in n-type silicon}$$

$$\text{and } d \approx 3\sqrt{\rho V} \times 10^{-5} \text{ cm in p-type silicon}$$

where ρ = specific resistance of the silicon used in ohm cm, and V = the applied bias voltage.

The depletion depth required to stop a charged particle depends on the type of particle and its energy. For example, a 5.5MeV α-particle requires a depletion depth of about 25μm in silicon for complete absorption, whereas a β-particle of about 56 keV or a proton of about 1.4 MeV will penetrate to a similar depth. A depth of about 0.2 mm of silicon is required to stop a 0.21 MeV electron or a 5 MeV proton; this depth can be obtained by the use of a n-type silicon of resistivity 3.6×10^3 ohm cm at a bias of about 46V.

A germanium depletion region of a certain depth will stop particles of about twice the energy of those just absorbed by a silicon depletion region of the same depth.

The charge collection time, τ, in a thick detector is given by the approximate equation (3):—

$$\tau = \frac{W^2}{\mu V}$$

where W is the depletion depth of the detector, μ the carrier mobility, and V the applied bias voltage. As τ is proportional to W^2, it is desirable to keep W as small as possible consistent with the absorption of the particle. It is also desirable to make W only slightly greater than the particle range if there is an appreciable gamma background. On the other hand, it is desirable that W should be large for very high resolution spectroscopy, since the junction capacitance will then be small.

An excessive bias voltage will result in increased noise owing to the greater current flowing. At small bias voltages inefficient charge collection will also result in increased noise. An increase in the bias voltage will have the advantage that the charge carrier transit time will be reduced. The electric field strength at all points in the semiconductor material must be considerably less than that at which avalanche breakdown occurs in silicon (about 6×10^5 Vcm^{-1}). A graphical method for determining the optimum detector operating conditions has been published(4).

Junction detector construction

Silicon surface barrier junction detectors are made from n-type silicon, a p-type layer being formed at one face by spontaneous oxidation. A gold film of about 20 to 50 μg cm^{-2} is evaporated onto the oxidized face to form one electrode and an aluminium or magnesium alloy electrode is formed by evaporation on the back surface of the silicon. The depletion region extends from the gold electrode inwards to a depth which depends on the applied bias, but which is normally less than 1 mm. This type of detector is fairly easy to make in the laboratory, but the percentage of really good detectors which will withstand a high bias and produce little noise is not usually very high.

Silicon diffused junction detectors are manufactured by allowing an element such as phosphorus or boron to diffuse into one side of a silicon slab (normally p-type)' at a temperature of perhaps 900°C in an inert atmosphere. An aluminium film is simultaneously allowed to diffuse into the slab from the other side. One disadvantage of the diffused junction detector is that the high temperatures employed in its manufacture may lead to a reduction in the carrier lifetimes; surface barrier detectors are not raised above room temperature during manufacture and therefore do not suffer from this effect. Generally the diffused junction types are somewhat more robust and for this reason are likely to be more suitable for some purposes.

Lithium-drifted junction detectors can be made with depletion regions of 1 to 2 cm by employing a principle discovered by Pell[5]. Initially lithium is allowed to diffuse into one face of a silicon slab under very carefully controlled conditions. Lithium is a donor in silicon and the Li^+ ions rapidly diffuse into interstitial sites in the lattice. They are then caused to drift at a lower temperature under the influence of an electric field. This results in a deep depletion region being formed. The lithium ions tend to pair off with boron impurity atoms present in the silicon so that the specific resistance of the semiconductor material and hence the depletion depth is greatly increased. The amount of drifted lithium automatically adjusts itself to compensate for the presence of the acceptor ions to an accuracy of up to 0.001%. Lithium drifted germanium detectors can be made in a similar way.

Lithium-drifted silicon surface barrier detectors have been prepared with window thicknesses of less than 10^{-4} cm and depletion depths of a few mm.

JUNCTION DETECTOR APPLICATIONS

α-counting and spectrometry.—Silicon junction detectors are replacing scintillation counters for many α-monitoring purposes, especially where a probe of small size is required. The low background count of the semiconductor detector enables it to be employed to measure the activity of very weak α-sources; background counting rates of less than 0.15 counts per hour have been reported[6].

Silicon surface barrier and diffused junction detectors are ideal for α-particle spectrometry. α-particles of normal energies are completely absorbed in the narrow depletion region. The thin window of the detector combined with the small amount of energy required to form an ion pair in silicon enables very high resolution to be obtained. It is necessary to place the specimen and the detector in a vacuum if the best possible energy resolution is required, since α-particles lose an appreciable part of their energy in air.

The high resolution offered by silicon junction detectors in α-spectrometry almost always enables the emitting radioisotope to be identified. Indeed, the element no. 103, lawrencium, was first identified in this way although only a few counts per hour could be recorded. The high energy resolution obtainable with a semiconductor α-spectrometer is well illustrated by the americium-241 spectrum shown in Fig. 2.

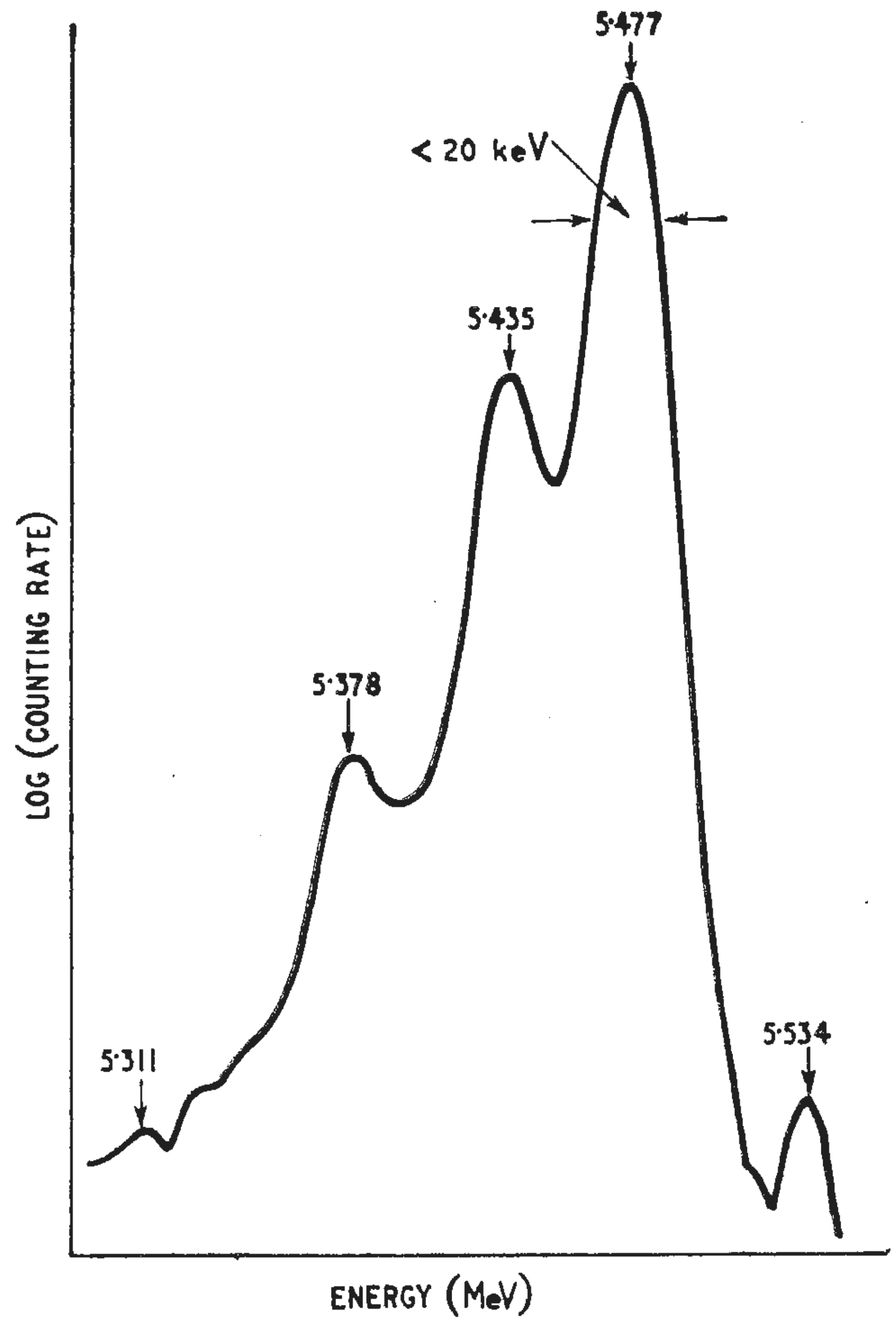


Fig. 2. The α-spectrum of americium 241. The excellent energy resolution is obtained by cooling a detector with a depletion depth of about 1mm.

If air containing α-emitting dust is drawn through a filter paper, the amount of each α-emitter present can be estimated from the energy spectrum of the material on the filter paper; when other types of detector are employed, it may be necessary to wait one or two days for the natural radioactive materials in the air to decay. An automatic α assay equipment which includes a 2 cm dia. solid-state detector has been designed for monitoring the activity of filter papers from the personal air samplers worn by people employed in active areas.

β-counting and spectrometry.—A junction detector can be used for β-counting if the depth of the depletion region is sufficient to absorb enough energy from each particle (10-15 keV) to produce a pulse which exceeds the level of the noise pulses. Semiconductor detectors are not very suitable for the counting of very low-energy β-radiation at room temperature. The small size of the detectors, however, renders them especially attractive for certain medical applications, especially in cancer work.

For β-spectrometry it is necessary that almost all of the particles shall be absorbed within the depletion region. High resistivity detectors should be employed at a fairly high applied bias for β-spectroscopy in order to obtain a suitable depletion depth. Lithium-drifted silicon detectors should normally be used for β-energies exceeding about 500 keV. They can be made with depletion regions deep enough to absorb β-particles with energies up to about 8 MeV and may be used at room temperature or, for better resolution, at liquid nitrogen temperature.

The detectors offer better resolution than scintillation β-detectors but have the disadvantage that they require a low-noise amplifier. Except at low energies a semiconductor detector is very suitable for use in magnetic β spectrometer instead of a Geiger-Müller or scintillation detector.

γ-counting and spectrometry.—Solid state detectors are not efficient γ-detectors, since their volume is small and the atomic number of the semiconductor material is low. They are much more satisfactory for the counting of fairly low energy γ-rays or of X-rays than high energy γ-rays, since a much greater fraction of the former cause ionization in the crystal. Scintillation detectors employing a thallium-activated sodium iodide crystal are more efficient γ-ray detectors than any semiconductor device available at the present time, since the size of the crystal can be fairly large, its density is high and the iodine (of the sodium iodide) has a high atomic number.

Silicon junction detectors are available for the measurement of γ-radiation dose rate. They are small, rugged and stable devices, the typical sensitivity being 10^6 to 10^8 counts per rad. In medicine lithium-drifted silicon devices are used to measure the doses given in cobalt therapy. Owing to their low γ-efficiency, semiconductor detectors are more useful for measuring medium to moderately high levels of γ-radiation than very low levels.

For γ-spectroscopy lithium-drifted germanium devices offer resolutions exceeding those of other types of detector at energies greater than about 300 keV. At lower γ-ray energies the quartz crystal spectrometer offers greater resolution at smaller efficiencies. Lithium-drifted silicon detectors can be used for low-energy γ- and X-ray spectroscopy (preferably at liquid air temperatures), but germanium (atomic number 32) doped with gallium or zinc has a much greater photoelectric absorption coefficient than silicon (atomic number 14).

Lithium-drifted germanium detectors must not only be used at low temperatures, but they must also be stored at low temperatures. RCA state that their lithium-drifted germanium diodes should be stored at or below −20°C and that storage at liquid nitrogen temperatures should prolong their life indefinitely. Storage at room temperature may cause failure within three months.

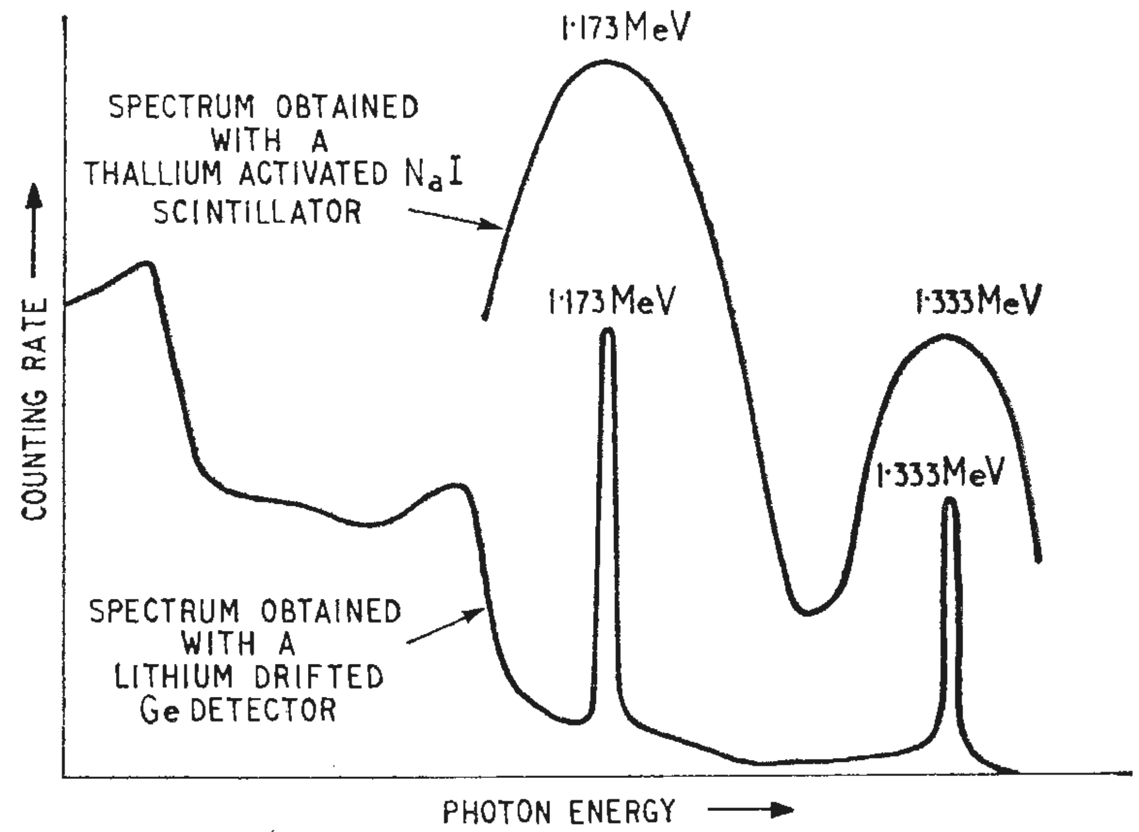


Fig. 3. Cobalt-60 γ-spectra showing resolution of lithium-drifted Ge detector compared with that of a normal spectrometer.

Lithium ions are quite mobile in a germanium lattice at room temperature and the compensated depletion region will be partly lost after the device has been at normal temperatures for a few hours. This is almost unavoidable during shipment, but the compensated region can be regenerated by bolting the device to a heat sink and applying a reverse bias of about 150V in series with a 1 kΩ current-limiting resistor. The time for which this potential should be applied depends on the length of time for which the device has been at room temperature. After one week at room temperature the reverse current should be passed for about three hours. No reconditioning should be required for detectors which have been stored at temperatures below −40°C.

Lithium-drifted germanium detectors offer very high γ-resolution, since the formation of an ion pair in this material requires an energy absorption of only 2·8 eV and the atomic number is great enough for the probability of absorption by the photoelectric effect to be appreciable. The resolution can be better than 10 keV at energies of up to about 6 MeV. The high resolution of the detector for the two γ-ray energies of cobalt-60 is shown in Fig. 3, together with the type of spectrum obtained from a typical scintillation spectrometer employing a thallium-activated sodium iodide crystal.

Neutron detection.—When neutrons pass through matter they produce very few ions, since with no charge and a high mass they do not react with electrons appreciably. Neutrons are detected by allowing them to react with certain nuclei so that ionising radiation is formed which can then be detected in the usual way.

Fast neutrons are often detected by allowing them to strike protons in a hydrogenous material. The recoiling protons are detected by the ionization they produce. Both thermal and fast neutrons can be detected by allowing them to interact with the nuclei of boron-10, when α-particles are produced, or with lithium-6, when protons are formed. Ionizing particles are also formed when uranium undergoes neutron-initiated fission.

Semiconductor detectors can easily be converted into neutron detectors by placing a thin plastic cap (which contains many hydrogen atoms) or a thin neutron conversion foil containing one of the elements mentioned in the previous paragraph in front of the windows of the detector.

Neutron spectrometers can be made by placing two matched semiconductor detectors on each side of a neutron conversion foil. The total energy of the particles formed when a neutron reacts with the foil is absorbed by the detectors and the incident neutron energy may be calculated from the output pulse size.

Other particles.—Semiconductor detectors can be employed for counting other types of ionizing particles such as protons, deuterons, tritons, fission fragments, etc. If suitable depletion depths are used, the energy spectrum of the particles may be obtained. Generally a lithium-drifted device should be used if a depletion depth exceeding 0·6 mm is required.

SPECIAL TYPES OF DETECTOR

Special types of semiconductor detector are available, but they will not be discussed in detail, since they are likely to be of interest only to the specialist. A fully depleted transmission detector may be used to measure the energy lost by a particle per cm of its path and in combination with a thicker detector provides information which often enables an unknown particle to be identified. Special types of detector are available for work on the polarization (spin) of particles formed in nuclear reactions. Another special detector, the “ nuclear triode ” provides two coincident output pulses which provide information on the energy of the particle and its position from one end of the detector.

Detectors can be designed which provide internal amplification by transistor action [8], but unfortunately this does not yield an improved signal to noise ratio. If a detector could be designed which would give an amplification similar to the gas amplification of a proportional counter, it would almost certainlv have a bright future.

A phosphor has been used in contact with a photodiode[9]. Although this system is much smaller than the conventional scintillation counter, the energy resolution is inferior owing to the noise produced by the photodiode. Nevertheless, the energy required to produce an ion pair is about 70 eV which is less than required for a conventional scintillation counter.

RADIATION DAMAGE

Gas-filled detectors are not permanently damaged by very high radiation levels, but the atoms of semiconductor detectors can be displaced in the lattice by the energy of the radiation and this results in the so-called Frenkel defects[10]. The effect of impurity atoms created under neutron bombardment may also affect the detector properties. Lithium-drifted devices are about one hundred times more sensitive to radiation damage than other types of junction detector. The latter are likely to be affected by about 10^{10} α-particles per cm^2, 10^{15} β-particles per cm^2, 10^{12} fast neutrons per cm^2 or 10^8 rad of γ-radiation. This limits the application of junction detectors in reactor instrumentation and in the van Allen belts. However, the amount of radiation damage to a semiconductor detector may be estimated from the electrical properties of the device and used as a measure of the integrated radiation dose received.

INSTRUMENTATION

Although a particle of ionizing radiation will produce more ions in a semiconductor material than in a gas filled detector, semiconductor counters lack the gas amplification which occurs in proportional and Geiger-Müller detectors. The output pulses from semiconductor detectors are therefore relatively small and low-noise pre-amplifiers are required.

Let one ion pair be formed in a semiconductor material for each w electron volts of energy absorbed. The charge of an electron is about $1{\cdot}6 \times 10^{-19}$ coulomb and therefore the charge collected at each electrode of a detector (assuming no losses) when E MeV of energy are absorbed will be:—

$$Q = \frac{10^6 E}{w} \times 1{\cdot}6 \times 10^{-19} = \frac{1{\cdot}6\ E}{w} \times 10^{-13} \text{ coulomb} \quad . \ . \ . \ (1)$$

The change in the voltage across the detector, δV, will therefore be given by the equation:—

$$\delta V = \frac{Q}{C} = \frac{1{\cdot}6\ E}{w\,C} \times 10^{-13}\ \text{V} \quad \dots\dots\dots\dots\dots\dots (2)$$

where C is the capacitance of the detector plus stray capacitance. For silicon $w = 3{\cdot}5$ eV and, if C is 50pF, V can be calculated from (2) to be 0·9 mV when a particle of 1 MeV energy is completely absorbed in the depletion region. The pulse rise time can be as small as 10 ns but when the detector is connected to its pre-amplifier, stray capacitance is likely to increase the pulse rise time to about 100 ns. A normal low-noise amplifier of the type used for proportional counting with a gain of 80 to 90 dB may be employed for simple counting.

It can be seen from (2) that the amplitude of the voltage pulse produced by a semiconductor detector is dependent on the capacitance of the device and on the associated stray capacitance. Changes in capacitance will occur when the voltage across the detector is altered to change the depletion depth, when this voltage drifts slightly or when a change in the cathode temperature of the first valve of the pre-amplifier causes an alteration of the space charge in the valve. Any of these changes will cause a semiconductor particle energy spectrometer to drift during operation if the output voltage from the device is amplified in the normal way.

Equation (1) shows that the charge collected at the electrodes of a semiconductor detector is independent of the capacity of the device. The difficulty mentioned in the previous paragraph can therefore be avoided if a charge-sensitive pre-amplifier is used which produces an output voltage pulse of an amplitude proportional to the charge fed to the input of the amplifier.

The basic circuit of a charge-sensitive pre-amplifier is shown in Fig. 4. Capacitive feedback occurs *via* C_f and the effective input capacitance therefore becomes $C_f(1 + A)$ where A is the loop gain of the system (compare with the Miller effect in a valve). If A is very large, the output voltage, V_o, is given by the equation:—

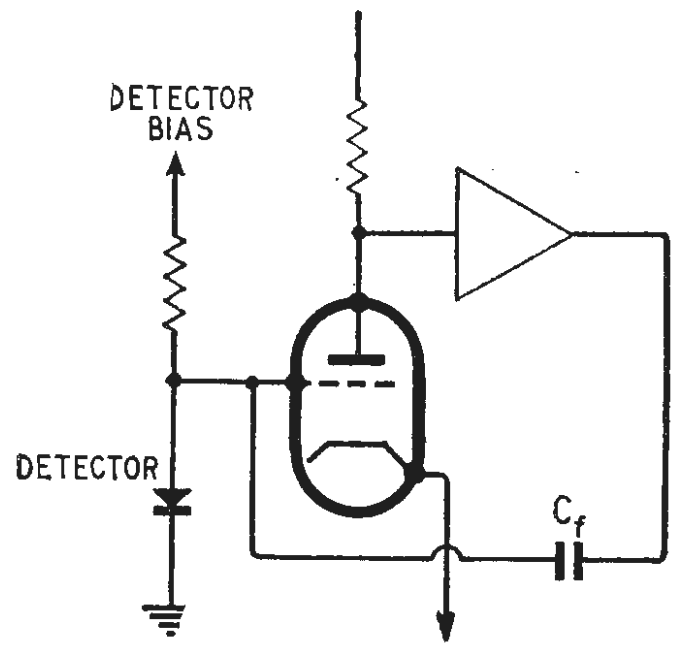


Fig. 4. Basic arrangement of a charge-sensitive pre-amplifier.

$$V_o = \frac{Q}{C_f}$$

Thus the output voltage is independent of the diode and stray input capacitance. The large effective input capacity produced by the feedback renders any change in the diode or stray input capacitance negligible.

Apart from the elimination of drift, the use of a charge-sensitive pre-amplifier for energy spectroscopy enables the effect of variations of the detector bias on the spectrum to be observed without taking into account the change in the detector capacitance. The use of a charge-sensitive preamplifier results in the same signal to noise ratio that would be obtained with a similar voltage-sensitive amplifier. The feedback capacitor, C_f, has a typical value of 5 pF, in which case the output voltage will be about 9 mV per MeV, of absorbed energy.

The complete circuit of an Elliott charge-sensitive pre-amplifier is shown in Fig. 5. A cascode input stage is employed to minimize noise while providing a high gain. The input stage is completely screened and this helps to ensure that feedback occurs only *via* C_f. If square waves of voltage V are injected into the test pulse input, charges of V/C_s (where C_s is the 2.5 pF series capacitor shown) will be injected into the first stage of the amplifier and will produce a peak in the spectrum which is useful for checking the calibration and resolution.

Other designs for charge-sensitive valve pre-amplifiers can be found in ref. 12. Valve amplifiers provide a lower noise than transistor amplifiers[13] if the detector capacitance is less than about 500 pF, since the grid current

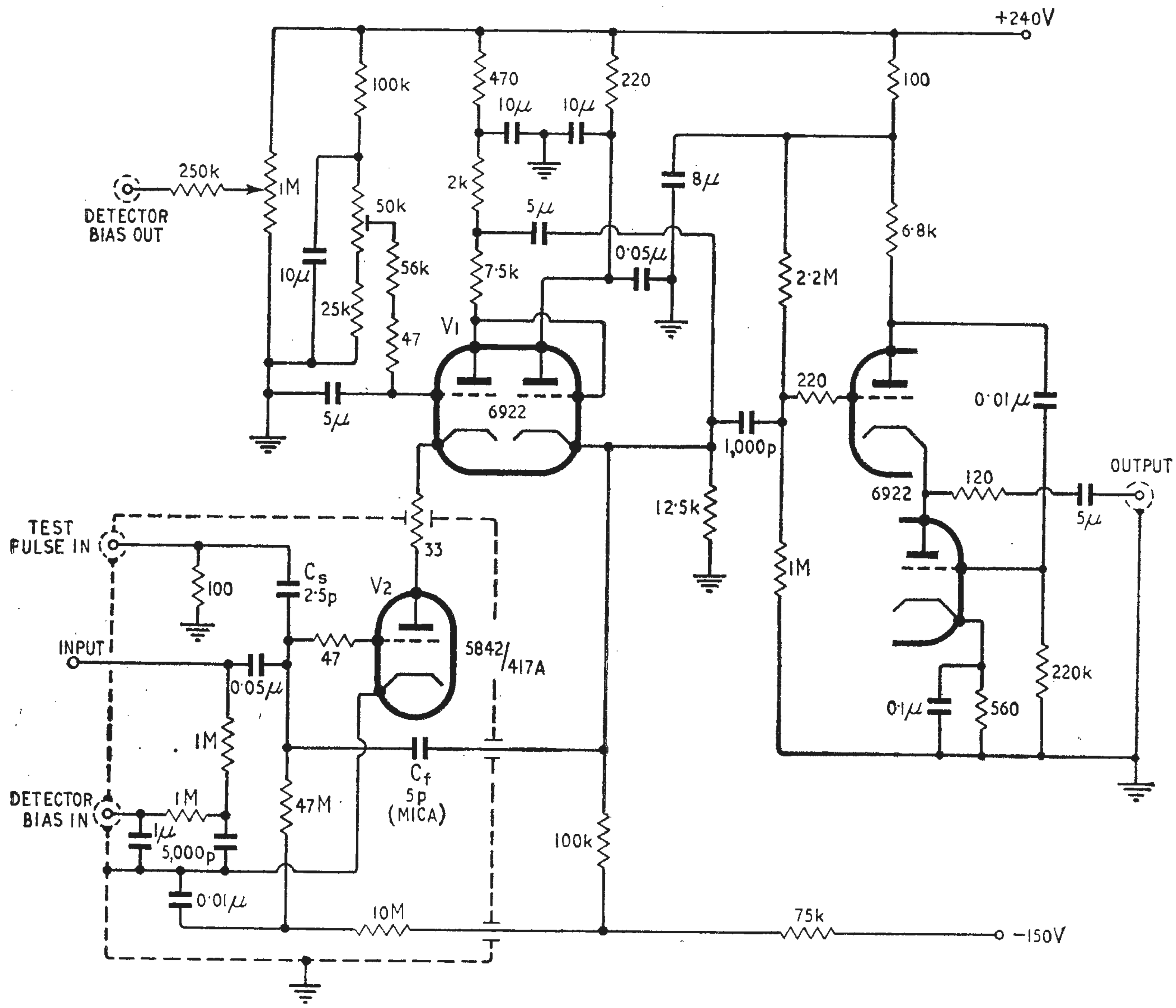


Fig. 5. A charge sensitive pre-amplifier.

of most valves is less than the base current of most transistors.

Due to the large effective input capacitance of charge-sensitive pre-amplifiers they are unsuitable for fast counting, particularly in coincidence work.

Conclusion

Semiconductor detectors have been widely used in nuclear physics laboratories, but are now commonly used elsewhere when small, lightweight and rugged detectors are required which provide a low background counting rate. They can be used for the high resolution spectroscopy of particles which do not have very low absorption coefficients in semiconductors, although they must be cooled for the best results. It seems unlikely that they will completely replace the normal Geiger-Müller tube for simple radiochemical work since they require more complicated instrumentation, and most semiconductor junction detectors are at present more expensive than common Geiger-Müller tubes.

It has only been possible to discuss some of the major points of interest in this survey of semiconductors detectors. Readers requiring further information are referred to ref. 2. Commercially available equipment is surveyed in ref. 13.

Acknowledgements—The writer is indebted to Elliott Bros. Ltd., Mullard Ltd., R.C.A. (Gt. Britain) Ltd., Simtec Ltd. of Canada, 20th Century Electronics Ltd., and to the librarians of A.E.R.E., Harwell for information they have kindly provided.

REFERENCES

1. C. G. Clayton and J. B. Whittaker. "Bulk Photoconductivity Detectors" *Nucleonics*, Vol. 21, No. 4, p.60 (April 1963).
2. G. Dearnaley and D. C. Northrop. "Semiconductor Counters for Nuclear Radiations" (E. & F. N. Spon Ltd., 1963).
3. F. S. Goulding. "Semiconductor Detectors—their Properties and Applications" *Nucleonics*, Vol. 22, No. 5, p.54 (May 1964).
4. J. P. Adams. "Field Strength Relationships for Silicon Surface Barrier Detectors" *Nucleonics*, Vol. 22, p. 112 (August 1964).
5. E. M. Pell. "Ion Drift in an N-P Junction" *J. Appl. Phys.*, Vol. 31, p. 291 (1960).
6. P. G. Salmon and F. L. Allsworth. "Silicon Surface Barrier Radiation Detectors: Some Designs and Applications" A.E.R.E. Harwell, Report R 4122 (1963).
7. A. Ghiorso, T. Sikkelande, A. E. Larsh and R. M. Latimer. "New Element, Lawrencium, At. No. 103." *Phys. Rev. Letters*, Vol. 6, p. 473 (1961).
8. R. L. Williams and P. P. Webb. "Transistor Form of Nuclear Particle Detector" *Trans. I.R.E.*, Vol. NS-8, No.1, p. 35 (1961).
9. N. G. Blamires. "Combination of a Scintillator and a Semiconductor Photo diode for Nuclear Particle Detection." *Nucl. Inst. & Methods*, Vol. 24, p. 441 (1963).
10. G. Dearnaley. "Radiation Damage Effects in Semiconductor Detectors" *Nucleonics*, Vol. 22, p. 78 (July 1964).
11. "315/S.R.D.1/& 1A Radiation Detector." Published by Elliott Bros. Ltd.
12. R. L. Chase, W. A. Higinbotham and G. L. Miller. "Amplifiers for Use with P-N Junction Radiation Detectors" *Trans. I.R.E.*, Vol. NS-8, No. 1, p. 147 (1961).
13. "Commercially Available Semiconductor Detectors and Preamplifiers" *Nucleonics*, Vol. 22, No. 5, p. 63 (May 1964).

NEWS FROM INDUSTRY

Anglo-French Collaboration

WHETHER the Concorde supersonic airliner gets off the ground or not one thing is certain, the collaboration in technical know-how since its inception has improved the bonds between the British and French industrialists, especially in the electronics field. In past months several Anglo-French links have been announced and in recent weeks two more have come to light.

Aircraft Navigational Equipment.— Ferranti Ltd. and SAGEM (Societe d'Applications Generales d'Electricite et de Mecanique), of Paris, have entered into an agreement whereby the two companies will pool their knowledge and experience in the design and development of aircraft navigation equipment. This agreement has already borne fruit in the award of a contract to Ferranti for an attitude reference system and ground test equipment for the European Satellite Launch Vehicle (Eldo). The gyroscopes and accelerometers for the system will be made by SAGEM. In addition, Sud Aviation (joint constructor with the British Aircraft Corporation of the Concorde), have decided to equip the Concorde with an inertial navigation system developed and manufactured jointly by SAGEM and Ferranti.

Computers. — The two British giants English-Electric-Leo-Marconi Computers and International Computers & Tabulators have put forward a proposal for a joint Anglo-French project for a large computer to the Minister of Technology, Mr. Frank Cousins. A proposal for an identical project has been submitted to the French Government by CITEC (Compagnie pour l'Informatique et les Techniques Electroniques de Contrôle). CITEC is a jointly owned subsidiary company of C.S.F. (Compagnie Generale de Telegraphie sans Fil) and C.G.E. (Compagnie Generale d'Electricite). It was formed last year to develop and produce industrial, scientific and military computers.

The companies concerned have made it clear that without Government support, the proposals will never see the light of day.

Another plan under discussion is the formation of a European consortium including I.C.T. and E.E.L.M. from Britain, CITEC from France, Telefunken from Germany and Ericsson from Sweden.

Plessey Automation Group.—Following the major reorganization of Plessey, which came into effect on 1st July this year, the company's automation group is to be located at Poole in Dorset. The automation group will eventually comprise four divisions covering the principal activities of data handling, data processing, traffic management and automation accessories. Mr. H. E. C. Nash who joined Plessey as a consultant last January from Elliott-Automation is the group's director.

Bristol to Exeter Microwave Phone Link.—Standard Telephones and Cables Ltd. have received a contract from the Post Office for an extension to the London-West Country radio network being installed by them. The links between London and Bristol and between Bristol and Cardiff are under construction and next year work will begin on the Bristol-Plymouth-Goonhilly leg, of which the new Bristol-Exeter project forms a part. Two r.f. channels will be used (using the aerials already planned) for the extension.

Microwave Associates Ltd., of Luton, have received a contract from the B.B.C. that calls for portable solid state television link equipment operating in the 7 Gc/s band. This equipment is to be used by the B.B.C. for outside broadcast purposes. Either monochrome or colour signals can be transmitted. Microwave Associates have also received contracts from the B.B.C. for point-to-point links and for special ultra light-weight battery operated survey and path test equipment.

Cossor Electronics Ltd. have formed a marine division to market the wide range of marine products manufactured within the Raytheon organization, of which Cossor is a subsidiary. From 1st October, the new division will operate from Shelley House, Noble Street, London, E.C.2. Included in the present range of products are Cossor v.h.f. transceivers, Raytheon 3 and 10 cm radars and Loran navigational equipment. Mr. S. D. Coode-Bate is divisional manager.

H.C.D. Research Ltd. established four years ago to make precision crystal oscillators, frequency standards and associated equipment, recently formed a subsidiary company to handle their growing semiconductor business. The new company, called Semikron Rectifiers and Electronics Ltd., operates from the parent's headquarters at 77 Gloucester Road, Croydon, Surrey (Tel.: THOrnton Heath 7485). Last month we made reference to the new company Semikron, but inadvertently transposed the names of the parent and subsidiary. We apologise for any misunderstanding that may have arisen.

Abbey Electronics and Automation Ltd., have, through the acquisition of a new 5,000 sq ft factory, doubled the size of their manufacturing premises at Delamare Road, Cheshunt, Herts. (Tel.: Waltham Cross 25106.)

English Electric's £200,000 computer centre at Huyton, Lancs., was formally opened on 16th July by the Prime Minister, the Rt. Hon. Harold Wilson.

Mullard Applications.—The applications staff of the Mullard Research Laboratories, Redhill, Surrey, have been moved to the company's Central Application Laboratory, New Road, Mitcham, Surrey. (Tel.: Mitcham 3471, Telex 23709.)

Plessey Radar Ltd. are supplying, under a contract worth £40,000, three air traffic control radar installations to the Bulgarian Government. They will be located at Sofia, Varna and Burgas and will provide air surveillance for civil aviation over Bulgaria.

Tektronix U.K. Ltd. have, since the 1st July this year, been operating a repair centre for the maintenance and recalibration of their oscilloscopes and ancillary instruments. Information on this service can be obtained from the field support department, Beaverton House, Harpenden, Herts. (Tel.: Harpenden 61251, Telex 25559.)

The British Radio Corporation, who now market HMV, Marconiphone and Ultra radio and television sets, are moving to 284 Southbury Road, Enfield, Middx. (Tel.: HOWard 2477.) Ultra's former premises at Eastcote, Middx., and the headquarters of the sales division of His Master's Voice and Marconiphone at Cavendish Place, London, W.1, are being vacated.

Texas Instruments have acquired a 6,000 sq ft warehouse and office site at 12 Wellcroft Road, Slough, Bucks. (Tel.: Slough 28578, Telex 84363.) From this address the company's supplies division will operate a same-day service for the supply of small orders for T.I. devices.

C. & N. (Electrical) Ltd., of The Green, Gosport, Hants., offer industry and research an enquiry service in the field of sequential control, data processing and logic circuitry. (Tel.: Gosport 80221, Telex 8621.)

Control Logic of Boston, U.S.A., who manufacture a wide range of digital logic circuit modules, are to have their products marketed in the United Kingdom and Western Europe by Electro Mechanisms Ltd., of 218-221 Bedford Avenue, Slough, Bucks. (Tel.: Slough 27242.)

Mial S.P.A., of Milan, manufacturers of capacitors, have appointed Waycom Ltd., of Capacity House, Rothsay Street, Tower Bridge Road, London, S.E.1, (Tel.: HOP 2615) sole U.K. distributors.

U.K. Solenoid Ltd.—Since the formation of Chilton-Solenoid (U.K.) Ltd. three years ago, there has been some confusion owing to the similarity in name with Chilton Electric Products Ltd., both of Hungerford, Berks. In future, the former company is to trade under the name U.K. Solenoid Ltd.

Pye H.D.T. Ltd.—To form one body within the Pye organization to look after their closed circuit television interests, the industrial division of Pye Telecommunications Ltd. has been combined with the original Pye H.D.T. Company. The initials stand for High Definition Television.

Experimental Thyristor Control Circuits

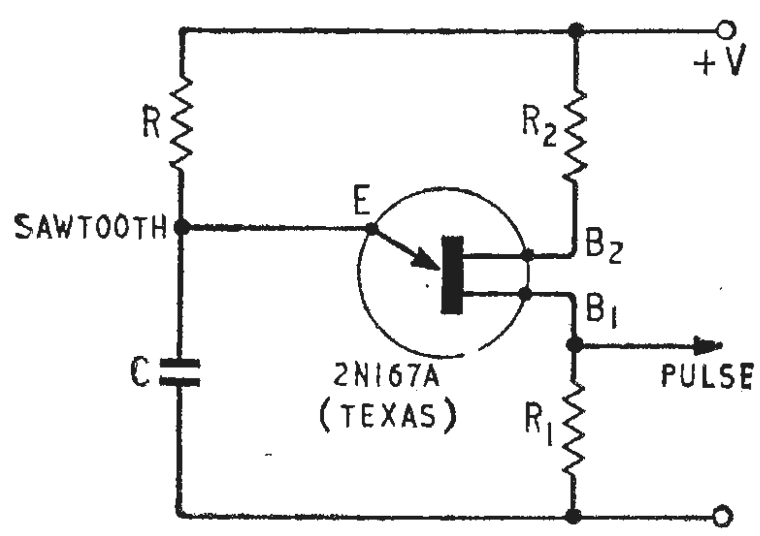
By N. M. MORRIS,* B.Sc., A.M.I.E.E., A.M.I.E.R.E.

Conclusion of a two-part article presenting a range of thyristor control circuits for use by students and experimenters. The article starts with pulse circuits using unijunction transistors and Shockley diodes then goes on to applications of the control circuits in closed-loop regulators.

UNIJUNCTION TRANSISTOR

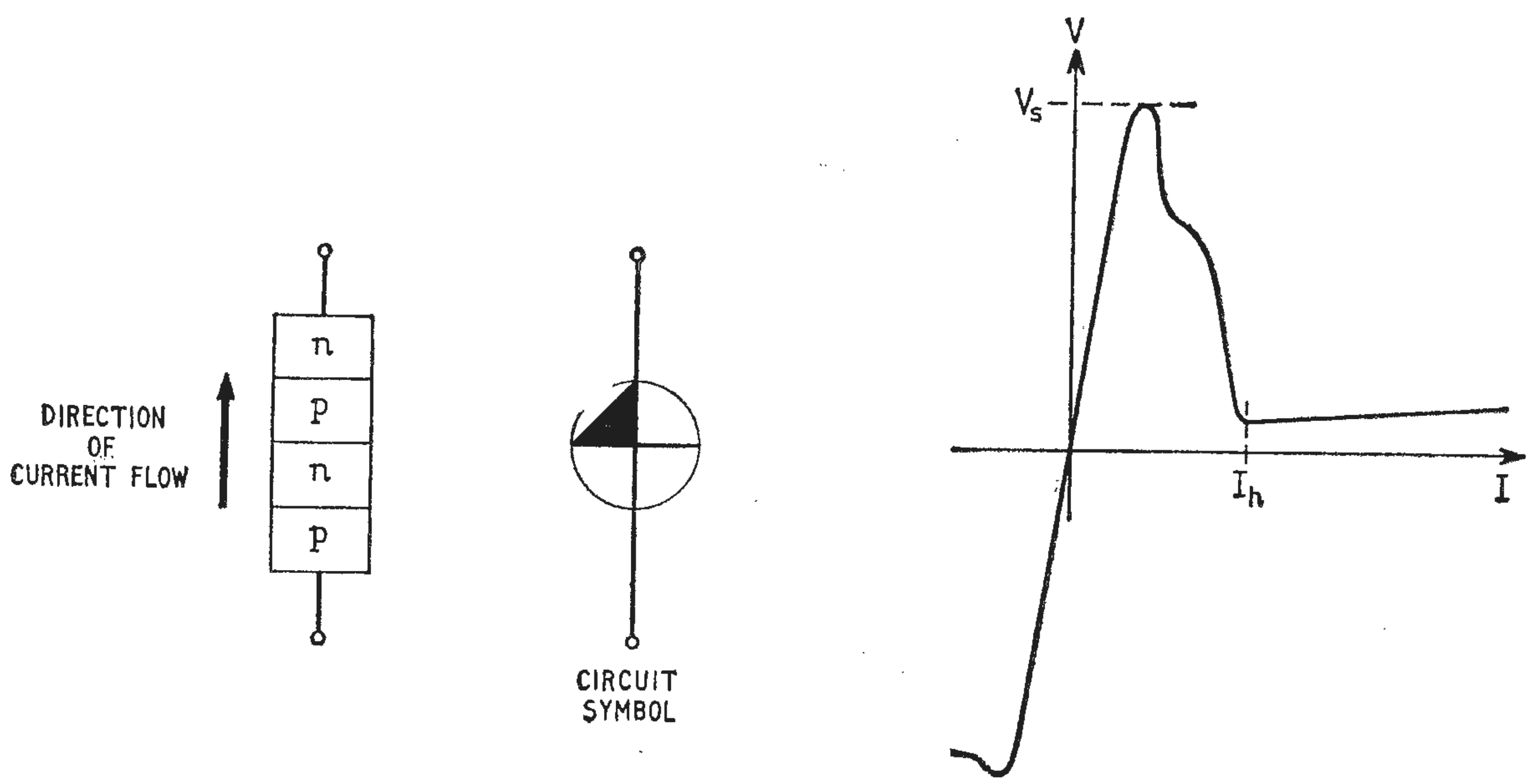
THE unijunction transistor is a convenient device for pulse generation in thyristor circuits. The device comprises a bar of n-type material with two ohmic contacts and one p-n junction. The two ohmic contacts are known as base-one (B_1) and base-two (B_2) respectively and the p-type material is known as the emitter (E). The circuit employed to produce pulses is shown. While the p-n junction is reverse-biased the voltage across the capacitor rises exponentially, giving a sawtooth waveform at the emitter. When the capacitor voltage reaches a value known as the peak-point voltage, the p-n junction becomes forward-biased and the capacitor discharges through R_1. This R_1 has a low value, resulting in a pulse output; after the capacitor has discharged the p-n junction returns to a blocking state and it is again possible to charge the capacitor. A pulse of 10 to 20 microseconds duration at an amplitude of about 5 volts is produced and the pulse repetition rate is about 0.8 RC seconds. The actual values depend on the unijunction transistor and components used. Typical values with a 2N1671A (Texas Instruments) unijunction transistor are: V, 22 volts; C, 0.1 μF; R, 10 to 100 kΩ; R_1, 22 Ω; R_2, 100 Ω (required to give temperature stability).

*North Staffordshire College of Technology.



The pulse repetition rate is controlled by the methods outlined for the two-transistor pulse generator circuit above, i.e. by shunt or series control of capacitor charging current. Small modifications to the values of circuit components are necessary, but the principle is unchanged. The output pulse may be connected directly to the gate of the thyristor or through an RC network as shown above. The unijunction circuit may be used directly to replace the two-transistor pulse generator section of the pre-amplifier described last month, p. 399, by connecting the unijunction emitter to the point marked A.

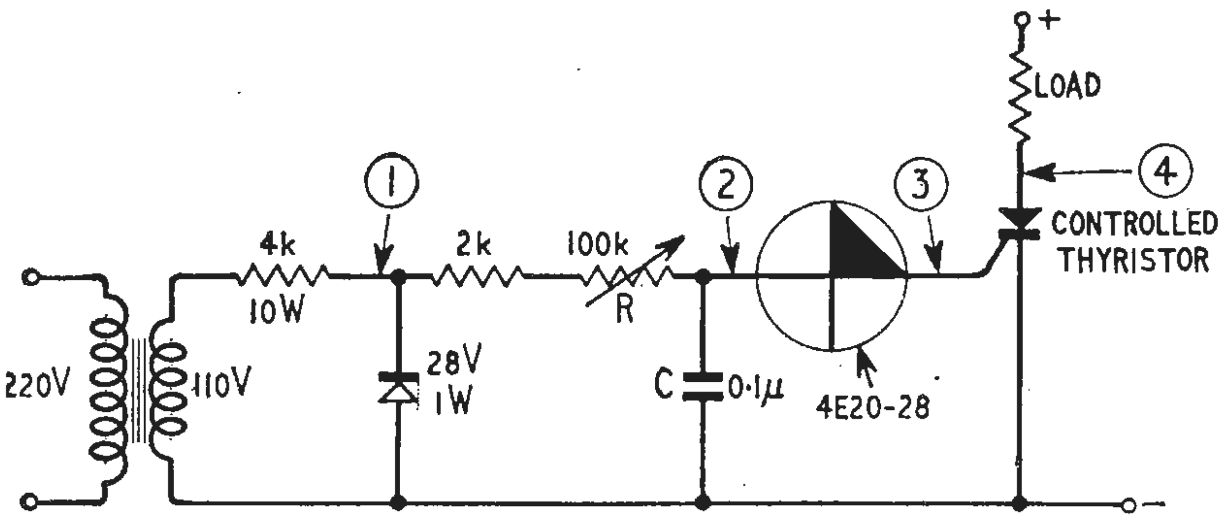
FOUR-LAYER (SHOCKLEY) DIODES

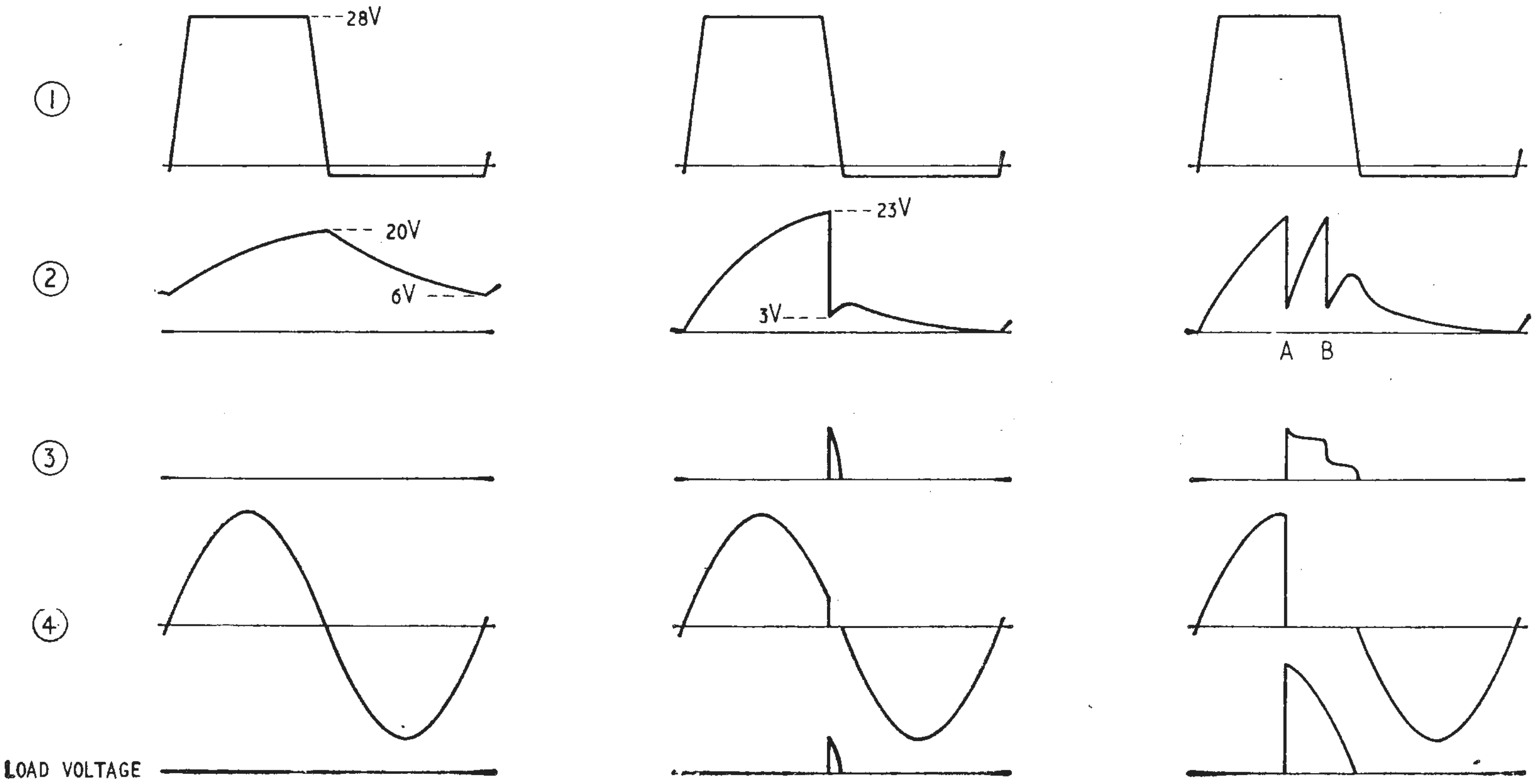


THE Shockley diode is a p-n-p-n device which is triggered from a forward blocking state to a conducting condition when the voltage across it exceeds the switching voltage, shown here as V_s (I_h is holding current). The current at the switching voltage is typically a few hundred microamperes. In the conducting state the dynamic resistance is a few ohms and the device can deliver a peak current of the order of one ampere for about ten microseconds.

GATE CONTROL CIRCUIT USING A SHOCKLEY DIODE

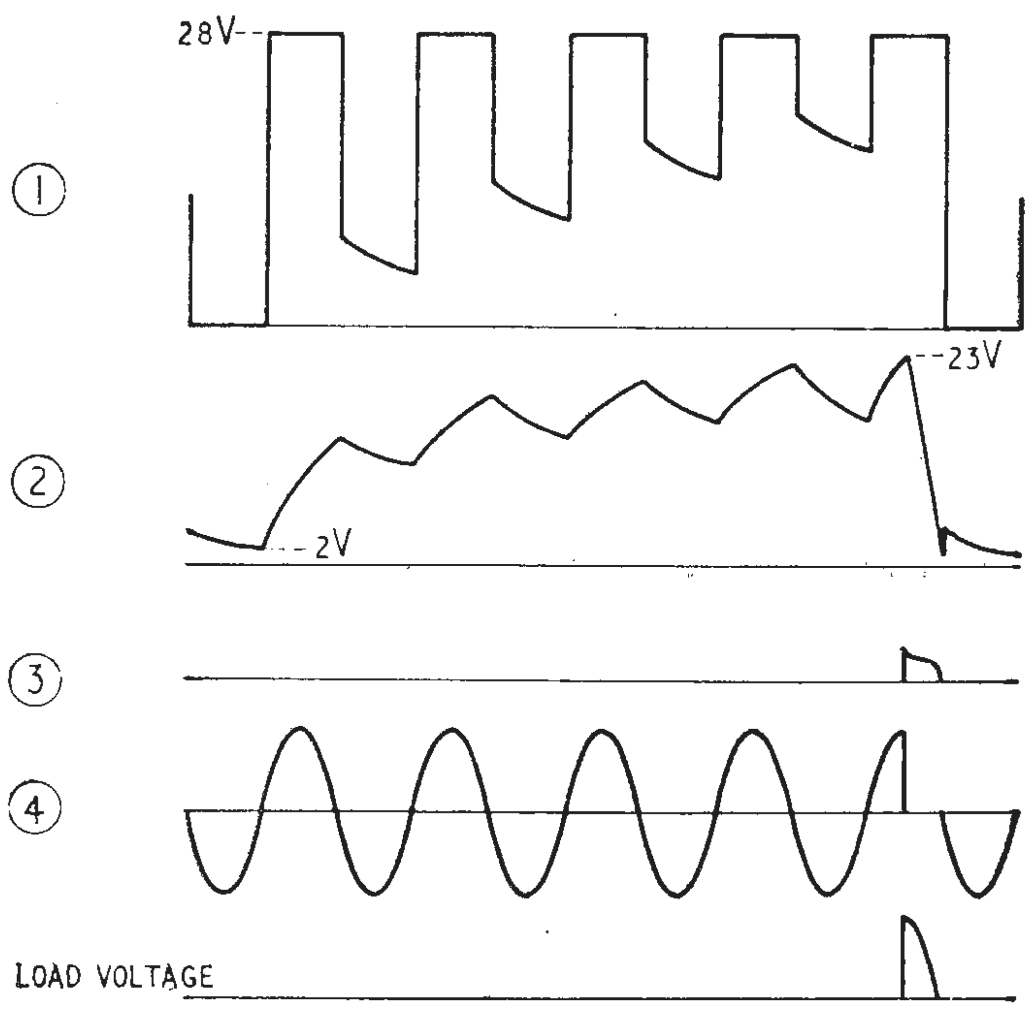
THE gate control circuit shown here is fed from a Zener diode limiting circuit providing a clipped positive voltage of 28 V, which is in excess of diode switching voltage. A suitable diode is the Brush-Clevite Type 4E20-28. The negative voltage applied to the circuit is limited to about $1\frac{1}{2}$ V. If the charging time-constant RC is very large, the peak voltage across the capacitor in the positive half-cycle may not be sufficient to break down the diode. Relevant voltage waveform for one such value of RC is shown on the left-hand column of waveform diagrams. Reduction of R to about 70 kΩ results in stable firing in the last 10° of each positive half-cycle; waveforms for this condition are shown in the middle column. Further reduction in R results in earlier firing at A (righthand column) giving an increased voltage across the load. At this point the capacitor voltage suddenly falls to a value which cannot sustain the diode holding current and the device reverts to a blocking state. This allows the capacitor voltage to build up again in the positive half-cycle, switching the diode on again at B. By adjustment of R it is possible to control the thyristor conduction over practically the whole of the positive half-cycle.



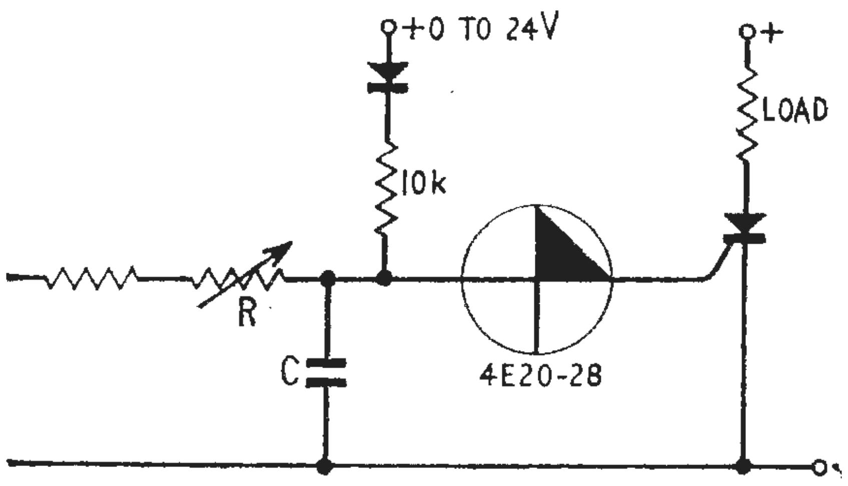


TIME-DELAYED FIRING USING A SHOCKLEY DIODE

THE introduction of a diode between the transformer and the 4 kΩ resistor in the previous gate control circuit allows firing to be delayed. Without the diode in circuit the capacitor can discharge through R and the Zener diode in the negative half-cycle of the supply voltage. With the diode in circuit the leakage resistance is very high and the voltage across the capacitor is retained. If the charging time-constant is large, the thyristor is not switched on in the first positive half-cycle and the potential across the capacitor stays substantially at this value during the negative half-cycle. In succeeding half-cycles the capacitor voltage is "pumped up" until it reaches the switching voltage of the Shockley diode, when the capacitor is discharged and the thyristor is turned on. Reduction of R reduces the time taken to reach the switching voltage, the maximum value of R being set by the condition that the charge and discharge time constants are nearly the same. Waveforms for this mode of operation are shown here.



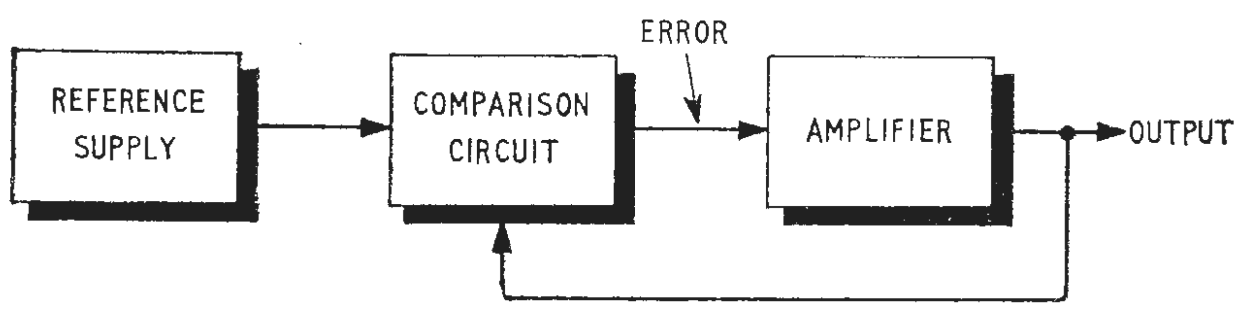
CONTROL OF SHOCKLEY CIRCUIT USING A VOLTAGE INPUT



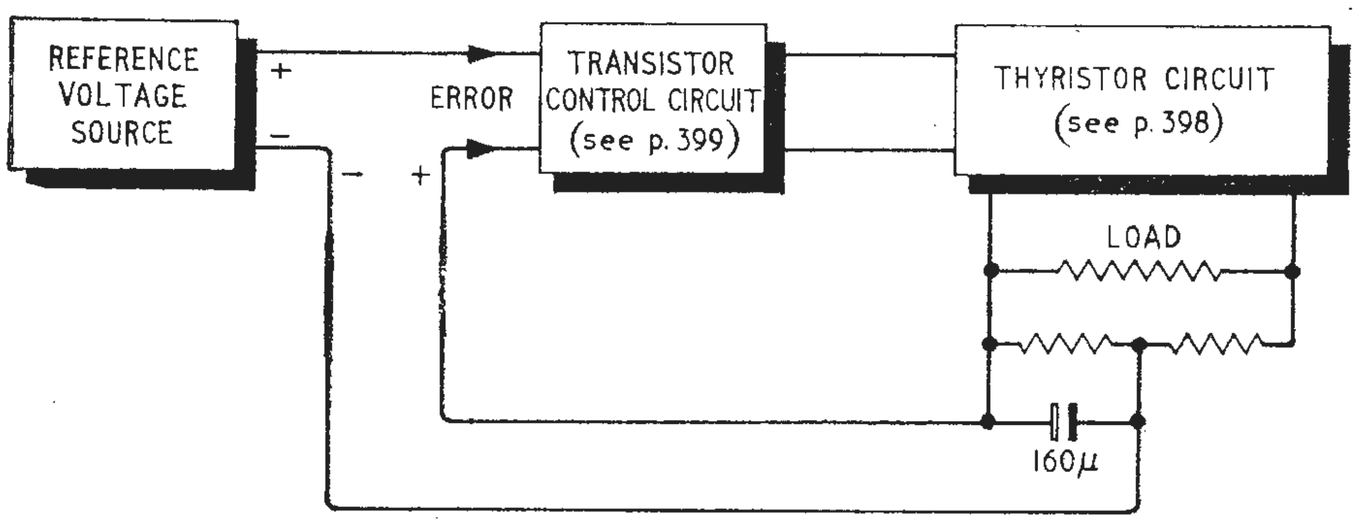
IF the gate control circuit is modified as shown here, the additional potential allows the Shockley diode switching voltage to be reached earlier. Time delayed firing again is obtained by the insertion of a diode in the 110-V supply. Variable resistor R is adjusted to the point where the thyristor just fires. Increasing the externally applied voltage from 0 to 20 V gives full control of firing pulses over the whole positive half-cycle. The external control voltage can conveniently be obtained from the d.c. amplifier given last month (bottom of p. 399).

APPLICATION TO CLOSED-LOOP REGULATORS

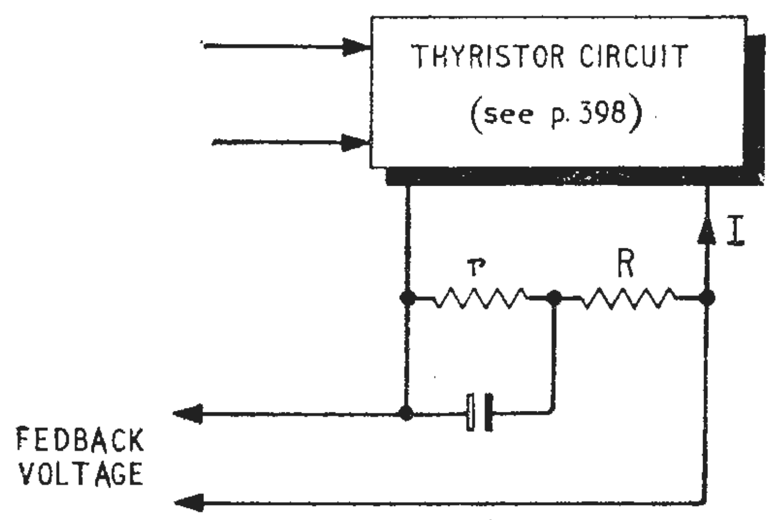
THE basic requirements of a closed-loop regulating system are shown at (a). The output, or a signal proportional to it, is compared with a reference voltage and the difference between the two (the error) is amplified to give the output. The higher the gain the lower the error, the limit of gain being set by overall stability, which is dictated by the time lags present in the regulator. A simple voltage regulator is shown at (b). The reference voltage circuit is given next in this article; the transistor control circuit given on p. 399 last month (pre-amplifier); and the thyristor circuit was given on p. 398 last month ("Full wave power control"). The only time lag of any significance in the system is the RC smoothing network in the voltage signal feedback path. Since there is only one lag involved, the regulator is inherently stable and the amplifier gain may be increased to its maximum value. By feeding back the voltage developed across a low resistor *r*, as shown in (c), the current in the load resistor R can be maintained constant. For accurate control *r* should be as small as possible, consistent with the fact that the potential developed across it should be much greater than the allowable error.



(a)



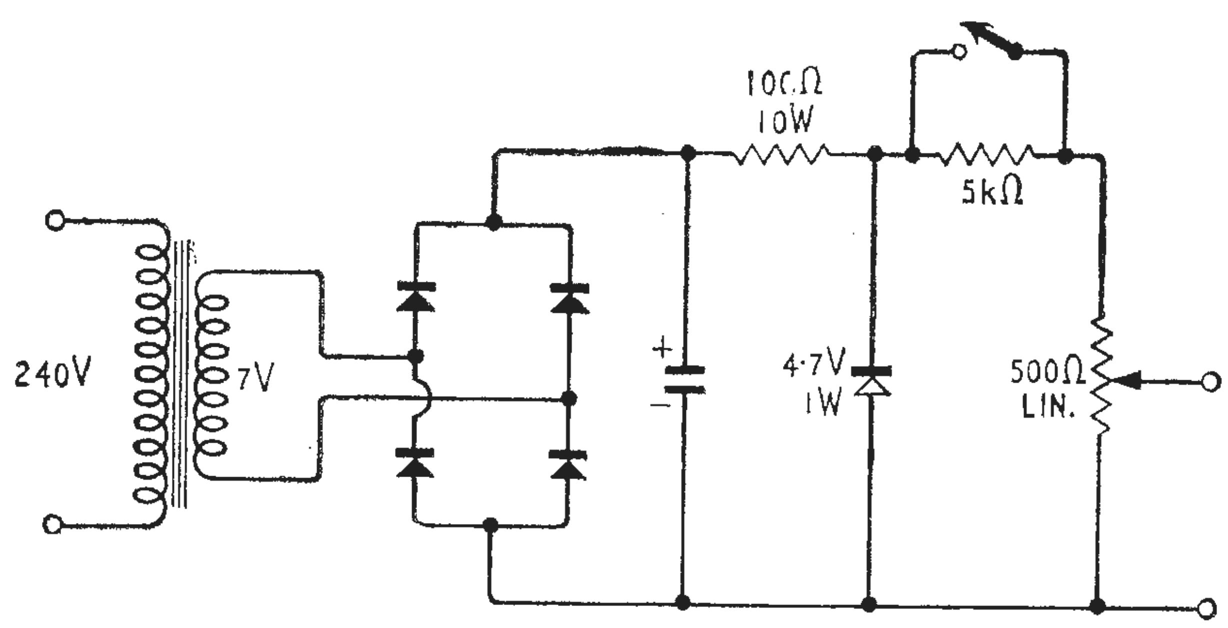
(b)



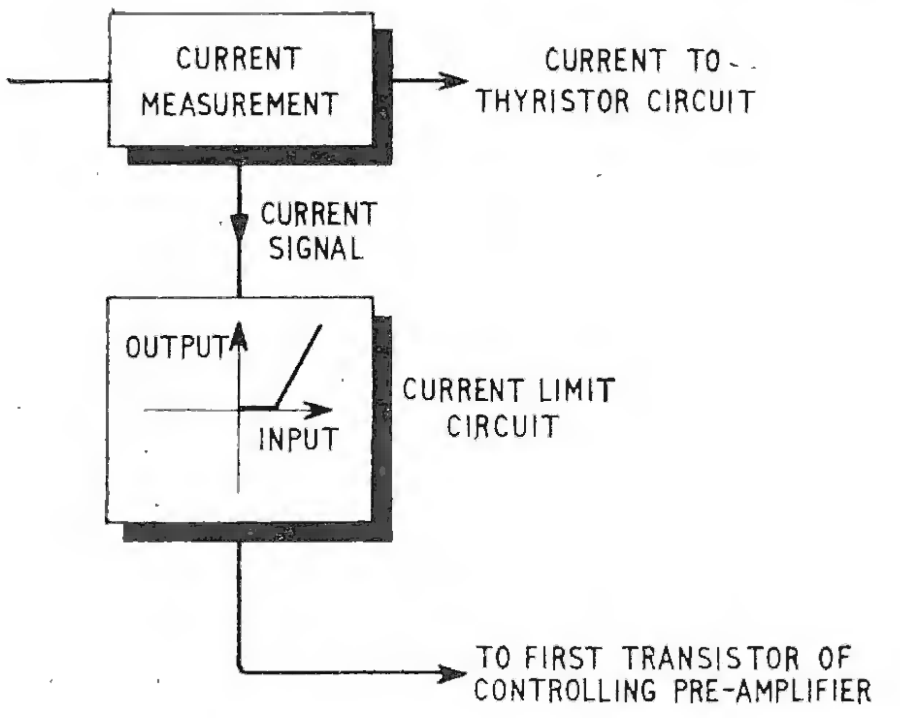
(c)

REFERENCE VOLTAGE SOURCE

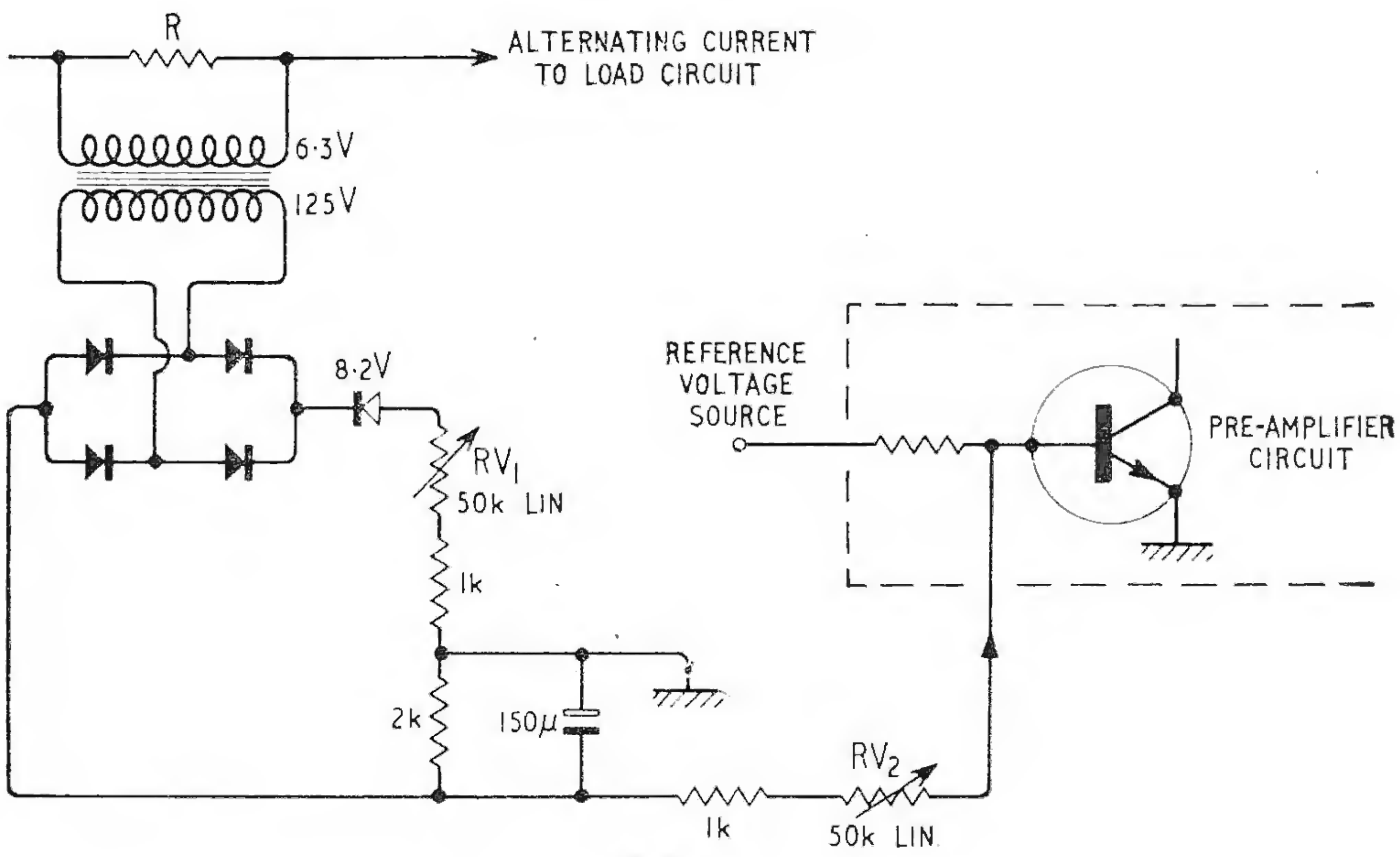
THE reference voltage source in a closed-loop control system can conveniently be obtained from a single-phase, full-wave rectifier with capacitor smoothing, followed by a Zener diode to stabilize the voltage across the reference potentiometer. If the output of the accompanying circuit is connected directly to the input of the pre-amplifier above the 5 kΩ resistor must be connected into the circuit to limit the maximum excursion of the reference voltage. When it is used in a feedback regulator circuit to be described later the 5 kΩ resistor is short-circuited.



CURRENT LIMITATION IN THYRISTOR CIRCUITS



(a)



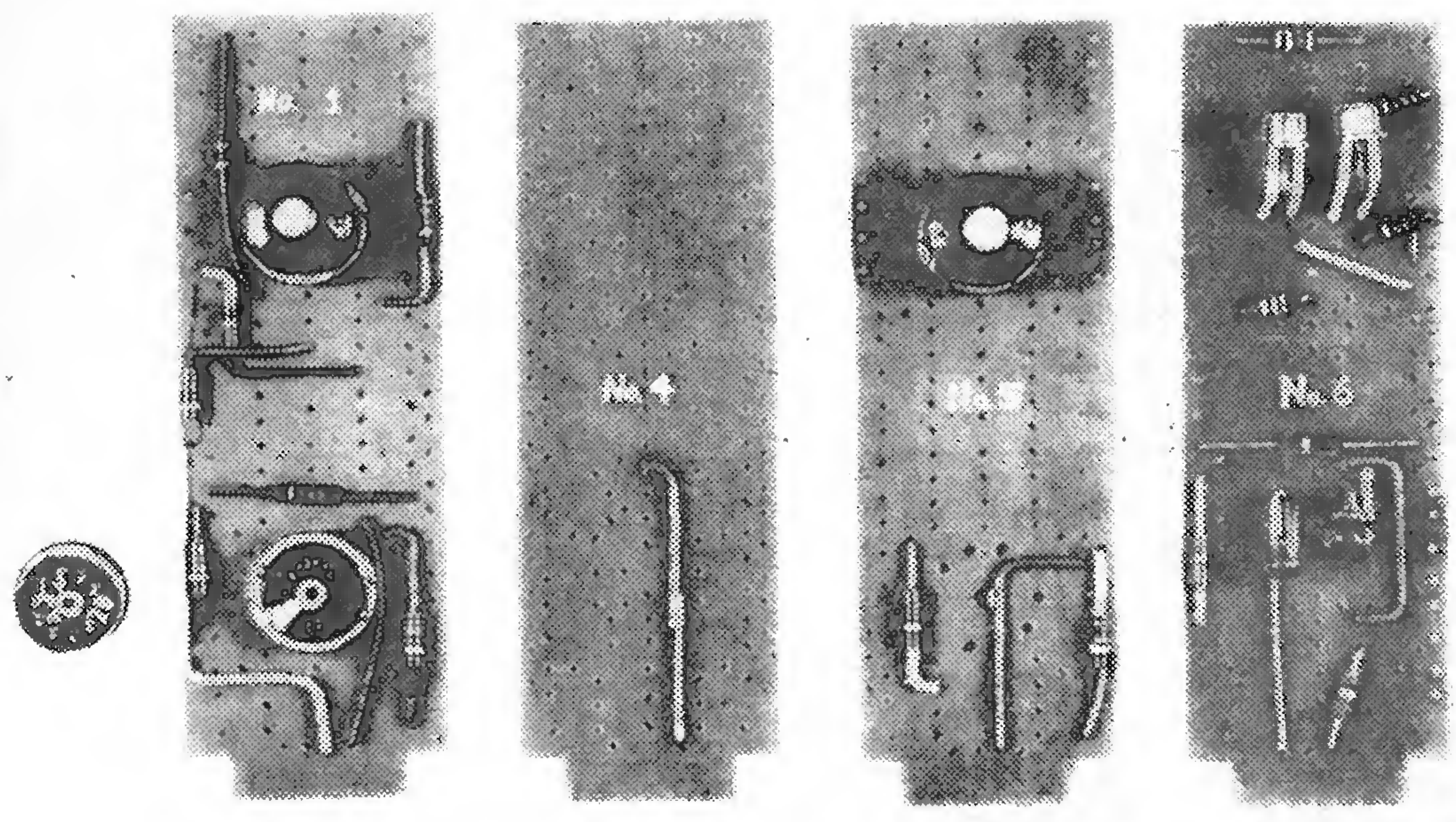
(b)

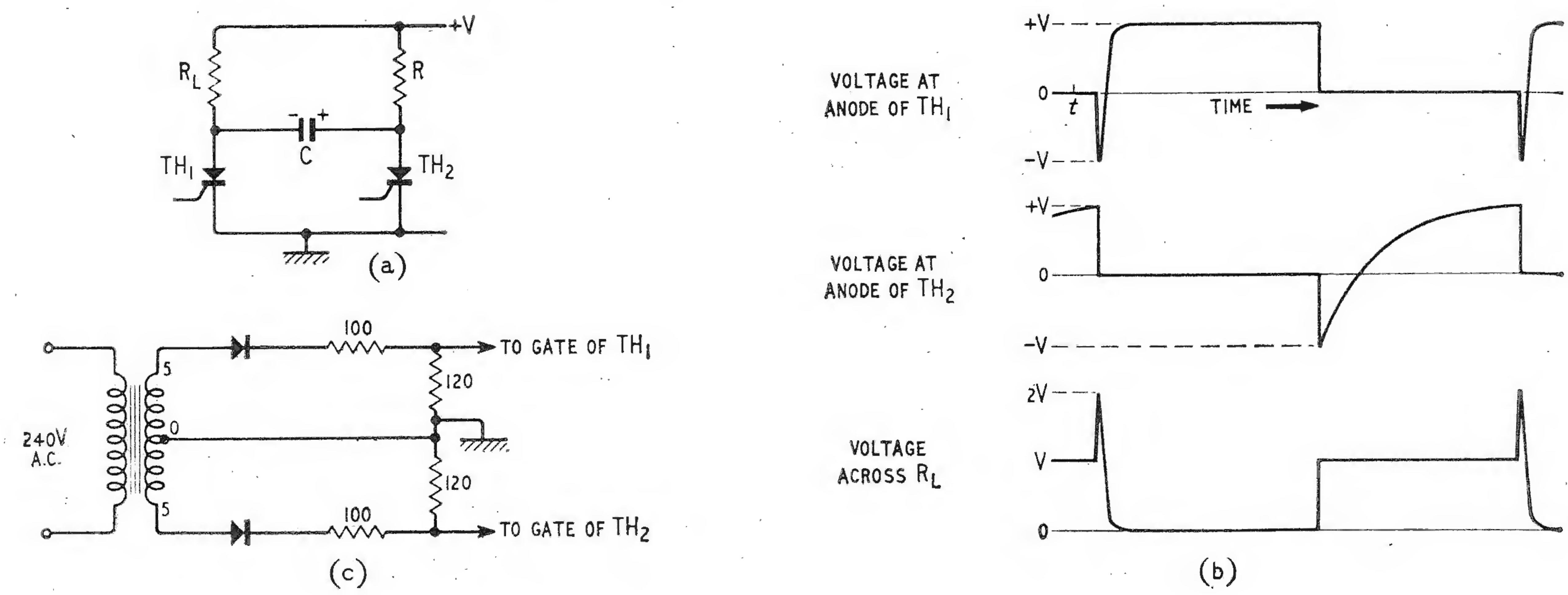
IN order to keep the average dissipation in the thyristor within specified values, even in experimental circuits, it is desirable to provide some method of current limitation. The basic principles are shown here at (a). The current is measured and a signal proportional to it is fed into a circuit which gives zero output for a given range of input signals; beyond this point the output increases with input. The knee of the characteristic is arranged to coincide with the current limit setting. The output of this circuit is applied as negative feedback to input of the controlling pre-amplifier (p. 399 last month), so reducing the overall gain of the regulator. This has the effect of reducing the pulse repetition rate to the thyristor; hence the load current falls to the required value. It is generally convenient to measure the load current on the a.c. side of the supply by inserting a resistor in series with the load current (b). The r.m.s. voltage across this resistor, R, should be about 1½ V at the value of current to be limited. A heater transformer has been found suitable for this application, the non-linear characteristic being obtained by the Zener diode—resistance network. For minimum current limiting effect RV_1 and RV_2 should be set at their maximum values. If they are reduced to zero the current in the thyristor circuit is limited to a very low value.

CONSTRUCTION OF EXPERIMENTAL CIRCUITS

THE circuits outlined in this article have been used by the author in conjunction with thyristors with ratings between 4 A, 25 p.i.v. and 10 A, 400 p.i.v. Many other methods of control are available including electromagnetic methods, blocking oscillators and Schmitt circuits, and references to the design of these are given on page 454.[2] [3] [4]

For convenience of storage and interconnection of circuits, printed circuit boards were used. A selection of these is shown in the photographs. No. 1 (left) is the two-transistor pulse generator; No. 4 (second from left) is the Shockley diode; No. 5 (third from left) is the unijunction transistor circuit; and No. 6 is a circuit comprising the first two sections of the controlling pre-amplifier. The transistor and Unijunction transistor pulse generator circuits were built up using boards with valve bases on them for convenience of removal of transistors for other experiments. One transistor is shown removed from its holder.





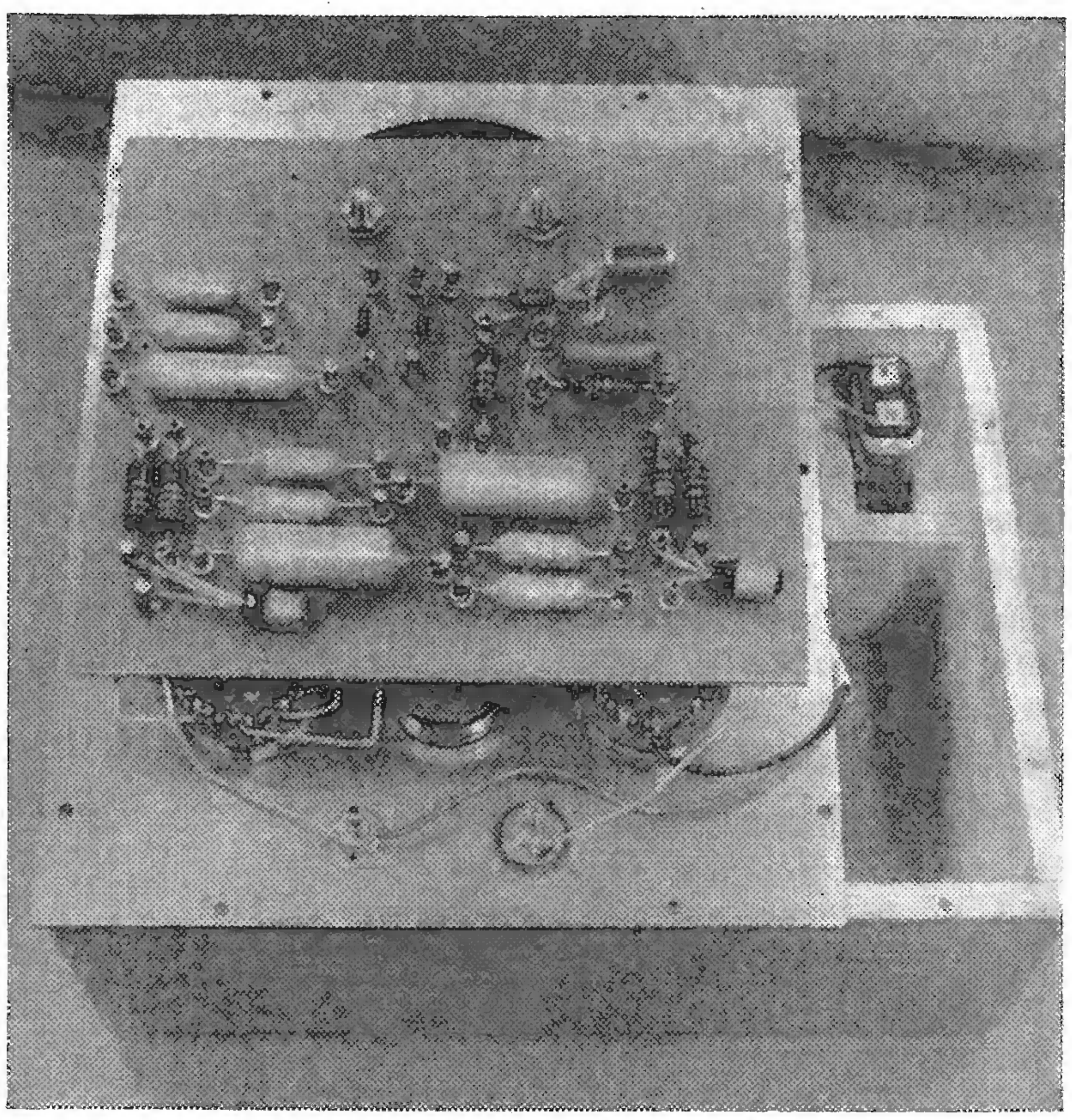
TO switch off a direct current it is necessary to reduce the thyristor current to a value below its holding value so that it can assume its blocking state. Various methods have been devised to do this, most of them involving charging or discharging a capacitor, since it may be regarded as a load or source of practically zero resistance at the time of switching. One simple circuit is shown here at (a).

Suppose TH_1 is conducting at time *t* as shown in (b). The polarity of the potential across the capacitor is shown in (a); if TH_2 is switched on a little later, the positive terminal of the capacitor is connected to earth, making the anode of TH_1 instantaneously $-V$ volts relative to earth. This thyristor is now reverse biased, and provided forward current does not flow for a time equal to the turn-off time of the device (typically 25 μs), the thyristor will assume its forward blocking condition. With most commercially available thyristors this condition can be satisfied if the product R_LC is greater than 30, where C is in microfarads. To switch the load current on, a signal is applied to the gate of TH_1 which turns TH_2 off by the process outlined above. Resistance R does not have any effect on the switch-off of load current, but the minimum time between switching operations is set by the time taken for the capacitor to charge up to *V* volts. Resistance R can be selected on the basis that the minimum time between switching operations should be greater than 5RC seconds, where C is in farads. In diagram (a), $V=30$ volts, $R_L=15\Omega$, $R=660\Omega$, $C=3\,\mu$F. In practical cases the load usually has some inductance and it is necessary to shunt R_L with a diode to allow the load current to decay slowly when the thyristor is turned off.

To allow inspection of the switching waveforms on a c.r.o. the two thyristors must be switched alternately. A simple circuit to perform this operation is shown at (c).

REFERENCES

1. "Firing Requirements for Silicon Controlled Rectifiers," by T. J. Jarratt. *Mullard Technical Communications*, Vol. 6, No. 55, March 1962.
2. "Transistorized SCR Firing Circuits," by T. J. Jarratt. *Mullard Technical Communications*, Vol. 7, No. 65, June 1963.
3. "Simple Electromagnetic Methods of Pulse Generation," by R. F. Burbridge and M. James. *Proc. I.E.E.*, Vol. 112, No. 2, February 1965.
4. "Silicon Controlled Rectifier Manual." General Electric Co. of New York.
5. "Controlled Rectifiers in Stabilized Power Supplies," by F. Butler. *Wireless World*, October 1963.



First prize *in the Junior Section of the annual Constructors' Competition organized by the Welwyn Garden City Group of the R.S.G.B. was won by Trevor Baker, aged 16, with this version of the capacitance meter described in* Wireless World *in April 1964. He used Formica bonded to the non-copper side of a piece of printed-circuit board for the front panel; the copper being connected to the low-potential terminal to provide a hand-capacitance screen. Trevor Baker planned and produced a printed circuit board on which to mount the components.*

Electronic Laboratory Instrument Practice

9.–AUDIO AMPLIFIER MEASUREMENTS

By T. D. TOWERS,* M.B.E., A.M.I.E.E., A.M.I.E.R.E.

UNDER the impact of British Standard 3860 : 1965 and the recommendations of the American Institute of High Fidelity Manufacturers (I.H.F.M.), audio amplifier measurements now begin to follow a common pattern. Where American and British practice differ, the British standard is followed in this article.

Output power

The measurement—like the design—of an audio amplifier must start with the output end. The first consideration is "*rated output power*," i.e. the power the manufacturer or designer claims can be delivered continuously by the amplifier to a stated load resistance at 1 kc/s without the harmonic distortion rising above a specified limit. Typical distortion limits are 10% for "entertainment" applications, 1% for average high-fidelity and 0.1% for very high fidelity. To verify the rated output of an amplifier a 1 kc/s sinewave is fed through it at a level sufficient to produce the rated output power in a non-inductive load as specified by the manufacturer, and, after not less than 30 seconds, the harmonic distortion is measured by one of the methods described later in this article.

Another output characteristic of the amplifier, not to be confused with the rated output power, is the "*maximum output power*." This is the power output at 1 kc/s that can be obtained when the level is raised until the output total harmonic distortion equals the limit used by the manufacturer for specifying the rated output power. Naturally the maximum should not be less than the rated power.

In the U.S.A., the term "continuous output power" is used synonymously with the British "maximum output power" to describe the greatest single-frequency power that can be obtained from an amplifier for not less than 30 seconds without exceeding its rated total harmonic distortion. Other terms formerly used for the same concept have been "sine-wave power," "r.m.s. power" or "steady state power."

Manufacturers have always tried to find more valid (or more customer-attractive?) methods of rating the power available from an amplifier than the continuous output power. The British Standard does not recognize these, but American practice is sometimes to specify a "music power output." This is the greatest single-frequency power that can be obtained from an amplifier without exceeding its rated distortion where the measurement is made immediately after the sudden application of a signal and during a time interval so short that supply voltages within the amplifier have not changed from their no-signal values.

Another concept sometimes used (and beloved of advertising staff!) is the "peak power" rating. This can be taken as twice the corresponding single-frequency rating. For example, by the specific term "peak power rating" is usually meant twice the rated output power defined earlier; similarly the "peak music power output" is twice the "music power output."

As described in the last article (No. 8) of this series, the output power can be measured on an audio power meter or calculated from the r.m.s. voltage across the load resistance. In the latter case, a true r.m.s. reading meter should be used, and it is prudent to inspect the output waveshape with an oscilloscope to ensure that it is reasonably sinusoidal.

On the load resistance, the British Standard merely provides that it should not vary from its nominal value by more than 5% while dissipating any power up to the amplifier rating. The American I.H.F.M. recommends that it should be capable of dissipating the full output of the amplifier while maintaining its resistance within 1% of the rated value, but also that it will not have more than 10% reactive component at any frequency up to 5 times the highest test frequency.

The 1 kc/s input test signal to the amplifier should be sinusoidal and accurate in frequency to ±2%. It should be low distortion relative to the amplifier distortion being measured, the B.S.I. recommendation being that the r.m.s. total of all components other than the fundamental should not be more than 1/5th of the expected harmonic distortion in the amplifier. This need for a pure test signal is sometimes overlooked, particularly in measuring high-quality, low-distortion amplifiers. I have known cases of apparently high amplifier distortion traced back to the generator. Conversely, I have known of high-distortion amplifiers measuring low because the generator and amplifier distortions balanced each other out.

In discussing output power we have tacitly assumed we are dealing with power amplifiers. For pre-amplifiers we are concerned with rated and maximum output voltages, but the same principles apply. The manufacturer specifies a rated output voltage which the pre-amplifier can supply at 1 kc/s without exceeding a stated limit of harmonic distortion. The maximum output voltage is the actual voltage output at this stated distortion limit.

Harmonic distortion (single tone)

In commercial amplifiers it is customary to consider the available output power in relation to the total harmonic distortion at that power.

The simplest (and fastest) method of measuring harmonic distortion is to use a commercial *distortion-factor meter* (also known as an harmonic-distortion meter or total-distortion meter). The basic arrangement of a distortion-factor meter is illustrated in Fig. 63(a). A single frequency sinewave from the a.f. generator (usually 1 kc/s) is applied to the amplifier under test. This signal should be as free of distortion as possible, and to this end a tuned filter is often interposed after the signal

*Newmarket Transistors Ltd.

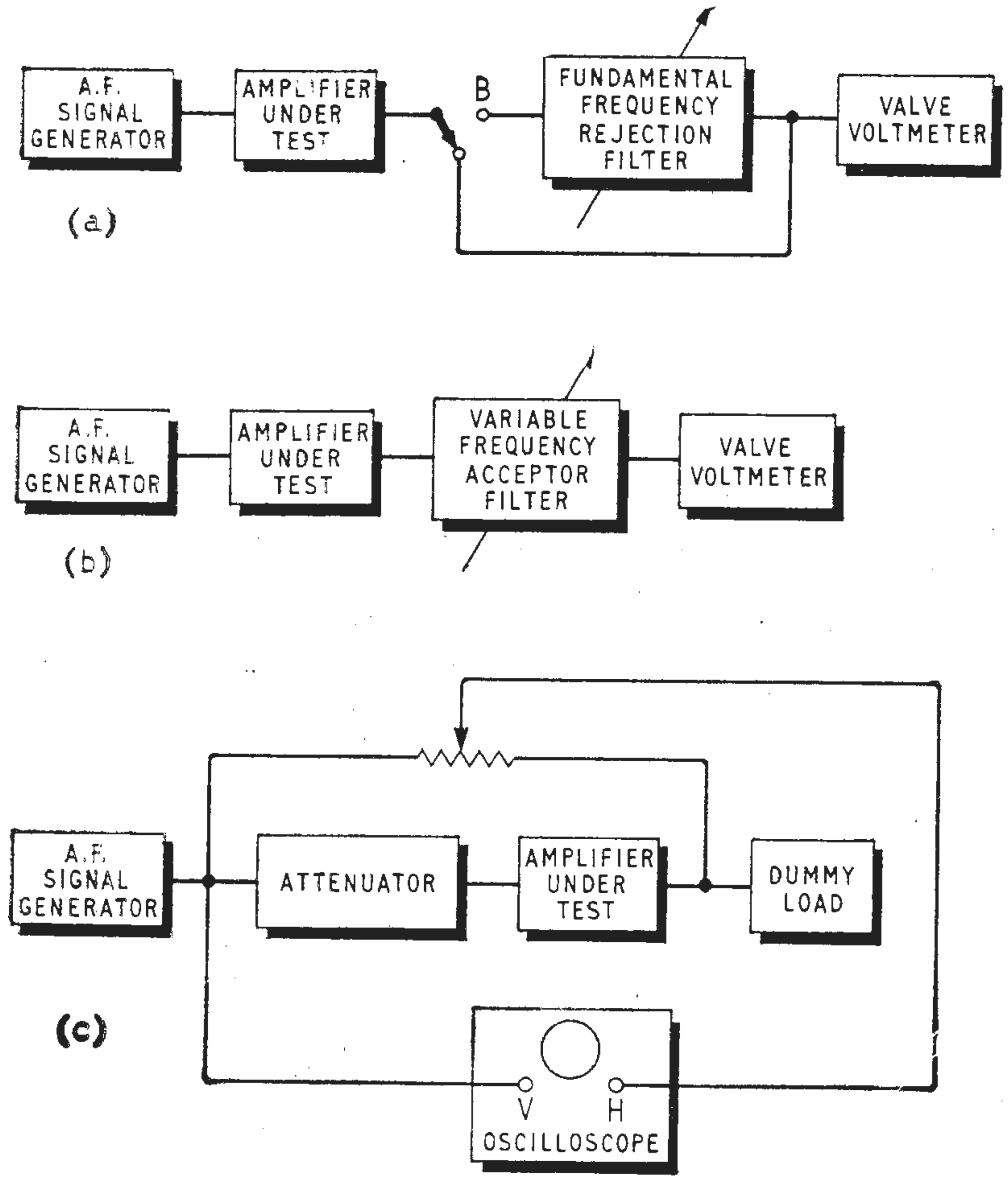


Fig. 63. Basic arrangements for different methods of measuring audio amplifier harmonic distortion: (a) distortion-factor meter; (b) wave-analyser; (c) " balance "-method.

generator. With the switch in position A, the amplifier output voltage (comprising fundamental and harmonic components) is measured on the valve voltmeter. The switch is then transferred to position B and the fundamental frequency rejection filter is tuned for minimum output voltage. The ratio of this minimum voltage (which represents harmonic components) to the first voltage (which represented fundamental plus harmonics) is computed to give the distortion percentage.

While distortion-factor meters are adequate for measuring total harmonic distortion, more refined testing requires that each harmonic in an amplifier output should be assessed separately. The "*wave analyser*" is the instrument normally used for separate measurement of each of a series of harmonics. Fig. 63(b) shows in diagram form the basic arrangement of the wave analyser. In this case the output signal from the amplifier is passed through a variable frequency acceptor filter which is tuned in turn to the fundamental and each successive harmonic. By this means it is possible to read off the comparative voltage of each frequency and compute the percentage of 2nd, 3rd etc. harmonics present individually in the amplifier output.

A third method sometimes used to measure harmonic distortion whose accuracy is much less affected by distortion in the input signal to the amplifier under test is shown in Fig. 63(c). This "*balance-method*" consists of balancing the fundamental of the amplifier output signal against the input signal at the vertical input of an oscilloscope. If no harmonic distortion were introduced by the amplifier, the vertical signal at the scope input would be zero, i.e. a horizontal line. Harmonics introduced by the amplifier gave rise to a vertical deflection trace which can be calibrated to give a direct visual indication of each harmonic. (The circuit shown assumes that phase inversion occurs across the amplifier.)

Commercial distortion measuring equipment can be expensive, but it is possible to build your own distortion factor meter reasonably easily. Fig. 64 gives a suggested three-transistor circuit with a Wien-bridge network to suppress the fundamental, and leave only the harmonics,

(continued on page 457)

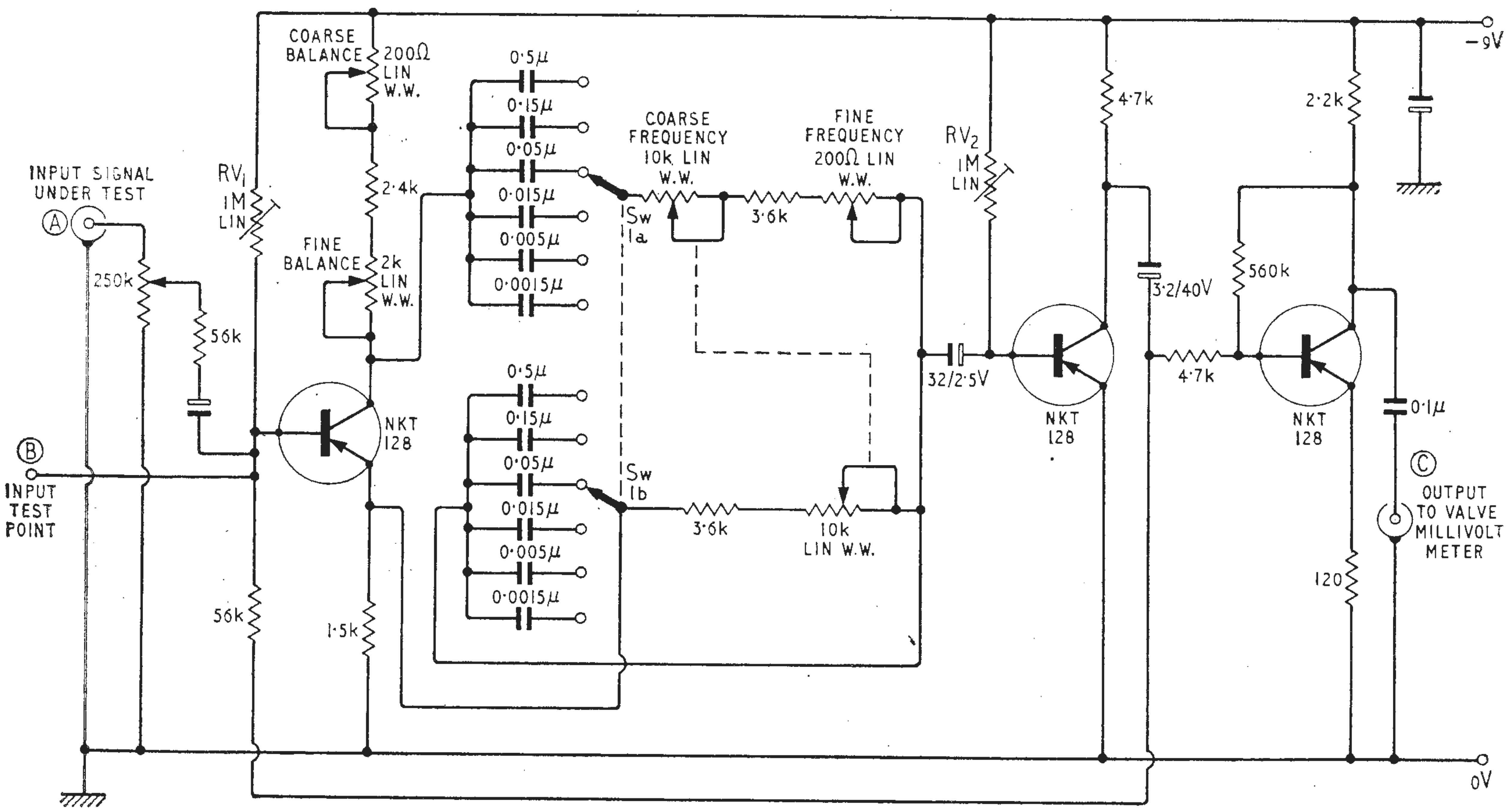


Fig. 64. Suggested circuit for transistor distortion-factor (total-distortion) meter covering 20-20,000 c/s.

of the signal under examination. With a 1 kc/s signal from the amplifier applied to the input point (A) the balance and frequency controls are adjusted for minimum reading on the valve voltmeter at the output point (C). The amplifier test signal is then changed to 2.5 kc/s (well beyond the second harmonic of 1 kc/s) and the level adjusted with the 250 kΩ input potentiometer until the output voltage reaches a convenient reference level, V_O (e.g. 1 V r.m.s.). The voltage V_B, at the base of the first transistor is also noted. The amplifier test frequency is returned to 1 kc/s and the input level adjusted (if necessary) to give the same base voltage, V_B. The balance and frequency controls are re-nulled and the resultant voltage, V_D, at the output measured. The percentage total distortion is then given by $(V_D/V_O) \times 100\%$. With a 1 V reference, a 10 mV reading represents $(10/1000) \times 100 = 1\%$ total distortion.

Sensitivity

The sensitivity of an audio amplifier is nowadays (following the British Standard) often specified in terms of a "*sensitivity voltage*," i.e. the e.m.f. applied in series with the stated source resistance, to the input terminals in order to obtain the rated output power or voltage. Note that for a sensitivity voltage specification you must define the source impedance and the rated output power. Sensitivity voltage is measured as shown in Fig. 65(a), where V_S is the e.m.f. from a voltage (low impedance) source which, when applied *via* the specified source resistance R_S to the amplifier, gives the rated power output as measured by the valve voltmeter across the specified load, R_L. A practical arrangement to provide the correct generator drive is shown in Fig. 65(b). It should be noted that the sensitivity voltage is *not* the voltage at the input of the amplifier, but is the voltage applied to a source resistance in series with the amplifier input. Even some experienced engineers are confused on this point.

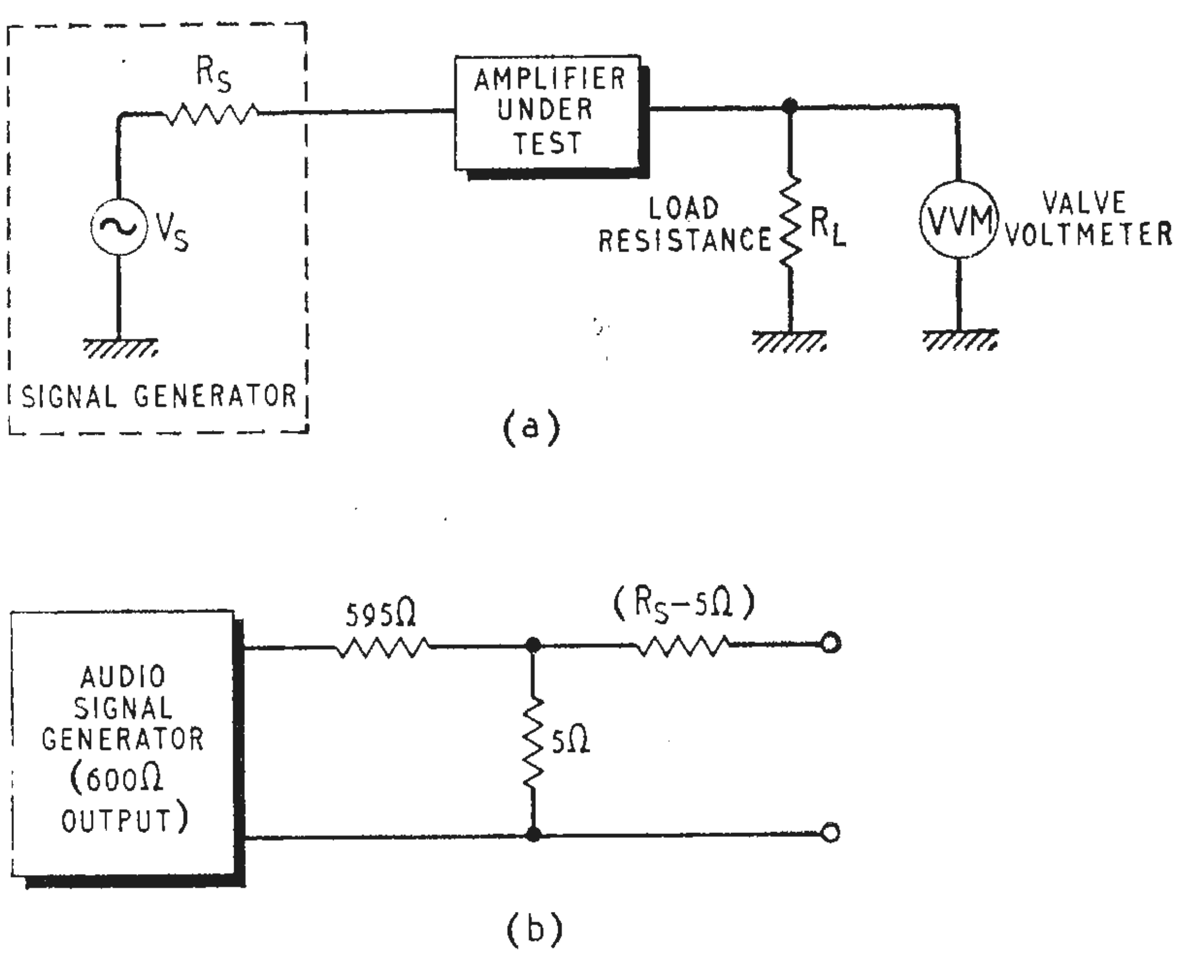


Fig. 65. Sensitivity voltage measurement:— (a) general arrangement; (b) simulating a source resistance R_s with a standard 600Ω audio generator.

Gain

A concept related to sensitivity is amplifier gain. The British Standard recommends the use of "transducer" gain, G, with defined source and load resistances. This is measured with the same arrangement as for sensitivity in Fig. 65. The source e.m.f., fed into the amplifier via the defined source resistance R_S, is adjusted to a value V_S for which the output voltage V_O across the load resistance R_L gives an output power one tenth (10 dB down) of the amplifier's rated output power. The maximum available power from the source (obtained only if the amplifier input resistance exactly equals the source resistance) is $P_S = V_S^2/4R_S$, and the power in the load is $P_O = V_O^2/R_L$. The transducer gain G (in dB) $= 10 \log_{10}(P_O/P_S)$. Once again, note that the gain defined here is not the ratio of output power to amplifier actual input power.

The gain of a pre-amplifier is measured in the same way. A source of e.m.f. fed through a specified source resistance is adjusted until the pre-amplifier output voltage, measured on a high impedance meter, is 0.707 (i.e. 12 dB down) of rated output voltage. The transducer gain is then calculated as before.

It scarcely needs pointing out that in all amplifier measurements unless specifically stated otherwise, any volume control should be set for maximum gain.

Frequency-amplitude response measurements

Frequency response measurements rank with distortion measurements in assessing amplifier fidelity. They fall into two main categories, referred to as (a) "power bandwidth" and (b) "bandwidth."

Power bandwidth is the curve of maximum output power (for the defined total distortion) versus frequency, plotted with logarithmic scales on both axes. The British Standard recommends that measurements should be made up to 5 kc/s. The lowest value of maximum output power on this curve is of interest because it is used in the measurement of bandwidth discussed below. The measurement of the power bandwidth response reduces itself to measuring the maximum output power as described earlier over a range of frequencies instead of at the normal 1 kc/s reference frequency.

Bandwidth relates to the variation of amplifier sensitivity with frequency. For this measurement, the amplifier controls are first set "flat"—i.e. gain control at maximum and tone controls or filters set for most uniform frequency response. A 1 kc/s sinusoidal signal is then applied to the input and adjusted in amplitude to a specified output power, which must not be more than the minimum noted on the power/frequency curve referred to above. (American practice here is to set a 1 kc/s output power at least 10 dB down on the rated output power and not less than 20 dB above residual noise.) The input signal frequency is then varied in steps above and below 1 kc/s over the frequency range of interest and the change in sensitivity voltage (i.e. e.m.f. into source resistance into amplifier) necessary to keep the output constant is measured in decibels. This change in decibels (reversed in sign) is plotted on a linear vertical scale against frequency on a logarithmic scale. The "bandwidth" is often popularly specified as the lower and upper limit frequencies where the sensitivity has dropped by a certain amount—frequently 3 dB—from the 1 kc/s value.

Typical 3 dB bandwidth specifications are

(a) Telephone 300-3500 c/s; (b) Radio receivers etc. 100-4500 c/s; and (c) "Average" hi-fi 20-20,000 c/s.

Frequency response tests can be carried out using conventional good-quality signal generators and valve voltmeters, but the plotting of results is time-consuming.

Commercial equipment is available in the form of strip chart recorders, which can produce a pen record in a few minutes and wobbulators which display an instantaneous scope trace of the frequency response.

Intermodulation or two-tone distortion

With a single frequency tone, non-linearity in an audio amplifier gives rise to harmonic distortion discussed earlier. When two separate single-tone audio frequencies are fed simultaneously through the amplifier, a new kind of distortion, "*intermodulation distortion*," arises from the non-linearity. The a.f. components interact and give rise to sum and difference frequencies as well as the two fundamental test frequencies and their harmonics. For example, in an amplifier with intermodulation distortion, the feeding of 100 c/s and 5,000 c/s input signal will produce significant outputs not only at the two test frequencies but also at 4,900 and 5,100 c/s. Such distortion is the more objectionable in that it introduces frequencies not harmonically related to the test frequencies. Until the issue of B.S. 3860:1965 several different methods of measuring intermodulation distortion were used, but the preferred method is now the "high-low" frequency one. In this a small high-frequency signal (about 5,000 c/s) is applied to the amplifier together with a large low frequency one (about 100 c/s) of four times the amplitude. The intermodulation distortion percentage in the output can be arrived at by filtering out the two test frequencies and computing the residual r.m.s. signal as a fraction of the full r.m.s. output. This gives the total intermodulation distortion, but a wave analyser can also be used, as with harmonic distortion, to evaluate the separate frequency components of the total.

Commercial intermodulation distortion test sets are available, but anyone interested in doing a few intermodulation tests can set up the arrangement in Fig. 66 with instruments available in most laboratories. Fig. 66(a) shows frequencies of 100 and 5,000 c/s with a 4 : 1 amplitude ratio being fed into the amplifier via a balanced bridge which prevents intermodulation distortion at the input. The bridge transformer is a high-quality 1 : 1 audio isolating transformer and the four 680 Ω resistors must be carefully equalized to isolate the two signal generators. The amplifier output is fed through a high-pass filter to reject the low frequency. Fig. 66(b) shows an RC filter circuit used by the author for 100 c/s rejection. The residual modulated 5,000 c/s signal is fed to the scope vertical amplifier and its time base synchronized direct from the 5,000 c/s generator. The scope trace is shown in Fig. 66(c) with the method of computing the percentage intermodulation distortion.

Crossover distortion

With the recent popularity of transistor amplifiers "cross-over distortion" has been much bandied about. I have heard some claim that it is a form of intermodulation distortion, but one should be clear on this point—it arises with a single frequency signal and is a form of *harmonic* distortion. A sinewave input as Fig. 67(a) becomes transformed to the waveshape at Fig. 67(b). Why it is called "crossover" distortion should be clear from the little plateau in crossing over the zero axis. In most forms of harmonic distortion the higher harmonic distortion components are usually relatively small, but with cross-over significant components can sometimes be found out to the fifth and higher harmonics. This should be remembered when using a wave analyser as it is possible to overlook these higher harmonics.

Hum

Hum in an amplifier output is usually measured with a voltmeter or power meter isolated from the amplifier output by a low-pass filter passing only up to the fourth harmonic of the power supply frequency, i.e. to 200 c/s in the United Kingdom. The meter should preferably be true r.m.s. reading. (A wave analyser may also be used, and the hum voltage computed from the square root of the sum of the squares of the component voltages.) The hum level of the amplifier is specified in decibels relative to the rated output of the amplifier when the input is terminated with a standard value resistor (which should be a low-noise high-stability resistor screened to prevent stray hum pick-up). The standard resistor is usually made equal to the source resistance of the input transducer for which the amplifier is designed.

The r.m.s. meter plus low-pass filter method of measuring hum can lead to erroneous readings because it does not discriminate against noise in the low-frequency

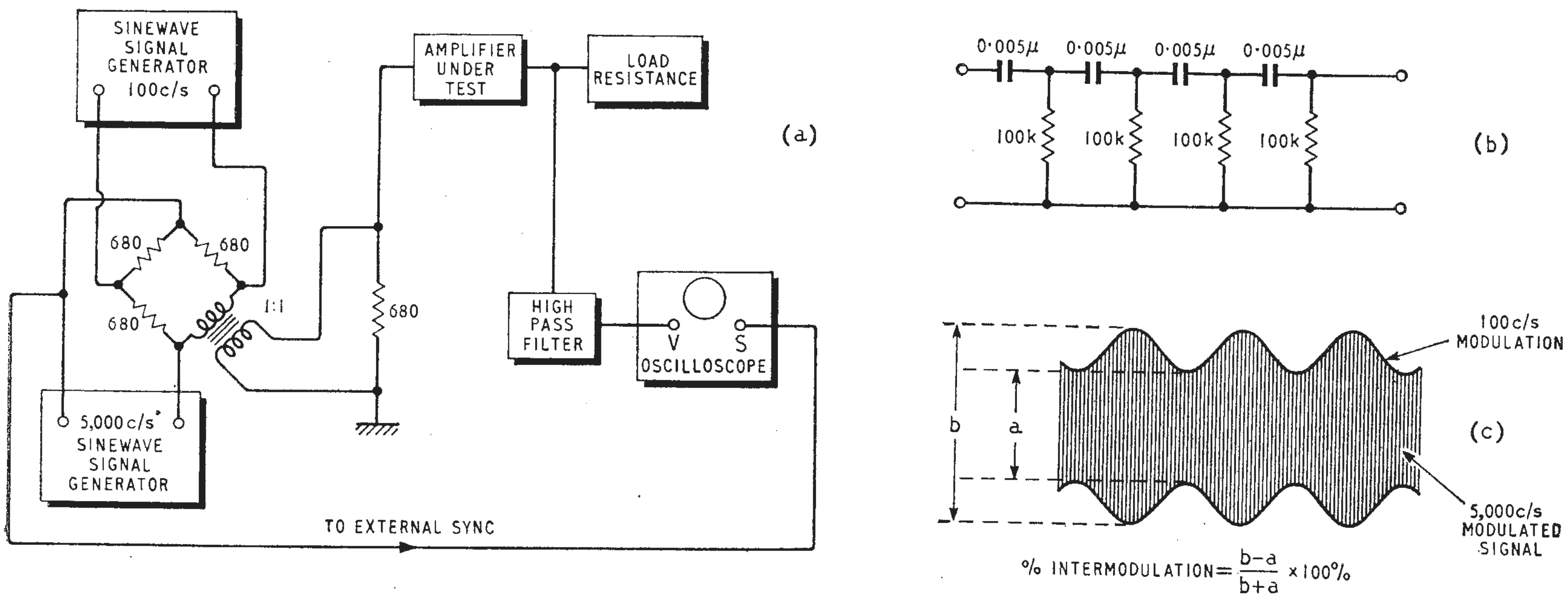


Fig. 66. One experimental arrangement for measuring intermodulation distortion:— (a) general block diagram; (b) RC high-pass filter for 100 c/s rejection; (c) intermodulation distortion computed from 100 c/s modulation depth on 5,000 c/s.

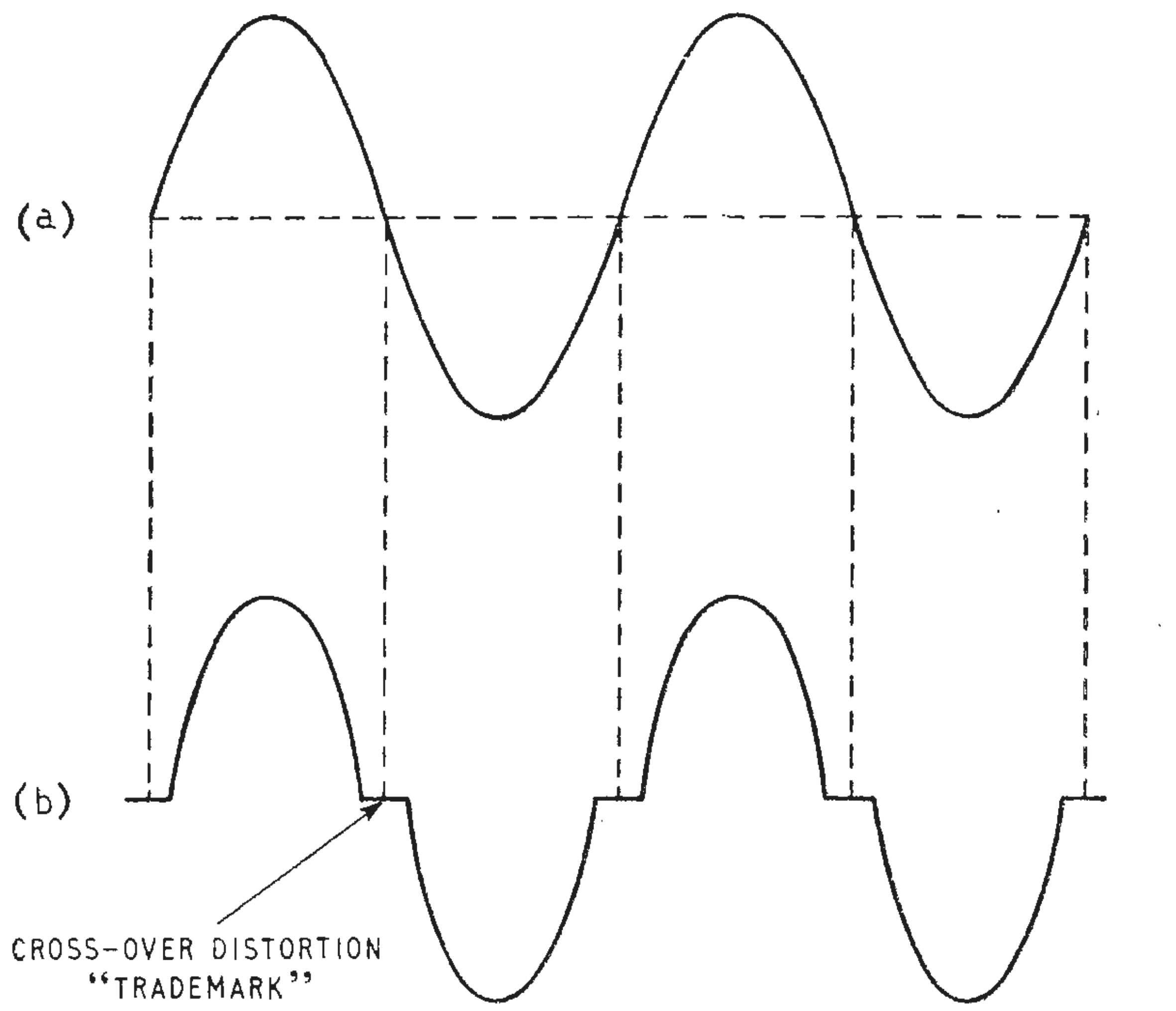


Fig. 67. " Crossover " distortion waveforms:— (a) input sinewave; (b) output waveform with significant crossover distortion.

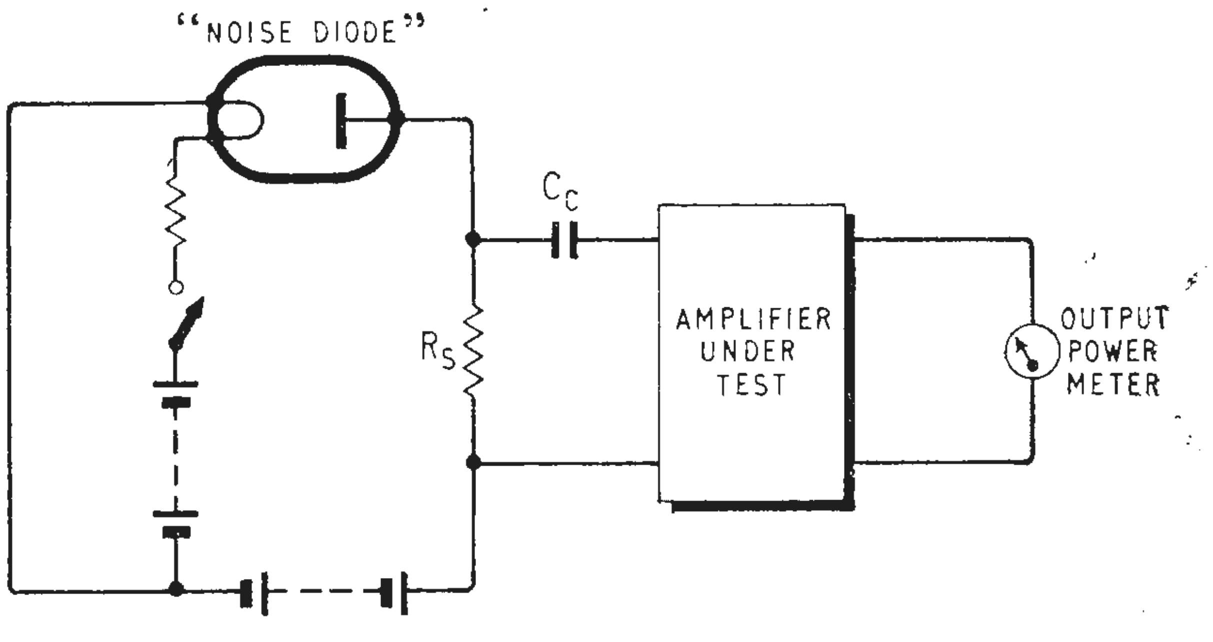


Fig. 68. Noise figure measurement circuit.

passband of the filter. For this reason it is usual to inspect the hum voltage on a scope at the same time to ensure no significant noise signals.

Noise

Apart from hum, noise in an amplifier system may show up as hissing, crackling, popping, etc. It is usual to treat " noise " as not including hum, and such noise output may be measured with an r.m.s. voltmeter or power meter isolated from the amplifier output by a high-pass filter that effectively removes hum components. As with hum measurements, the input should be terminated with a specified resistance.

The simple high-pass filter method treats all noises in the spectrum in the filter passband equally, but owing to the selective hearing of the human ear, a better indication of the noise assessment of an amplifier is obtained by using a selective high-pass filter which still blocks hum voltage but accentuates noise at the frequencies where they have the most effect on the normal listener. This gives rise to a " weighted noise output voltage " instead of a simple noise output voltage, but, except for the filter design, measurement methods are the same as for unweighted noise.

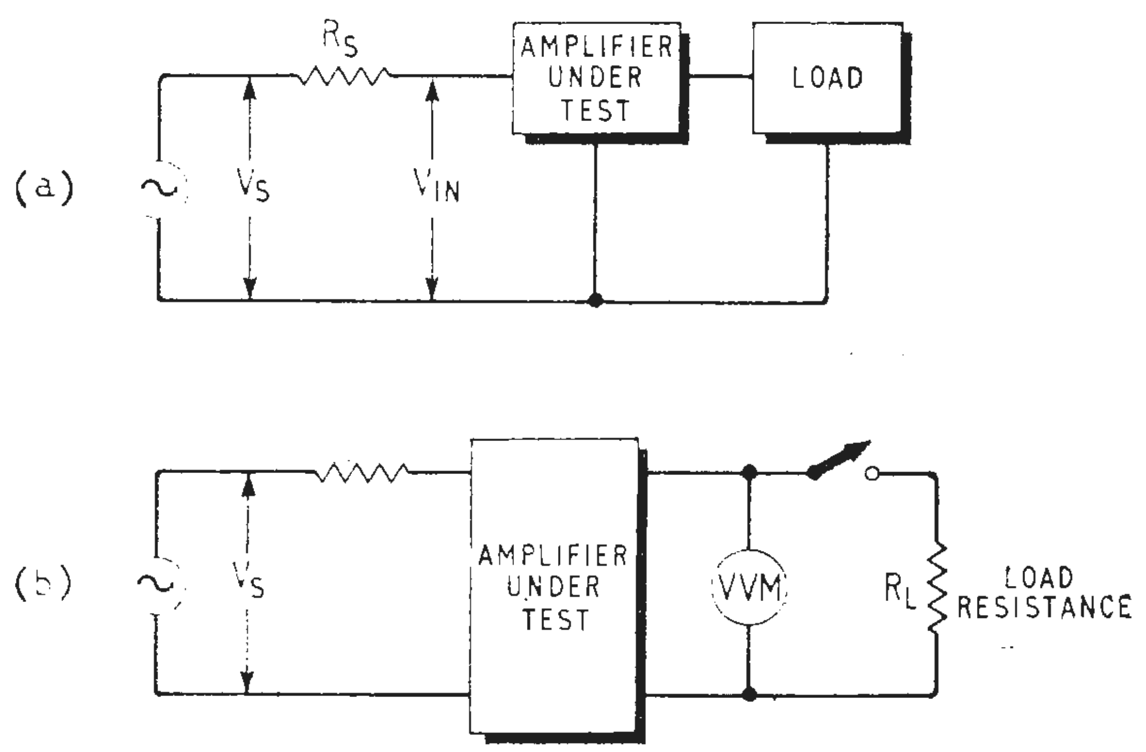
The noise output power (r.m.s. voltage into load resistance) expressed in decibels down relative to the rated output power is one index of the noise performance of the amplifier. Another index sometimes used is the " *equivalent noise input voltage* ". This is the input voltage at 1 kc/s in series with the stated source resistance that would produce an r.m.s. output voltage across, or power in, the stated load resistance equal to that produced by amplifier noise. To measure the equivalent noise input voltage a 1 kc/s sinewave test signal voltage, V_S, is applied to the amplifier input *via* the specified source resistance, to produce an output voltage, V_O, across the load resistance R_L, such that the output power is less than the rated output power of the amplifier. The test signal is then removed and the input terminated by a screened resistor (usually equal to the source resistance). Under these conditions, an r.m.s. noise output voltage V_N is read. The equivalent noise input voltage is then equal to $(V_S \times V_N)/V_O$.

Another way of specifying the noise performance of an amplifier is by means of its " *noise factor* ". This is the ratio of the total r.m.s. noise output voltage to that part of it which is due to the thermal noise of the source circuit treated as a passive network at 290°K over the frequency range of the amplifier. The noise factor, N, can be measured using a noise generator (generally a saturated thermionic diode) and an output meter arranged as shown in Fig. 68. The resistor R_S should be within 5% of the specified amplifier source resistance, and the coupling capacitor C_c should be not less than $3300/R_S$ microfarads (where R_S is in ohms). The noise output is first measured with the diode filament cold. The filament current is then increased until the noise output power is increased by a convenient factor P (usually × 2) and the diode current I_D (amps) is measured. If the resistor R_S is at 290°K (normal room temperature), the noise factor N expressed as a numerical ratio is given by $N = 20I_DR_S/(P-1)$. Often N is expressed in decibels rather than as a pure ratio.

Impedances

The *input impedance* of an amplifier is the impedance looking *into* the amplifier input. It is difficult to measure because in many cases the impedance being measured can depend upon the source impedance presented to the amplifier input by the measuring circuit. An impedance bridge may be used, but it is essential to see that it presents the proper source impedance to the amplifier input. So far as the input resistance is concerned a simple method of measuring this is shown in Fig. 69(a). A sinewave voltage input V_S at the test frequency (usually 1 kc/s) is applied *via* a specified source resistance R_S to give an output below the rated output power. The source open circuit voltage V_S being known, the voltage

Fig. 69. Measuring input and output resistances of any audio amplifier:— (a) input resistance; (b) output resistance.



V_{IN} at the amplifier is also noted, and the input resistance computed from $R_{IN} = R_S \cdot V_{IN}/(V_S - V_{IN})$.

Amplifier output impedance too can be measured with an audio-frequency impedance bridge, but in the absence of such an instrument the arrangement shown in Fig. 69(b) can be used for measuring output resistance. A 1 kc/s source being applied to the input, the output voltage, $V_{O'}$, with no load attached, and V_O with the specified amplifier load R_L are measured. Then the amplifier output impedance, R_{OUT}, is given by

$$R_{OUT} = R_L(V_{O'} - V_O)/V_O$$

Connected with the amplifier output resistance is its "*damping factor*", i.e. the ratio of the specified load resistance to the output impedance (assumed to be resistive) of the amplifier at a stated frequency. The damping factor is usually measured at 50 c/s. A 50 c/s signal is applied to the input to produce one quarter of the rated output power in the specified output load resistance. Let V_O be the output voltage for this. Now remove the output load, keeping the input signal constant, and let the measured open circuit output voltage be V_i. Then the damping factor, F_D, is given by

$$F_D = V_O/(V_I - V_O)$$

Stability

An important thing to check, especially in professional audio amplifiers, is the stability margin and whether the amplifier behaves satisfactorily towards both ends of the frequency response. The stability test prescribed by B.S.3860:1965 is to operate the amplifier without a load but with a capacitor connected across the output terminals. Where the amplifier is claimed to be unconditionally stable, the capacitor load is varied by steps of 0.01 μF from 0.01 to 0.1 μF, and by steps of 0.1 μF from 0·1 to 1 μF for a nominal 15 Ω load. For other stated loads these values should be adjusted inversely as the load resistance. Where no claims of stability are made, the capacitor should be such that its reactance at 200 kc/s is equal to the nominal load impedance, e.g. 0.05 μF for a 15 ohm load. The actual test of stability when the amplifier is capacitor-terminated is to inspect the output voltage in an oscilloscope to ensure no spurious oscillations, first with no input to the amplifier and then with a signal varying from 10 c/s to 70 c/s in frequency and an amplitude equal to the sensitivity voltage (see earlier) at 1000 c/s.

One popular method of amplifier stability assessment is "*square-wave testing*" in which a suitable square wave is applied to the input, and the output inspected on an oscilloscope screen. To reproduce faithfully a square wave of frequency f the amplifier must be capable of passing frequencies down to $f/10$ and up to $10f$. A little thought is therefore required in selecting the square wave repetition frequency. For example, 1 kc/s is suitable for a general test on an amplifier with a bandwidth from below 100 c/s to above 10 kc/s. A square wave can be regarded as made up of an infinite number of odd harmonic related sinewaves, and therefore an amplifier being tested with square waves is being checked simultaneously at a number of frequencies. Some experience is necessary to interpret the significance of output distortion of a square wave, but as a rough generalization rounded leading edges indicate poor high-frequency response, upward tilt of the wave tops, excessive l.f. response or bass boost and downward tilt or "droop" poor low-frequency response. If the output has spikes, "ringing", or damped oscillations on the wave tops, the amplifier may have excessive high-frequency response, excessive amplification in some band of frequencies or instability.

Precautions

In all audio amplifier measurements it is important, especially in low-level measurements (such as hum or noise) to ensure that the measurement technique does not give rise to spurious effects such as hum introduced by a ground loop formed between the instrument and the amplifier.

In all distortion measurements always measure the distortion of the signal generator itself to verify it is not less than five times down on the amplifier distortion.

Always check the calibration of any instruments before making exact measurements. Some things, like the accuracy of the frequency setting of your generator, are seldom questioned, but a few weeks before writing these words the author found the explanation for some curiously inconsistent amplifier response results in a standard commercial signal generator that gravely showed 9 kc/s on its setting dial while it delivered a steady 6 kc/s from its output terminals!

Finally if you have occasion to carry out any substantial tests in audio amplifiers, buy a copy of B.S.3860:1965 and consider its recommendations very carefully. In this also you will find described a number of other tests sometimes carried out on such amplifiers which could not be covered in this article.

Commercial Literature

A 52-page catalogue containing electrical and mechanical design information on the "**valves and cathode ray tubes for industry**" manufactured by the M-O Valve Company, of Chelmsford, has been forwarded to us.
9WW 321 for further details.

"**Simplification of Biasing Circuits using Transistors BCY42 and BCY43**" is the title of an application note available from the Semiconductor Division of Standard Telephones and Cables Ltd., Footscray, Kent. The transistors mentioned are low level silicon epitaxial planar types with a two-to-one spread in gain, at a collector current of 1 mA.
9WW 322 for further details.

"**SESCO Semiconducteurs.**"—This 44-page catalogue contains details of many hundreds of semiconductors ranging from signal diodes and rectifiers to thyristors and u.h.f. transistors. Also included are thin film circuits, microwave diodes, photosensitive devices and ring modulators. Copies of this catalogue are obtainable from SESCO's (Société Européenne des Semiconducteurs) U.K. representatives M.C.P. Electronics Ltd., Station Wharf Works, Alperton, Wembley, Middx.
9WW 323 for further details.

"**Magnetic Recording Heads**" for computers, data recorders, simulators and magnetic drum information storage units are described in a new series of data sheets issued by Gresham Lion Electronics Ltd. Binders containing these data sheets (A4) are available from the company's magnetic recording head department, Lion Works, Hanworth Trading Estate, Feltham, Middx. Eleven types of head for digital and analogue applications with up to 33 tracks per inch are included.
9WW 324 for further details.

The "**Brimar Valve and Cathode Ray Tube Manual, Number 10**" is now available, price 7s 6d, from the Brimar publicity department of Thorn-AEI Radio Valves and Tubes Ltd., of 155 Charing Cross Road, London, W.C.2. Industrial cathode-ray tubes and industrial switching transistors have been added for the first time to this publication, which contains 416 pages and gives design data on 629 different valves and c.r.t's. An equivalents list containing over 1,200 commercial and CV types is included.

SELF-CONTAINED TELEPHONE SCRAMBLER

THE picture shows a portable voice scrambler recently introduced in America to combat the invasion of telephone privacy by line tapping—a subject of growing concern in the U.S.A. and not unheard of in Britain. The transistor battery-powered device is self-contained and requires no electrical connections to the telephone handset, the scrambled speech being transmitted acoustically to and inductively from the handset. A conversation is only possible when two correspondents have identically coded scramblers. Names of people and firms owning scramblers, and the codes used, are kept secret by the manufacturers. Weighing 26 oz, and containing a power pack of mercury cells with a life of 100 hours, the portable scramblers are manufactured and supplied by the Delcon Division of Hewlett-Packard, Palo Alto, Calif., at a price of $550 per pair.

In the U.K. the Delcon scrambler has not been approved by the Post Office for use with the public telephone system (under the official telephone regulations legal action can be taken against people using unauthorized attachments or accessories) but, of course, no such restriction applies to private telephone systems. The Post Office has, however, approved a British transistor scrambler equipment, the Secraphone

made by T.M.C., which requires electrical connections from the subscriber's instrument to a small unit (6in × 4in × 10in) and two switches on the instrument.

NEW THIN FILM MATERIAL

BETA TANTALUM is the name given to a recently discovered variant of the metal tantalum which may prove useful as a resistive material in integrated circuits. Discovered by workers in Bell Telephone Laboratories and Western Electronic Engineering Research Centre, U.S.A., the new material has a higher resistivity and a lower temperature coefficient of resistance than ordinary tantalum, and it becomes a superconductor at a much lower temperature (0.5°K instead of about 3.3°K). Like normal tantalum, it could be used to make thin-film capacitors because it readily forms oxides and can be anodized by the usual techniques.

So far, beta tantalum has been produced only in film form. Most of the experimental data has been collected from films produced by cathode sputtering, although the material has also been observed in films made by evaporation and chemical vapour deposition processes. When the films are formed in a sputtering system containing argon at a pressure of 10×10^{-3} to 30×10^{-3} torr, beta tantalum is frequently observed when the total pressure of other gases in the vacuum system is less than 1×10^{-5} torr.

Beta tantalum formed by sputtering has a resistivity ranging from 180 to 220 $\mu\Omega$ cm, and a temperature coefficient ranging from −100 to +100 p.p.m./°C. In contrast, normal sputtered tantalum films have a resistivity in the range of 24 to 50 $\mu\Omega$ cm and a temperature coefficient in the range of +500 to +1800 p.p.m./°C.

The new material has a more complicated crystal structure than normal tantalum, but converts to normal tantalum when heated in a vacuum to about 750°C.

SOLID-STATE IMAGE SENSING PLATE FOR CAMERA

THE National Aeronautics and Space Administration of the U.S.A. are experimenting with a small television camera which uses a solid-state image sensing panel in place of the conventional electron-beam pick-up tube. Presumably they plan to use it in observation spacecraft instead of vidicon cameras (which were installed in Mariner IV to take pictures of the planet Mars and in the Ranger series to photograph the moon). The image sensing plate is a mosaic of 2,500 phototransistors, measuring 0.5 in × 0.5 in, and has an image resolving power of 100 lines per inch of plate. The mosaic is an integrated-circuit 50 × 50 configuration, formed by 50 transistor collector structures running the length of the plate, each having diffused into it 50 individual base-emitter structures with 50 deposited metal conductors for the emitters running across the plate at right angles to the collector strips. The collector strips are diffusion isolated from each other.

Integrated-circuit structures are also used to provide the panel scanning circuits. A video output signal is obtained by sequential switching of a bias voltage to the phototransistor electrodes. The complete camera, which measures 6 in × 4 in × $2\frac{3}{4}$ in and uses a standard 16-mm lens, has been developed for N.A.S.A. by Westinghouse.

RESONANCE RECTIFICATION

THE phenomenon of "resonance rectification" occurs when an alternating potential is applied to a probe situated in a plasma. A direct current flows in the probe which reaches a maximum value as the frequency of the applied potential is varied through the plasma frequency. The phenomenon is being studied at the Radio & Space Research Station of the U.K. Science Research Council and is referred to in the annual report entitled *Radio Research 1964* (H.M.S.O.).

Theories have been proposed to explain the effect but none so far seem very satisfactory and some rely on the assumption of an unrealistic plasma sheath. An approach has been made which does not require the sheath postulate and a solution has been obtained for the frequency variation of the rectified current and admittance using a spherical probe. It was demonstrated that the direct current reached a maximum when the frequency had a value about two-thirds of the plasma frequency. Initial results using a Skylark rocket with a $2\frac{1}{2}$ in disc probe showed little evidence of a resonance. Later experiments carried out with a spherical probe of 1 in dia. carried 3 ft in front of the payload, showed that the probe behaved roughly as expected, although the magnitude of the current peak and its width did not appear to be as predicted. A sample record showed a peak at 2 Mc/s. Many of the experimental facts about this phenomenon are still confusing and the results of the experiments are still being worked out in detail.

NEW PRODUCTS

equipment systems components

Military H.F. Transceiver

THE multi-purpose A13 radio set developed by Plessey in conjunction with the Signals Research and Development Establishment of the M.o.A. for military applications is now in full production and has been officially accepted by the British Armed Forces. Many accessories are available for the A13 making the one-man pack, in its simplest form, into a mobile radio station.

Phase modulation is employed and is said to improve the equipment's range over that of amplitude modulated transceivers for a given power consumption. In fact, Plessey's claim an improvement of up to 30% in ground wave coverage is obtained for the same power consumption. Provisions are, however, made for a.m. working to enable the A13 to be used in current military systems. Provisions are also made for c.w. working and speeds of up to 25 w.p.m. are possible.

Simple free-running tuning is one of the main features of this transistor transceiver, which covers 2 to 8 Mc/s and offers a choice of 2,400 (2.5 kc/s) channels. Calibration markers are provided at 100 kc/s and 10 kc/s intervals. The transceiver is powered by a 12-volt nickel-cadmium battery that can be quickly recharged from either a vehicle's supply or from an ancillary hand generator. Output power of the transceiver is 1.5 watts, giving a working range in open country of five miles. With a transmit-receive ratio of one to nine the basic transceiver has an operational life of 8 hours per charging.

An r.f. power amplifier may be added to the simple one-man pack (as shown in the photograph) to increase the power output to 16 watts. Although this power amplifier has its own 12-volt battery, the operational life of the A13 is then reduced to 6 hours per charging, with a transmit-receive ratio of one to nine. The normal working range using the amplifier and a standard 8ft whip aerial is 15 miles. Several other types of aerial are available, including two 150ft lengths of braid for long-distance working.

The basic unit is built on modular lines, making extensive use of printed circuit boards to simplify servicing.

Using another of the optional items, the harness adaptor unit, the A 13 will provide reliable vehicle communication. When installed, the equipment is powered from the vehicle's supply, via a regulator unit, another optional item. This provides a stabilized 14·4 volts from a nominal 24-volt source.

9WW 301 for further details

TAPE/DISC UNIT

SUITABLE for use with most types of ancillary equipment for producing background music, is the new tape/disc unit Type G/CD2 from the Coventry Shop Equipment Company, of 66 Canterbury Street, Coventry, Warks.

A Planet half-track, 3¾ in/sec tape deck is employed and—using 7-in spools with 2,400 ft of tape—offers four hours of non-repeat playing time. Automatic track reversal is provided, but no recording or fast wind facilities are included.

The associated disc deck is a Garrard Type 3,000 LM. Either a Ronnette TX88 or one of the Decca Deram mono cartridges is fitted as standard.

A transistor power supply unit, to feed the tape head pre-amplifier and the relays, is also included in the G/CD2, which measures 20×16×13½ in. Weight is approximately 40 lb.

The price ex works is £145. Ancillary equipment, including a range of Leak amplifiers in strong wooden cases, can also be supplied.

Several other items of equipment for producing background music, including one which has an integrated f.m. tuner, are available from the Coventry Shop Equipment Company.

9WW 302 for further details

Hall Effect Devices

TWO field probes and two multipliers using Hall Effect techniques are being manufactured by the Electronics Group of Associated Electrical Industries Ltd., of Carholme Road, Lincoln. The semiconductor material selected for these devices is indium arsenide which offers stable performance over a wide temperature range and has good power efficiency characteristics.

The field probes comprise a thin semiconductor plate mounted on a beryllia backing which has a high electrical restivity and a high thermal conductivity—equivalent to that of aluminium. Input and output resistance of the two devices is between 4 and 20 ohms, hence the effective output induction area is negligible, thus ensuring minimal a.c. pick-up from external sources. Power dissipation of up to 500 mW (200 mW for the smaller unit) can be tolerated, and with a field of 10 kilogauss, the Hall output is approximately 2.5 volts. Temperature coefficient for the two devices (designated field probe Mk. II and miniature field probe Mk. III) is 0.1% per degree Centigrade (between 20°-60° C).

A semiconductor magnetic circuit combination, which accepts two inputs in the form of electrical currents (preferably from relatively high impedance sources), is used in the multipliers to obtain an output voltage proportional to their product at a level suitable for amplification by either valves or transistors. Two standard types of multiplier are available differing only in the nature of their coil windings; the Type A being suitable for valve circuits and Type C for transistor applications. Both types are potted in resin, and are fitted with an International Octal valve base.

In addition to their use in analogue computers and for power measurement, these multipliers can also be used in modulation and frequency changing circuits; producing a minimum of unwanted harmonics. Other possible uses are as linear or square law detectors, for frequency analysis and in d.c. to a.c. converters.

9WW 303 for further details

SPEAKER ENCLOSURE

SPECIALLY designed for high fidelity enthusiasts with space problems is the "Minette" enclosure from Richard Allan Radio Ltd., of Bradford Road, Gomersal, Nr. Leeds, Yorks. This speaker unit is unconventional in as much as the duralumin front panel of the enclosure forms an integral part of the bass unit by supporting the cone assembly.

The bass unit is five inches in diameter and its cone is suspended on a flexible Neoprene surround, which is glued to the front panel and, in free air, resonates at 40 c/s. The magnet assembly of the speaker is attached to the front panel by four pillars and is claimed to overcome the normal chassis resonances. A ceramic magnet is used and provides a flux density of 14,000 gauss on a one-inch diameter pole and a total flux of 56,000 Maxwells.

The tweeter in this enclosure is a specially developed version of the 460T unit and has a flux density of 6,000 gauss on a 9/16-in pole, the cone being mounted on a Cambric suspension.

A five-element cross-over network is employed and brings the tweeter in at approximately 5 kc/s. The complete unit is said to have a flat response from 80 c/s to 12 kc/s, although the overall frequency response is quoted as 45 c/s to 20 kc/s. Continuous r.m.s. power rating is 6 watts and music power rating is 10 watts. The overall dimensions of the "Minette," which costs £17 10s 6d, are $11\frac{1}{2} \times 7 \times 6\frac{1}{4}$ in. Weight is 11 lb.

To meet the needs of the home constructor, it is hoped to market the front

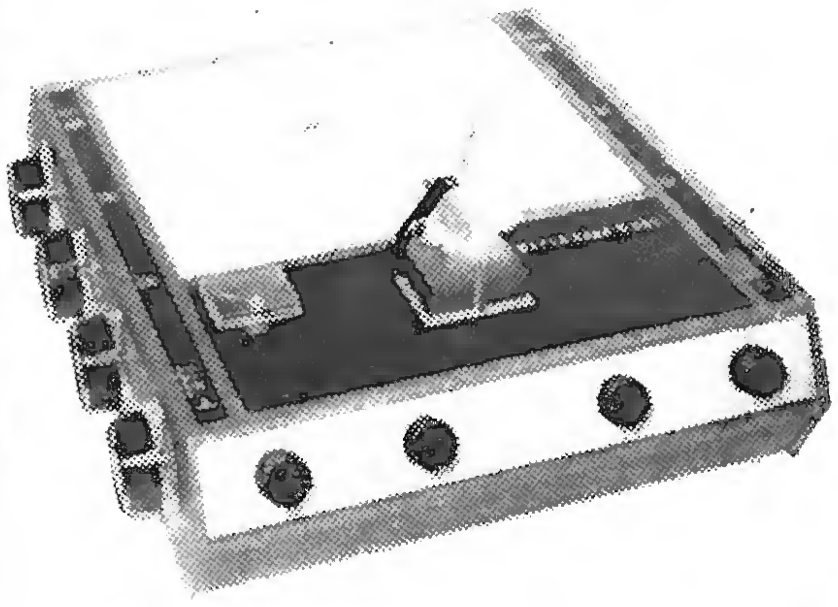
panel assembly, complete with speakers, but without the cabinet. The price has not yet been fixed, but it is understood it will be a little over half the complete price.

9WW 304 for further details

R.F. BRIDGE

USING transformers to obtain accurate voltage and current ratios, to compare an unknown capacitance and conductance with internal standards, the new wide-range bridge by Wayne Kerr offers 0.1% accuracy for capacitance and conductance measurement between 100 kc/s and 1 Mc/s. This instrument, designated B201, can also be operated, but with reducing accuracy, up to 5 Mc/s. Capacitance range is 0.0001 pF to 0.1 μF and the conductance range is 0.001 μmho to 1 mho. Internal modulation is at 1 kc/s.

A neutral terminal is provided on the connection block that allows three ter-



minal measurements to be made if required. At present only 100 kc/s and 1 Mc/s source and detector units are available for the B201, but dummy units may be inserted to permit external equipment to be connected for measurements over the range 100 kc/s to 5 Mc/s. The B201 measures $5 \times 12 \times 12$ in and weighs 12 lb.

The address of the Wayne Kerr Laboratories is Sycamore Grove, New Malden, Surrey.

9WW 305 for further details

R.F. Phase Measuring Instrument

OPERATING in the 15 to 100 Mc/s range, the Teltronics Type PD 200 phase measuring instrument allows accurate phase shift measurement. Basically, the phase detector comprises a dual channel amplifier, which is used to detect by nulling the relative zero phase and amplitude of two input signals. The voltage standing wave ratio is 1.1:1 and gain adjustment is variable from +5 dB to −15 dB; input voltage range is from 250 mV r.m.s. to 500 V d.c.

A series of similar instruments operating up to 2 Gc/s made by the American company Teltronics are also available in the United Kingdom through Microwave Systems Ltd., of 9-10 River Front, Enfield, Middx. The U.K. price of the Model PD 200 is £319.

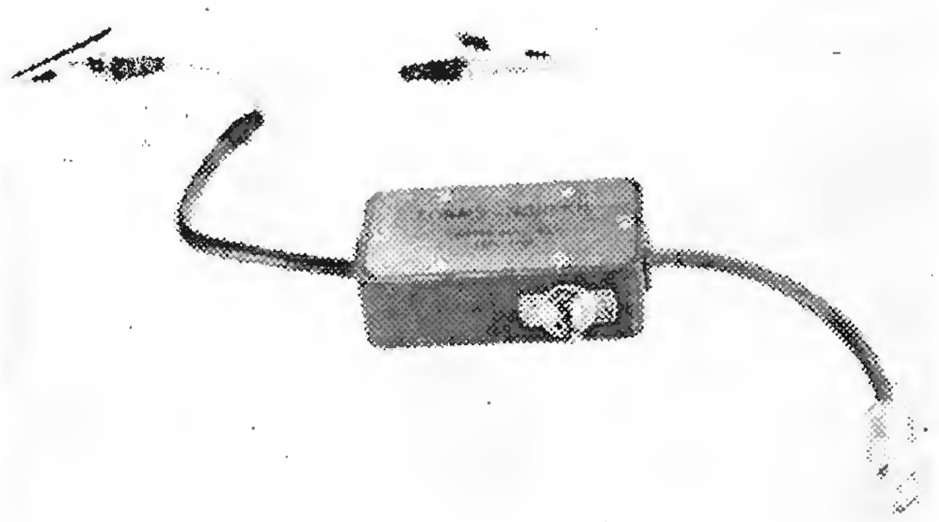
9WW 306 for further details

Impedance Converter

AN impedance converter that allows low impedance test equipment to be used without loading the apparatus under test is being manufactured by Adams-Norken Ltd., of Swindon. It comprises a unity-gain amplifier with an input impedance of 8 MΩ in parallel with 1 pF and an output impedance of 200Ω in series with 50 μF. Bandwidth is from 10 c/s to 3 Mc/s and the dynamic range is 4 volts peak-to-peak.

Designated EPO-1, the emitter follower is claimed to have a linearity of better than 1.0%. Other specification details include a noise figure of 20 μV p-to-p when measured with an impedance of 100kΩ, and less than 0.25% harmonic distortion when measured at 1 volt at 10kc/s. Two Mallory Type TM175 cells are used to power the probe giving a working life of 80 hours in continuous operation.

As can be seen from the photograph, the probe is quite small and as standard, is fitted with a double screened BNC plug. Different connector and lead arrangements are available to order.



An encapsulated version for either wiring into equipment or for plug-in applications is available. This is known as the EPO-2 and is housed in a $\frac{3}{4}$-in diameter $\times 1\frac{1}{2}$-in long aluminium can. Neither batteries nor coupling capacitors are fitted to this unit, which is available with either solder pins for direct connection, Pins for printed circuit board connection, or with valve base pins.

Both of these units are marketed by Kynmore Engineering Co. Ltd., of 19 Buckingham Street, London, W.C.2. The EPO-1 probe costs £18 10s the encapsulated version EPO-2, whatever the pin arrangement, costs £8 12s.

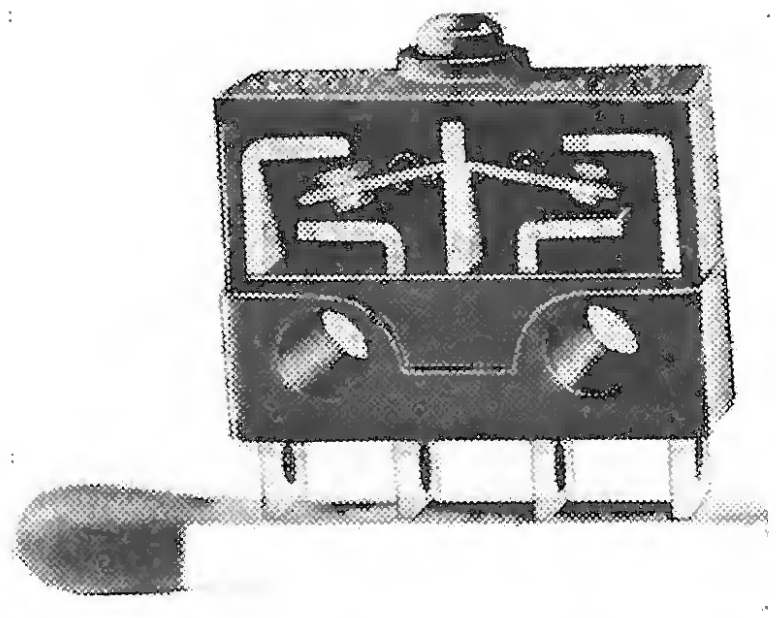
9WW 307 for further details

SUB-MINIATURE MICRO-SWITCH

THE new micro-switch from Plessey, designated Type 18, is particularly suitable for applications where reliability in a small space is of vital importance, such as in aircraft and satellite projects. Although the dimensions of the Type 18 are only 0.35×0.2×0.51 in, it has a contact rating of 8 amps at either 250 volts a.c. or 30 volts d.c.

This micro-switch is manufactured under licence from the Licon Division of Illinois Tool Works Incorporated, U.S.A., by the Plessey Components Group at New Lane, Havant, Hants. A "butterfly" snap-action mechanism is employed to obtain a good changeover; mechanical life is in excess of 10^6 operations. Good vibration and shock resistance characteristics are claimed for the changeover mechanism. In fact Plessey tests at frequencies from 10 c/s to 2,000 c/s show no contact chatter at 25 g, even with the actuator depressed to within 0.0025 in of trip. Non-stressed ebryllium copper blades and stainless steel coil springs are used in the switching mechanism. The contacts are diffused gold plated.

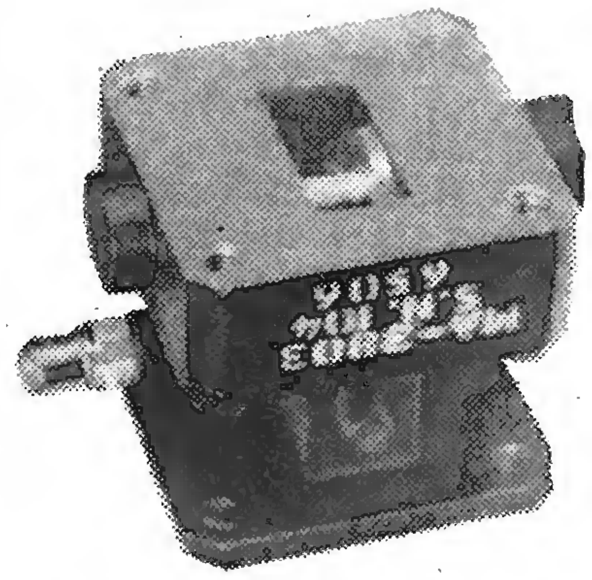
The case and cover (cut away to show the "butterfly" action in the photograph, which includes a match for comparison-purposes) are moulded in diallyl



phthalate. The Type 18 may be ganged if more than one circuit is required to be switched from the same actuator. Pretravel plunger movement is 0.050 in and up to 0.10 in overtravel is permissible.

These switches are available from the Electro-mechanical Division, Plessey-UK Ltd., New Lane, Havant, Hants.

9WW 308 for further details



X-Band TR-Limiter

BETTER receiver protection than that given by a TR tube alone, is claimed for the new TR-Limiter Type MA 3803 from Microwave Associates Ltd., of Cradock Road, Luton, Beds. In addition to a TR tube, this device contains a varactor diode, the action of which largely eliminates spike leakage (0.05 ergs) and, the makers claim, removes the major cause for crystal deterioration or burnout.

Compared with the normal TR tube, this unit has a similar insertion loss characteristic (0.8 dB) and has comparable dimensions (1.55×1.64×1.64). Other specification details include a centre frequency in the range 8.5 to 9.6 Gc/s with a bandwidth of ±100 Mc/s, an average power of 20 watts (peak 10 kW), recovery time of 2 μsec, v.s.w.r. of 1.3, noise ratio of 1.15, and a temperature range of −55°C to +85°C.

No additional power other than the "keep alive" electrode supply is needed and the protection claimed—particularly when a radar system is quiescent—is such that the device eliminates the need for a mechanical shutter.

9WW 309 for further details

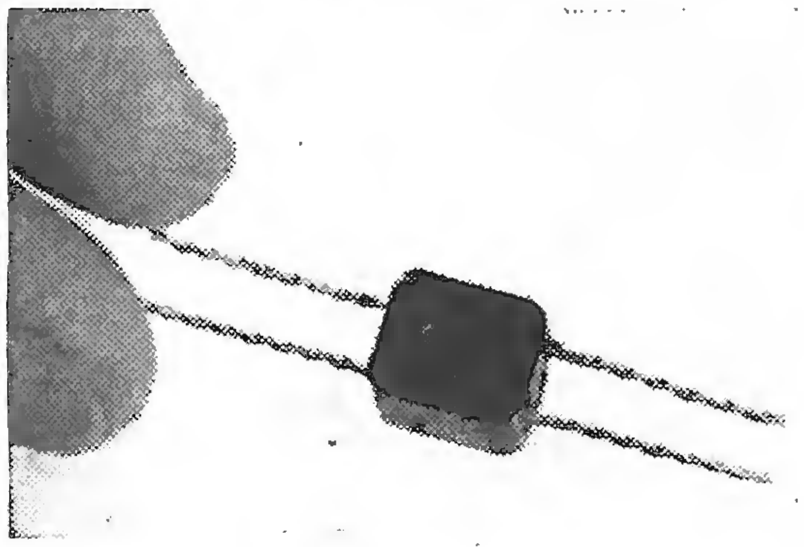
Low-loss Core Material

A NEW soft magnetic alloy core material, called Satmumetal and made by Telcon Metals, is characterized by low losses (about one quarter of those of silicon iron over the whole operating range of flux density up to 13,000 gauss) and a low magnetizing force requirement—again about one quarter of that for silicon iron. The magnetization curve extends beyond that of normal Mumetal to a flux density of 15,000 gauss. Permeability, varying with magnetizing force, ranges from an initial 40,000 to a maximum 250,000. Coercive force is 0.025 oersteds and remanence is 7,000 gauss. The new material, which at present is only in pilot production, is available in the form of 0.004-in thick tape of varying widths, for winding into toroidal cores.

9WW 310 for further details

Compact Silicon Bridge Rectifier

MEASURING only 12×10×7 mm, the new silicon bridge rectifier offered by Mullard's has an input rating of 42 volts r.m.s. and will provide a rectified output of up to 50 volts at 0.5 amps. This encapsulated device has been designed for



use in the power supply sections of mains-operated radiograms, record players and tape recorders. The peak surge current for this bridge rectifier assembly, designated BY122, is 25 amps.

9WW 311 for further details

Neon Indicators

THE number of high-intensity "Bright-life" neon indicators made by West Hyde Developments Ltd., of 30 High Street, Northwood, Middx., has been considerably increased and now includes units designed for $\frac{3}{8}$- and $\frac{1}{2}$-in hole mounting.

Those requiring $\frac{3}{8}$-in panel holes are made from polypropylene and the larger units are moulded in polycarbonate, a material which gives higher light transmission. Both types of material incidentally give sufficient glow from the rear to warn that equipment is live.

Three styles are available in each type of material with either clear, amber or red glow. The styles being dome, top-hat and square cap. Mounting is by means of a spring clip used to secure the indicator from the rear. Four other items complete the range: a neon, a neon with dropping resistor, a base with lead-out wires, and a neon with dropping resistor on a base.

Models are available to operate in the following ranges: 95 to 150, 160 to 260, and 270 to 500 volts a.c. or d.c. The average life of these indicators is quoted as 25,000 hours. Either six- or thirty-inch leads can be supplied.

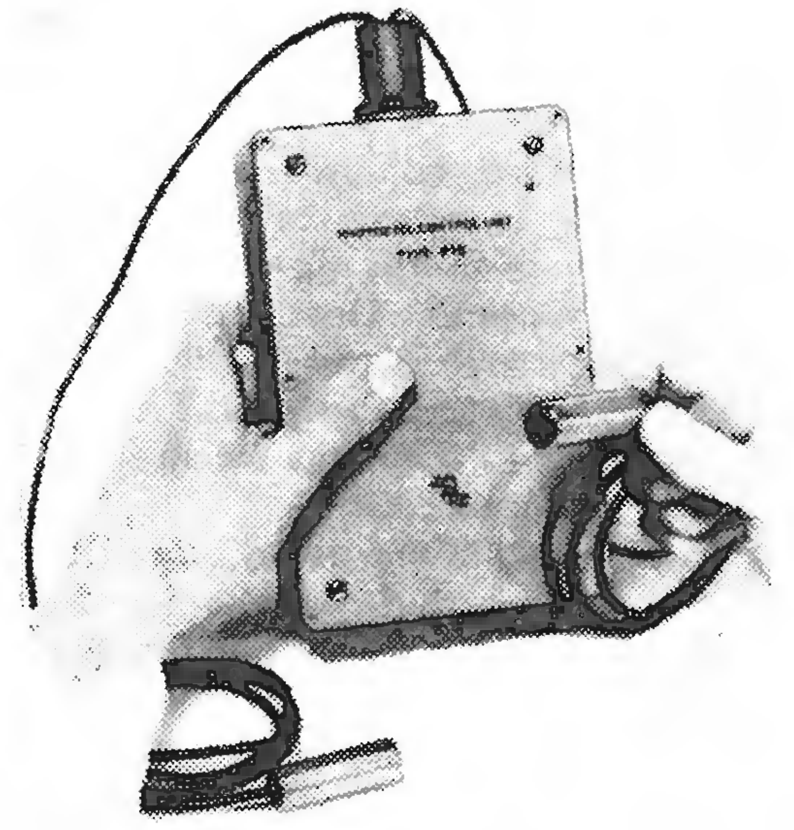
9WW 312 for further details

PHOTO-ELECTRIC EQUIPMENT

ABLE to detect objects as thin as $\frac{1}{16}$ in over distances of four feet, the new P 15 equipment being made by the industrial systems division of Electronic Machine Control Ltd. should find many applications in industry. As the illustration shows the equipment is quite small through the use of transistors.

The output of the unit when used in straightforward industrial applications, such at batchcounting, is sufficient to drive any counter directly without intermediate relays. However, for controlling external devices requiring relatively high currents—up to five amps, non-inductive—a changeover relay is provided in the standard equipment. A time delay can be incorporated if required.

This equipment is suitable for direct or reflected-light applications. Mounting clamps are available which allow the transmitting and receiving heads to be



adjusted to give the correct angle of incidence for any reflected light arrangement. The P 15 will operate from any 110 V or 200-250 V a.c. supply.

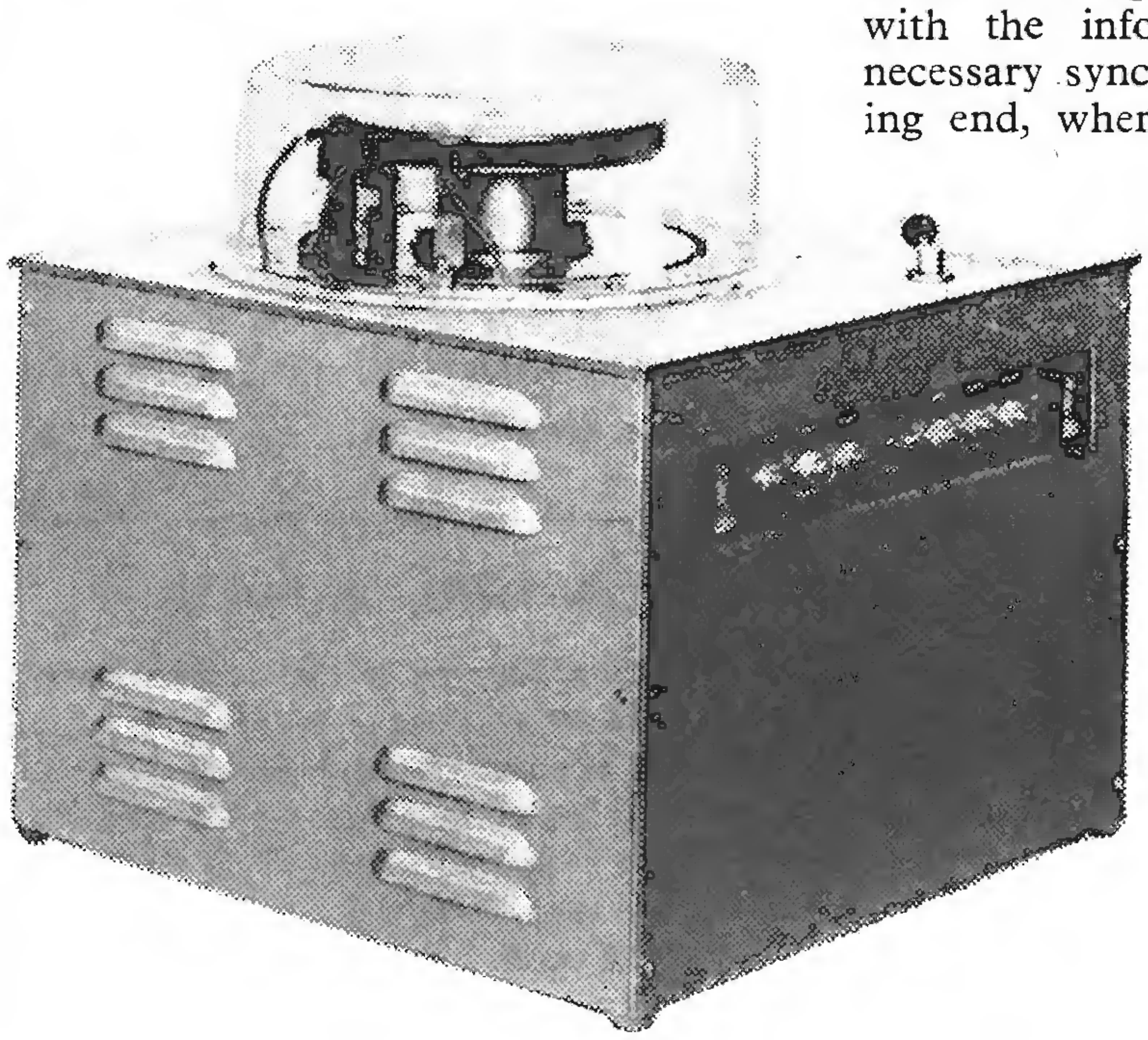
The ex works price of the P 15 is £22 10s and the company's address is Willow Lane, Mitcham, Surrey.

9WW 313 for further details

Interpolated Data and Speech Transmission

APPARATUS that allows privately leased (two-pair) telephone lines to be used for the transmission of data while the lines are in use for the transmission of speech is being manufactured by the Integrated Electronics Systems Division of Standard Telephones and Cables Ltd., of Enfield, Middx.

According to tests undertaken by the Standard Telecommunication Laboratories, only 32% of the total transmission time of two-pair circuits is used in average speech communications. Most of the wastage (50% of the time) is due, of course, to the fact that only one direction is used at a time. The remaining 18% has been shown to be through gaps and pauses in conversation.



All but a few per cent of this unused time is utilized by the IDAST (Interpolated Data And Speech Transmission) system for the transmission of data. A circuit transmission efficiency of approximately 96% is quoted.

In order to be able to observe and act upon the quiet periods, the input speech is delayed, up to a maximum of 1/5 second, while pulses are generated for marking the beginning and end of the forthcoming speech period. In addition to this function, the generated pulses are used to switch either the data or speech on to the outgoing line. A tone is sent with the information to provide the necessary synchronization at the receiving end, where the incoming signal is applied to parallel switch units, which head data and speech channels. This tone, which is transmitted only when speech is being sent, opens the speech channel and isolates the data channel. It can also be used to generate command signals for the data receiving equipment should this facility be required. A bandpass filter subsequently removes the tone from the speech.

9WW 314 for further details

Closed-circuit TV Over Telephone Lines

A VIDEO intercommunication system that utilizes standard two-pair telephone lines is being offered by the Multitone Electric Company. This system, developed in conjunction with Visual Engineers Ltd., employs Grundig line amplifiers to make up for the limitations of telephone lines.

Two line amplifiers are required for a simple camera and monitor installation for distances of up to 2,500 metres. At the transmitting end, the associated line amplifier converts the asymmetrical video signal to a symmetrical one and also amplifies parts of the video signal to compensate for distortion and exponential cable losses. At the receiving end, a line amplifier is used to return the symmetrical signal to an asymmetrical one and also to further compensate for cable losses and correct any distortions.

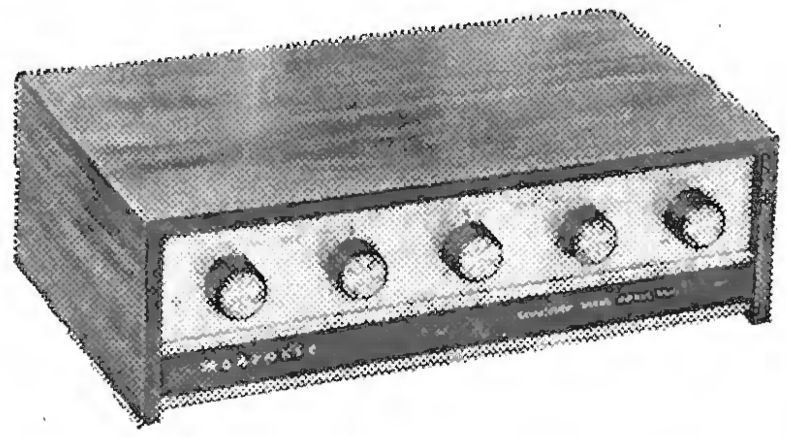
The actual amplifiers in the Multitone system are designed to compensate for cable losses of up to 10 Mc/s, making the system suitable for high-definition applications. Without the use of repeaters, Multitone claim that satisfactory pictures of moving subjects can be obtained over distances of 2,500 metres, and that a complete system can be remotely switched, through an automatic cross-bar telephone exchange, to allow any camera to be connected to any monitor in a private telephone circuit. With the use of repeaters, distances may be doubled.

The Multitone Sinus audio intercommunications equipment, which allows "hands-free conversation" and has been on the market for some time, has been integrated with the video system to allow a number of people to talk at the same time whilst watching a single picture.

The approximate prices of the various units are: monitors £250, camera heads (less lenses) £250, control units £250 and line amplifiers £200.

9WW 315 for further details

Audio Mixer Unit



DESIGNED for use with a wide variety of amplifiers, tape recorders and other signal sources such as dynamic and crystal microphones and radio tuners, is the Heathkit Model TM-1 mixer unit. Two high sensitivity and high impedance channels and two of lower sensitivity and input impedance are provided on this transistor mixer. Each channel has its own, continuously variable, level control and when not in use is automatically earthed when the input plug is removed. A master volume control is provided.

The sensitivities, for an output of 200 mV r.m.s. are as follows: Channel 1, 1.5 mV with 1 MΩ input impedance and 4.5 mV with a nominal 2.5 MΩ input impedance (in the "XTAL" pickup position); Channel 2, 1.5 mV at 1 MΩ; and Channels 3 & 4, 180 mV at 250 kΩ.

At full output frequency response is within ±3 dB from 15 c/s to 30 kc/s and the distortion is less than 0.2 %.

A music/speech switch, which in the speech position attenuates frequencies below 150 c/s, is fitted and has been found to be of benefit in public address applications where low frequencies often cause "boom" to occur. The power consumption at line voltage—9 volts d.c.—is approximately 6 mA. Dimensions are $3\frac{3}{4}\times 11\frac{1}{16}\times 7\frac{1}{2}$ in and weight is $4\frac{1}{2}$ lb.

In kit form the price of the Model TM-1 is £11 16s 6d. Assembled and tested, it is available from Daystrom Ltd., of Gloucester, priced £16 17s 6d.

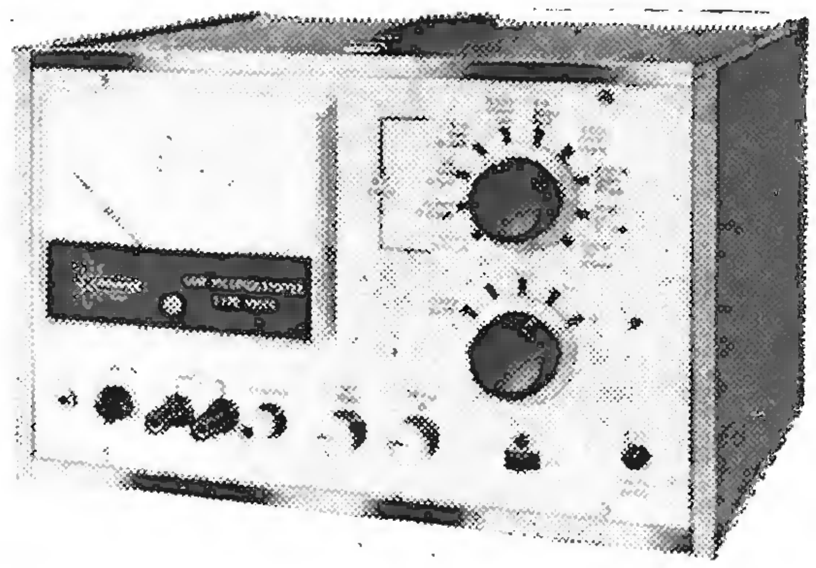
9WW 316 for further details

INFORMATION SERVICE FOR PROFESSIONAL READERS

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

We invite readers to make use of these cards for all inquiries dealing with specific products. Many editorial items and all advertisements are coded with a number, prefixed by 9WW, and it is then necessary only to enter the number(s) on the card.

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



U.H.F. MILLIVOLTMETER

A VERSATILE battery-operated millivoltmeter is announced by Advance Electronics Ltd., of Roebuck Road, Hainault, Ilford, Essex. This instrument, designated VM79, has six a.c. ranges covering 10 mV to 3 V f.s.d. and is suitable for use from 100 kc/s to 1 Gc/s.

Ten ranges are provided for d.c. measurement from 10 nA to 300 μA f.s.d. Resistance measurements (1Ω to 10 MΩ) can be made on most types of circuitry with this instrument as the polarizing voltage is only 4 volts.

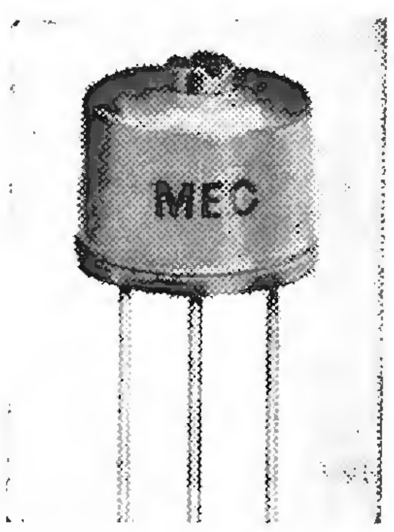
Readings are indicated on a four-inch meter which has separate scales for each facility. Accuracies quoted are as follows: a.c. voltage is ±3% of reading with a v.s.w.r. of 1; ±2% f.s.d. for d.c. voltage measurements; ±3% f.s.d. for direct current measurements; and ±6% (at mid scale) for resistance measurements. Among the accessories is a 50Ω coaxial T probe (PL60) which will provide a v.s.w.r. of better than 1.2 (unbalanced input) over the frequency range 100 kc/s to 1 Gc/s.

A d.c. output suitable to drive an *x-y* recorder is provided on this instrument which measures $7\frac{1}{2}\times 11\frac{1}{8}\times 9\frac{1}{2}$ in and weighs $10\frac{1}{2}$ lb. The price of the VM79 is £180.

9WW 317 for further details

Potentiometer in TO-5 Case

SINGLE-TURN top adjustment is provided on the new Model T20P trimming potentiometer from Miniature Electronic Components Ltd., of Copse Road, St. John's, Woking, Surrey. Housed in a case with identical dimensions to the TO-5 transistor can, this device has ½ watt rating at 70°C. Resistance values of 50, 100, 200, 500 ohms, 1, 2, 5 and 10 kΩ are available for T20P. Temperature range is from −55°C to +150°C.

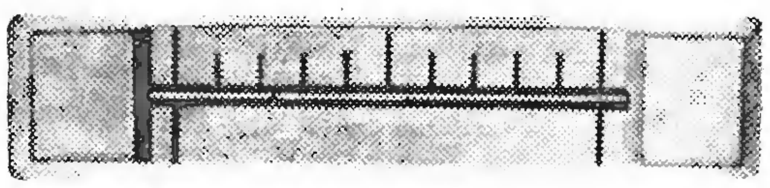


9WW 318 for further details

Elapsed Time Indicator

A RANGE of small electrochemical ampere-hour meters, made by Curtis Instruments (U.S.A.), is now available from Miniature Electronic Components Ltd., of Copse Road, St. John's, Woking, Surrey. The basic model is the 150, which is less than 2 in long and the four versions available allow panel, printed board or socket (polarized or non-polarized) mounting.

A glass capillary tube (0·015 in dia. which allows the device to be used in any attitude due to the high surface tension of mercury) contains two columns of mercury separated by a gap of electrolyte—an aqueous solution of a soluble iodide salt and mercuric iodide. Nickel wire is used for the two electrodes. When a potential is applied across the electrodes, mercury at the anode is transferred to the cathode and as a result the gap moves from cathode to anode. The rate at which the gap moves is, of course, proportional to the current-time integral and for a constant current the gap displacement is directly proportional to elapsed time.



For elapsed time measurement a series ballast resistor is used to determine the current which should not exceed 5 mA. A ballast resistor of 20-30 times the cell resistance (which is around a few hundred ohms) will swamp the positive temperature coefficient of the cell and reduce dependence on attitude. For a current of about 1 μA the elapsed time is 10,000 hours and for 5 mA the corresponding time is 2·08 hours. The accuracy is $\pm 2\%$. With a swamp resistor, a current limiting resistor and a shunt Zener diode, the cell may be used with "rough" d.c. or a.c. Temperature range is $-20°$C to $+90°$C.

The coulometer may, of course, be used as a general purpose integrator and remote readout is possible by capacitative coupling or by optical means.

9WW 319 for further details

"Press-Fit" Terminal

DESIGNED to save chassis area, the new feed-through from Sealectro Ltd. needs only 0.125 in diameter circular area on the chassis, but provides a minimum clearance above and below the chassis of 0.090 in. The body of this one-piece terminal, designated FT-SM-16L24, is of p.t.f.e.

The company's address is Walton Road, Farlington, Portsmouth, Hants.

9WW 320 for further details

A Touch of the Auld Lang Synes

BITTER experience teaches us that we can expect absolutely nothing of a day which starts with getting up in the morning. Armed with this philosophy one can, I find, accept the diurnal ration of slings and arrows of outrageous fortune with a fair percentage of stoicism. But, patently, some days are worse than others, and when a peremptory demand for me to attend upon the person of the Editor (no less) was delivered by express carrier pigeon, it became clear that no good could come of this one. Day, I mean, not pigeon.

To those who have had the good fortune never to have crossed the path of an Editor I should perhaps explain that it is a built-in characteristic of the race that they never demand audience in order to impart good news. The personal confrontation is traditionally reserved for matters of plague and pestilence, and so the sackcloth suit was the only possible choice of garments for the day.

Thus, in the fullness of time, after an initial interrogation at the portals of Dorset House, I was led, by a disdainful commercial equivalent of Jeeves, past cells crammed with galley-slaves until at length we hove to at the outer bastions of the *sanctum sanctorum*. Here I was received by the Editor's ravishing secretary.

Taking a compass bearing on entering the room I struck out for the hinterland and in due course came into sight of a massive desk supporting numerous telephones, with one of which the Editor was heavily entangled. He was, it seemed, at violent variance with a chap by the name of Caxton—a printer, I fancy—and as I made obeisance in the obligatory kneeling posture he slammed down the receiver and, snatching a sjambok, took off down the runway towards the doors without even a parting kick at what must have been, in the circumstances, a provocative target.

I mention all this in some detail to explain how I came to be browsing through vintage volumes of *W.W.* Being thus left *in vacuo* in a highly trepid state I approached the bookshelves which line the room from floor to ceiling, more in the hope of finding spirituous refreshment concealed behind the tomes than of imbibing mental refreshment from their contents*. But no; all were apparently genuine, and thus it was that I found myself in company with the 1913-14 volume of *W.W.*, with nothing better to do than to read it.

Fascinating stuff. In those far off days I found that *W.W.* ran to 108 pages for 3d and that a wireless operator's uniform, complete with gold lace and gold buttons, could have been mine for 60s. Editorially, there were the familiar erudite articles, leavened with features like "Across Bolivia with a Portable set"; but would you expect to find poems? And not only did the readers get the muse for their thruppence, but, believe it or not, a cliff-hanger serial as well.

Yes, a genuine cliff-hanger. Technically slanted, of course. The hero was Charles, a vicar's son, who had invented a wireless-controlled airship complete with death-ray guns. Charles' other hobby was a girl-friend, the Squire's daughter (occasionally referred to in the narrative as Charles' lover, but not, it is to be trusted, in the modern connotation. Not in the vicarage, surely?). Gwen (that's the girl friend, familiarly known to Charles as "chicko") is described as "a bright intelligent girl, secretly a member of the Fabian Society." A member of that institution she might have been (and after all, every silver lining has its dark cloud), but the "bright and intelligent" bit is suspect, since she persuades Charles to let her have a go at the controls and promptly graunches the prototype airship straight into the potting shed.

Other *dramatis personnae* include Doss and Suk (sic) a brace of unwashed pedlars, described as being "for ever on the prowl," and M. Dupont and Herr Buelner who are—guess what? That's right; secret agents for a foreign power.

I can't tell you all the ramifications of the plot, except to say that in the end Gwen atones by taking over the control tower and knocking out the entire invading German air force by radio control, deputising for Charles who had inconsiderately contracted a nervous breakdown at the critical hour when England had need of him. True love wins through and in the final scene we find Charles and Gwen abandoning radio control and going over to manual as they walk down the aisle together.

And when you come to think of it, and considering that World War I hadn't started, that story wasn't at all a bad forecast of what was to happen in 1940, if you substitute radar control for radio.

Letters to the Editor were mostly in the form of queries to which a reply was given, and some of these were pretty terse. One hapless correspondent, identified by the initials H. L. N., had his letter held up as a horrible example to others, and was told, *inter alia*, ". . . You ask too much . . . a full answer would approximate to the size and value of a text-book . . . . You are infinitely too vague . . . . Half your troubles would be removed if you would take the advice we have repeated over and over again—USE A WAVEMETER . . . . You have no possible right to use gas pipes as an earth and if you persist we run the risk of never hearing from you again . . . ."

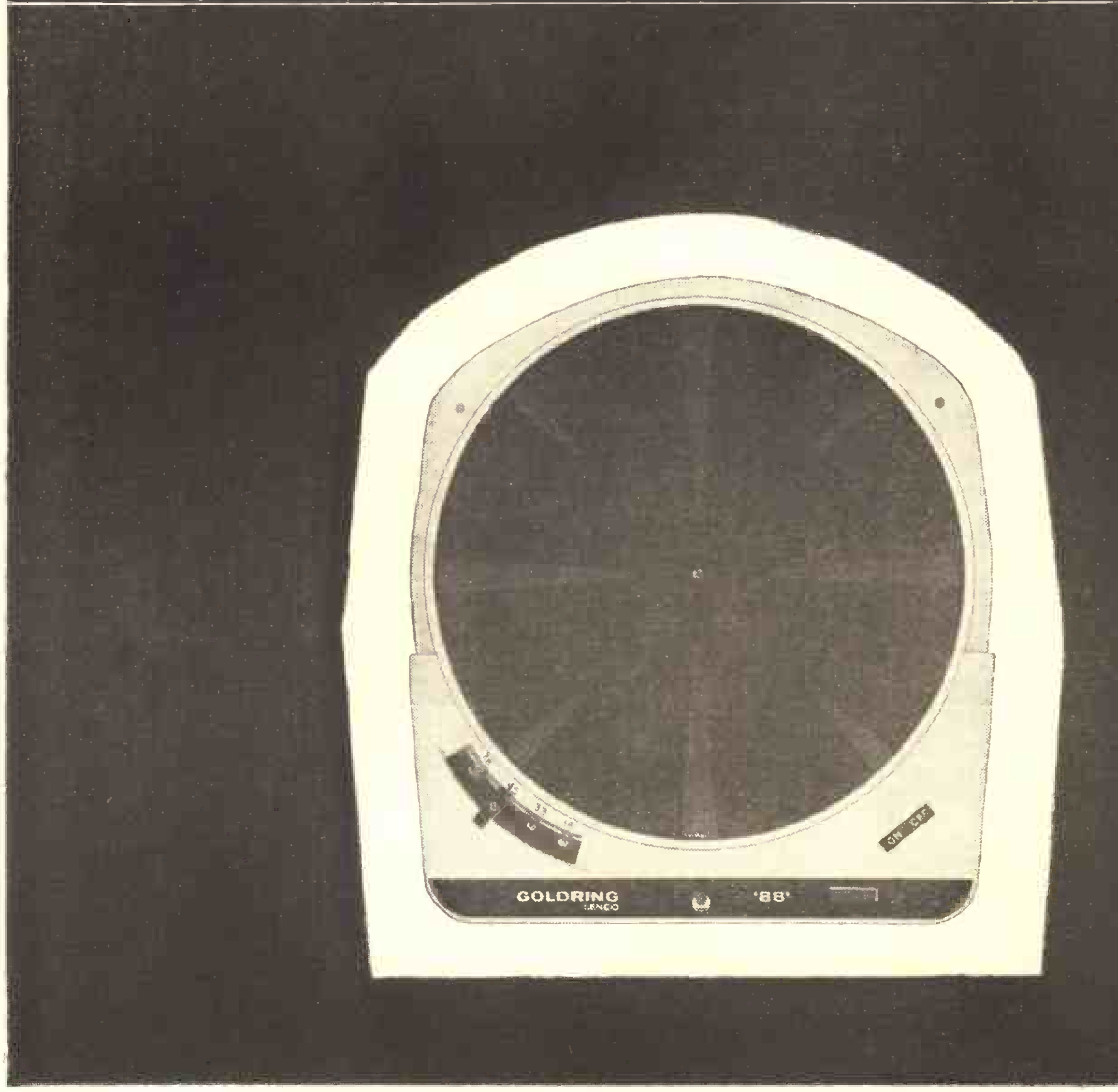
Which just shows what a superman an Editor must be. We weaker vessels would have encouraged the impossible H.L.N. to make his earth connection on to as many gas pipes as he could find . . . "Excellent results are obtained by perforating the main in one or two places and soldering the lead into position with the aid of a blow torch . . . ." But not the Editor. He knows that H. L. N. is the bed of nails which an inscrutable Providence has given him to lie upon, and accordingly he goes to the utmost lengths to keep the points sharpened. Of such stuff are demi-gods made.

To those Doubting Thomases who think that I have been making this up I extend my forgiveness and commend them to the library of the British Museum. And in browsing through the volumes, look also at the technical articles therein, and you may, like me, come to the conclusion that the old-timers were not nearly so far back into the Flintstone era as we are prone to think. But perhaps more of that another time.

Oh yes—just for the record—it eventually transpired that the Editor (the 1965 edition, I mean, not the 1913 one) hadn't wanted me at all, but had merely demanded to see a certain adjectival vector diagram which was in course of preparation for an article.

* Judging from his description I think he must have found it.—ED.

The shapes of sound



SOMETHING MISSING?

For a very good reason there is no transcription arm with the Goldring-Lenco '88' Transcription Unit. The '88' has been designed in response to the wide demand from enthusiasts for an extra high quality unit that will permit them to use a transcription arm of their own choice. Additional refinements include the push-button "on/off" switch which also engages and disengages the drive and is linked to a neon pilot light; and the entirely click-supressed switch circuit. As with *all* Goldring-Lenco transcription units the unique infinitely variable speed control offers particular advantages to musicians and to those with appreciation of precise pitch. Coupled with the exceptionally clean modern design and the capacity of the '88' to offer complete freedom in mounting arrangements, these unique features give the '88' immediately obvious advantages.

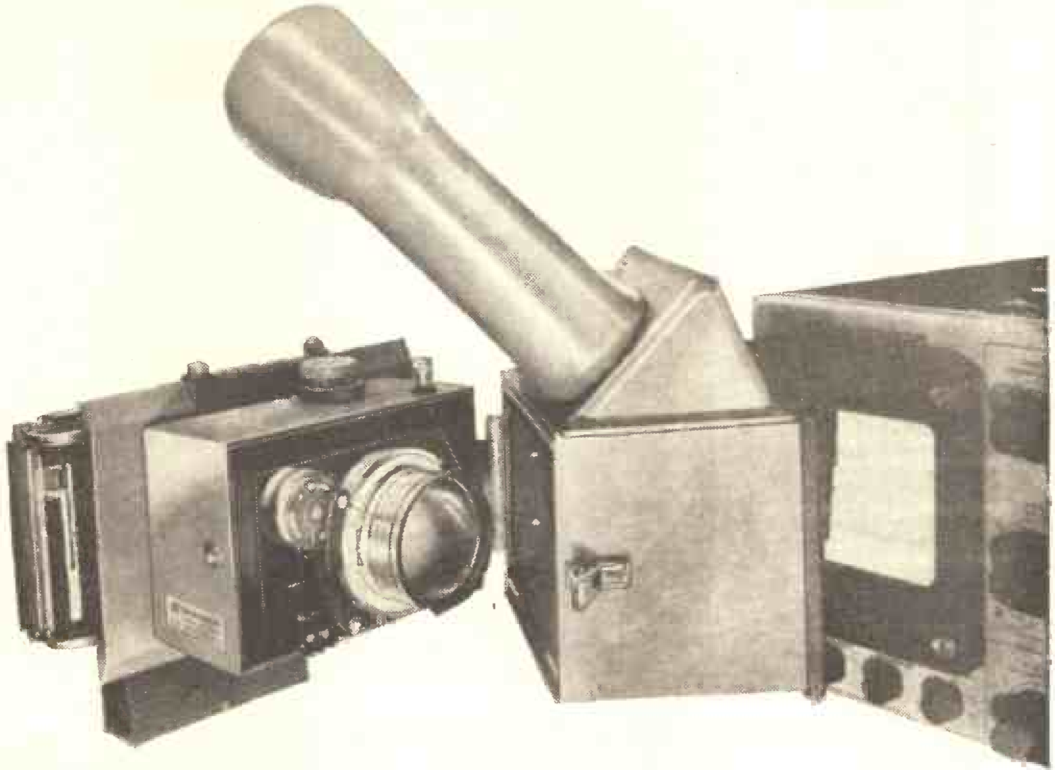
Goldring-Lenco unique vertical drive system. — Continuously variable speed from above 80 r.p.m. to below 30 r.p.m. and from 15 to 18 r.p.m. with four adjustable click-stops for 78, 45, 33⅓ and 16 r.p.m. — 8 lb. die-cast, accurately machined, non-magnetic turntable — Centre spindle of ground and lapped steel in sintered bronze main bearing. — Wow and flutter-0.2% maximum. — Rumble and hum — negligible. — Less than 1% speed change for 13% mains voltage change. — Press-button 'on/off' switch, linked to pilot light. Automatic disengagement of drive when switch is in 'off' position. Dimensions: 14¼" front to back; 13¼" side to side. Clearance required below mounting board 3".

GOLDRING-LENCO
'88'
Transcription Unit
£16.5.6 (+P.T. £2.1[illegible].11)

GOLDRING MANUFACTURING CO. (G.B.) LIMITED · 486-488 HIGH ROAD, LEYTONSTONE, LONDON, E.11 · TELEPHONE: LEYTONSTONE 8343

WW—006 FOR FURTHER DETAILS

NEW A-B-C CAMERA CAPTURES FASTER AND FAINTER TRACES



AVO-BEATTIE-COLEMAN OSCILLOSCOPE CAMERAS

f1.2 OSCILLOTRON

The new Mk. 2 565 — the world's most advanced oscilloscope camera—has a specially developed 86 mm f 1.2 lens and a 1 : 1 Object/image Ratio. When used with a suitable oscilloscope and Polaroid* 10,000 ASA film this camera gives probably the fastest film writing speed yet obtained.

The ability to produce distortionless prints in ten seconds is coupled with great ease of operation and other advanced features, many of which are exclusive to A-B-C.

A joint product of AVO Ltd. and Beattie-Coleman Inc.

** Regd. Trade Mark of Polaroid Corporation.*

- ☐ Electric shutter actuator and synch contacts.
- ☐ Binocular and non-parallax view of CRT.
- ☐ Calibrated focusing scale.
- ☐ Multiple exposures: up to 13 on one frame.
- ☐ Data logging and ultra-violet attachments available.

● Ask AVO for leaflet and how to obtain a no-obligation demonstration.

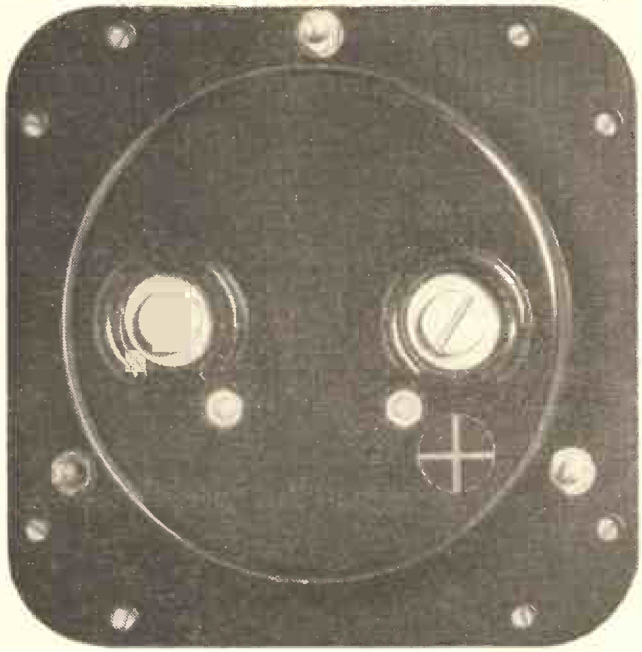
AVO LTD INSTRUMENTS DIVISION · 92-96 VAUXHALL BRIDGE ROAD · LONDON · S.W.1

Telephone: VICtoria 3404

(IN NORTH AMERICA: BEATTIE-COLEMAN INC., SANTA ANA, CALIFORNIA.)

ABC/3

We could show you the front...



...but which front do you want?

Here at Anders we have hundreds of meters of all types. Immediate off-the-shelf delivery from the largest stocks in the country—and a complete range of ancillaries, too. You need never be held up for a meter again. That's part of the Anders Meter Service which will meet the most urgent and unusual demands a customer can make—fast! If you want a meter calibrated to your own special requirements Anders can do it . . . and Anders experts will solve your metering problems in detail from just a broad outline. Whatever you want in metering — leave it to Anders.

■ Meters of all kinds from stock ■ Meter calibration/Meter modification/Ancillary equipment ■ Custom-designed meter circuitry and components □ *Sole U.K. distributors of FRAHM vibrating reed frequency meters and tachometers*

ANDERS METER SERVICE

ANDERS ELECTRONICS LTD 103 HAMPSTEAD ROAD LONDON NW1
TELEPHONE EUSTON 1639 *MINISTRY OF AVIATION APPROVED*

. . . and Marconi Instruments use it at every stage of panel layout and design. *Handleability* is seldom specified, but ergonomics is a very special study at St. Albans.

Look at any instrument in the new '2000 Series'. That light grey panel colour was not chosen—it was *formulated* to give maximum legibility to lettering. Combined controls are linked to give integrated readings, and link lines have explanatory legends clearly engraved. All controls are positioned for logical sequences of operation, colour-coded and conveniently spaced. Bar knobs are used for switches and milled knobs for variable controls—both types designed and made in the factory because those precise shapes and sizes were found to be *best* for each purpose.

Meters are placed where they can best be seen; scales have adequate resolution for the sensitivity of the instrument, and the whole layout is uncluttered and self-explanatory. These are *measuring* instruments, attractively styled and easy to handle.

If you have not received information about *all* the new instruments of the '2000 Series'—there are 30 of them now—a letter or telephone call will ensure that you are kept up-to-date.

A GOOD NAME FOR GOOD MEASURE

MARCONI INSTRUMENTS

MARCONI INSTRUMENTS LIMITED
ST. ALBANS · HERTFORDSHIRE · ENGLAND
TEL: ST. ALBANS 59292 · TELEX 23350

P4

WW—010 FOR FURTHER DETAILS.

So easy to build **Heathkit** DAYSTROM *So easy to use*

New ! !

TRANSISTOR MIXER
Model TM-1

"A must for the tape enthusiast"

Four channels with individual, continuously variable controls, plus a master volume control allows model to be used for recording from a wide variety of sources. e.g. dynamic and crystal microphones, radio tuners, record players, etc.

- ★ 7 transistor circuit and internal 9 v. battery (not supplied) allows unit to be used "in the field" as well as in the home, studio, etc.
- ★ Printed circuit board ensures consistent performance, easiest possible construction.
- ★ Professional, modern, compact, low silhouette styling.
- ★ Beautiful walnut veneered, fully finished cabinet.
- ★ Attractive anodised aluminium front panel.
- ★ Size: 11$\frac{11}{16}$in. x 7$\frac{1}{4}$in. x 3$\frac{3}{4}$in. high.

KIT **£11.16.6** Assembled **£16.17.6**

Full specification leaflet sent on request.

The Outstanding

20+20 WATT TRANSISTOR STEREO AMPLIFIER
Model AA-22U

This "International Class" amplifier offers you a realism and beauty of music never before obtainable at such a competitive price.

- ★ Professional, elegant, compact, slim-line styling.
- ★ The best of American transistor techniques in a British amplifier.
- ★ Beautiful walnut veneered, fully finished cabinet will harmonise with domestic furnishing schemes.
- ★ 5 stereo inputs (five on each channel) accommodate pick-up, radio tuner, tape and two other sources.
- ★ 20 transistor 10 diode circuit.
- ★ Dimensions: 15$\frac{9}{16}$in. wide x 3$\frac{7}{8}$in. high x 12$\frac{1}{8}$in. deep.

Kit **£43.18.0** Assembled **£68.16.0**

Send for full specification leaflet.

COMPARE ANY HEATHKIT MODEL FOR PRICE, PERFORMANCE, QUALITY

6 W HI-FI STEREO AMPLIFIER KIT Model S-33H

An inexpensive stereo-mono amplifier with the high sensitivity necessary for lightweight miniature ceramic pick-ups (e.g. Decca Deram). De luxe version of the S-33 with attractive two-tone grey Perspex panel.

Kit **£15.17.6** Assembled **£21.7.6**

5 W HI-FI MONO AMPLIFIER KIT Model MA-5

A low-priced general purpose Hi-Fidelity amplifier based on the popular S-33 for those who do not require a stereophonic system. Separate bass and treble controls. Gram and Radio inputs. Suitable for most crystal pick-ups. A printed circuit simplifies construction.

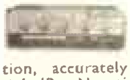
Kit **£10.19.6** Assembled **£15.10.0**

HI-FI MONO POWER AMPLIFIER KIT Model MA-12

A compact Hi-Fidelity power amplifier (including auxiliary power supply). 12 watts output. Wide frequency range and low distortion. A variable sensitivity control is fitted enabling it to be used with an existing amplifier in a stereophonic system. Other applications include sound reinforcement systems, transmitter modulators, for use with tape recorders, also as a general purpose laboratory amplifier.

Kit **£11.18.0** Assembled **£15.18.0**

STEREO CONTROL UNIT KIT Model USC-1



Incorporates all worthwhile features for Hi-Fidelity stereo and mono. Push-button selection, accurately matched ganged controls to ±1 dB. Negative feedback rumble and variable low-pass filters. Printed circuit boards. Accepts inputs from most tape-heads and any stereo or mono pick-up.

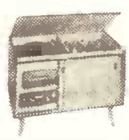
Kit **£19.10.0** Assembled **£26.10.0**

HEATHKIT-THOMAS (Transistorized) ELECTRONIC ORGAN KIT Model GD-232BE

Can be built with no knowledge of electronics.

Kit **£197.10.0** Bench **£14.10.0** (Surcharge extra)

HI-FI EQUIPMENT CABINETS



A range of equipment cabinets is now available. Designed for maximum operating convenience or for where room space is an over-riding consideration, this range includes easy-to-build kits or ready-assembled cabinets in the white for finish to own requirements.

"**MALVERN**" (*illustrated*) Kit. £18.1.0 (inc. P.T.) Assembled (left in the white) £23.6.0

"**GLOUCESTER**" Mk. 1 for Tape Deck or Record Player Kit £17.3.6 (inc. P.T.). Assembled £22.8.6

"**GLOUCESTER**" Mk. 2 for Tape Deck and Record Player Kit £18.10.0 (inc. P.T.). Assembled £23.15.0

"**CHEPSTOW**" for Record Player or Tape Deck. Kit £11.12.6 (inc. P.T.). Assembled £16.17.6

How to install Hi-Fi in YOUR home

If you are planning to install a Hi-Fi system in your home, and are uncertain of the type of equipment to use, our widely experienced technical staff will with pleasure put forward recommendations. All you have to do is state the type of installation contemplated, the price you are prepared to pay and give details of existing equipment you wish to include, if possible.

6 W STEREO AMPLIFIER KIT Model S-33

A versatile high-quality self-contained STEREO Amplifier with adequate output for a living room. 3 watts per channel: 0.3% distortion at 2.5 w/channel; 20 dB N.F.B., inputs for Radio (or Tape) and Gram, Stereo or Monaural; Ganged controls. Sensitivity 200 mV.

Kit **£13.7.6** Assembled **£18.18.0**

INTERNATIONAL MAIL ORDER SCHEME

Covering the American Heathkit range of 250 models

Direct from U.S.A. to your U.K. address. Illustrated American catalogue and full details can be obtained from us for 1/- post paid.

● **Deferred Terms available on orders above £10** ●

MONO CONTROL UNIT KIT Model UMC-1

Ideal for use with MA-12 or similar amplifier. Output 0.25 v. *Send for full details.*

Kit **£8.12.6** Assembled **£13.12.6**

HI-FI SPEAKER SYSTEM KIT Model SSU-1

Ducted-port bass reflex cabinet "in the white." Frequency response is 40-16,000 c/s. Power rating 10 watts. Matched speaker units 8in. high flux (12,000 lines) with hyperbolic cone and 4in. wide angle dispersion type for higher frequencies.

Kit (with legs) **£12.12.0** (Less legs) **£11.17.6** (inc. P.T.)

"COTSWOLD" SPEAKER SYSTEM KIT

This acoustically designed enclosure measures 26 x 23 x 14$\frac{1}{2}$in., and houses a special 12in. base speaker with 2in. speech coil, elliptical middle speaker together with a pressure unit to cover the full frequency range of 30-20,000c/s. Its polar-distribution makes it ideal for really Hi-Fi Stereo. Delivered complete with speakers, cross-over unit, level control, grille cloth, etc. Left in the white for finish to personal taste, all parts are pre-cut and drilled for ease of assembly.

Kit **£25.12.0** Assembled **£33.17.0**

"COTSWOLD M.F.S." SPEAKER SYSTEM KIT

This model, based on the standard Cotswold, measures only 36in. high, 16$\frac{1}{2}$in. wide by 14in. deep. Particularly recommended to those who require the best results in small rooms.

Kit **£25.12.0** Assembled **£33.17.0**

DAYSTROM LTD.

DEPT. W.W.9, GLOUCESTER, ENGLAND

A subsidiary of the Heath Company.

MANUFACTURERS OF THE WORLD'S LARGEST-SELLING ELECTRONIC KIT-SETS

WW—013 FOR FURTHER DETAILS.

Thoroughly **Heathkit** DAYSTROM *dependable*

AMATEUR TRANSMITTER KIT
Model DX-40U

Covers all amateur bands from 80 to 10 metres, crystal controlled. Power input 75 watts C.W. 60 watts peak controlled carrier phone. Output 40 watts to aerial. Provision for VFO. Filters minimise T.V. interference. Modulator and power supplies are built-in. Single knob band switching is combined with a pi-network output circuit for complete operating convenience. A high-grade moving-coil meter indicates the final grid or anode current. Provision is made for the use of 3 crystals with access through a trap-door in the back of the cabinet. A 4-position switch selects the appropriate crystal or a jack for external VFO which can be used instead of the crystal(s).

Kit ... £33.19.0 Assembled ... £45.8.0

SINGLE SIDEBAND ADAPTER KIT
Model SB-10U

May be used with most A.M. transmitters with certain provisions. Allows full use of existing equipment for SSB facilities. Band coverage: 80, 40, 20, 15, 10 m. Unwanted sideband suppression; better than 30 dB. Carrier suppression: better than 40 dB. Power requirements: 300 v. D.C. 85 mA. (average) 30 mA. (standby), 140 mA (transmit), 6.3 v. A.C., 3.5 A. Meter: 2½in. Scale edge reading, 200μA movement, indicates carrier null and relative power output. Cabinet 11in. high x 8in. wide x 14¾in. deep.

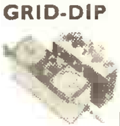
Kit ... £39.5.0 Assembled ... £54.18.0

AUDIO SINE-SQUARE WAVE GENERATOR KIT. Model AO-1U

Covers 20 c/s. to 150 kc/s. in four ranges with choice of sine or square waves. The latter up to 10 kc/s. Output 10 v. max. and distortion less than 1%. Ideal for audio testing. Size 9½ x 6½ x 5in.

Kit ... £14.15.0 Assembled ... £21.5.0

GRID-DIP METER KIT. Model GD-1U



Functions as oscillator or absorption wavemeter. With plug-in coils for continuous frequency coverage from 1.8Mc/s. to 230 Mc/s.

Kit...£10.19.6 Assembled...£13.19.6

Additional Plug-in Coils Model 341-U extend coverage down to 350 kc/s. With dial correlation curves, 17/6.

TRANSISTOR INTERCOM KITS
Models XI-1U and XIR-1U

Ideal for home or business use. Up to five remote stations can be operated with each Master. The Master unit can call any one, any combination, or all five Remote stations and any Remote station can call the Master. A private call to any Remote station cannot be interrupted or overheard by any other while a conversation is in progress. Any Remote station can talk to any one or all others provided the Master is manned. These kits have been designed for easy construction and high performance. The mahogany veneered wooden cabinets are supplied completely assembled and finished. The Master unit has a 4-transistor amplifier and is operated by an internal 9 v. battery as are the Remote units. Batteries are not included with the Kits.

Model XI-1U (Master)

Kit ... £10.19.6 Assembled ... £16.19.6

Model XIR-1U (Remote)

Kit ... £4.7.6. Assembled ... £5.16.0

A WIDE RANGE OF BOOKS ON ELECTRONICS AND RADIO AVAILABLE.
Send for Lists and Prices.

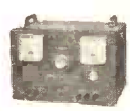
"MOHICAN" GENERAL COVERAGE RECEIVER KIT
Model GC-1U

This fully transistorised receiver which includes 4 piezo-electric transfilters, is in the forefront of receiver design. It is an excellent portable or fixed station receiver. The R.F. "front-end" is supplied as a pre-assembled and pre-aligned unit. Its many features include a 10-transistor circuit, printed circuit board, telescopic whip antenna, tuning meter, and a large slide-rule dial giving a total length of approximately 70 inches. Housed in a steel cabinet and powered by two 6 volt dry batteries (not supplied), mounted internally, it gives frequency coverage from 580 kc/s. to 30 Mc/s. in five bands; thus enabling world-wide reception. Electrical bandspread covers the amateur bands from 80 to 10 metres—each band having a scale length of approximately 8 inches. BFO tuning and Zener diode stabiliser. Size 6⅞ x 12in. x 10in.

Please write for specification leaflet.

Kit ... £37.17.6 Asmbld. ... £45.17.6

STABILISED POWER PACK
Models MSP-1M and MSP-1W



Specially recommended for industrial and laboratory use, meeting the need for a reliable and versatile stabilised power pack capable of a very high performance. Input 200-250 v. 40-60 c/s., A.C., fully fused. Outputs: H.T. 200-410 v. D.C. at 0-225 mA. in 3 switched ranges. Unstabilised A.C., 6.3 v. at 4.5 A. centre-tapped. Two 3in. "easy-to-read" meters for reading voltage and current simultaneously. Separate L.T. and H.T. supply transformers. All output circuits are isolated. Size 13in. x 8½in. x 9½in.

MSP-1M (with meters)

Kit ... £36.12.6 Asmbld. ... £43.12.6

MSP-1W (less meters)

Kit ... £29.17.6 Asmbld. ... £36.17.6

BALUN COIL UNIT KIT

Model B-1U. Will match unbalanced co-axial lines to balanced lines of either 75 or 300Ω impedance. Frequency range 10-80 m., input up to 200 watts.

Kit ... £4.15.6 Asmbld. ... £5.8.6

TAPE PRE-AMPLIFIER KITS
Models TA-1M and TA-1S

This Combined Tape Record/Replay Amplifier is available in both monophonic and stereophonic models. Model TA-1M can be modified to the stereo version with modification kit TA-1C.

TA-1M Kit £19.8.0 Asmbld. £28.18.0
TA-1S Kit £25.10.0 Asmbld. £35.18.0
TA-1C Kit ... £6.15.0

All prices include free delivery in the U.K.

Deferred Terms are available on all orders above £10

AMATEUR TRANSMITTER KIT
Model DX-100U

The World's most popular Amateur TX Kit

- Completely self-contained. 150 w. D.C. input.
- Built-in highly stable VFO and all Power Supplies.
- The KT88 high-level anode and screen modulator stage gives over 100 watts of audio from less than 1.5 mV. input.
- Keying on CW is via the VFO and buffer amplifier cathodes; the other RF valves are biased beyond cut-off.
- Provision has been made for remote control operation.
- Covers all Amateur bands up to 30 Mc/s. 'phone or CW.

Kit ... £79.10.0 Assembled...£104.15.0

AMATEUR BANDS RECEIVER KIT

Model RA-1 The ideal economically priced fixed station, portable or mobile receiver covering the Amateur bands from 160-10 m., each band separately calibrated on a large illuminated slide-rule dial. Features: Signal strength meter, tuned RF amplifier stage, half-lattice filter, adjustable noise limiter. Freq. coverage 160, 80, 40, 20, 15, 10 metre bands. I.F. 1620 kc/s.

Kit ... £39.6.6 Assembled ... £52.10.0

AMERICAN HEATHKIT
SINGLE SIDE BAND EQUIPMENT

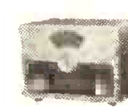
For direct delivery from U.S. Plant. Send for details of models. Fully illustrated American Catalogue of Heathkit range sent for only 1/- post paid.

REFLECTED POWER METER KIT

Model HM-11U. Indicates, reliably but inexpensively, whether the R.F. power output of your transmitter is being transferred efficiently to the radiating antenna.

Kit ... £8.5.0 Assembled ... £10.10.0

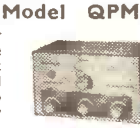
VARIABLE FREQUENCY OSCILLATOR KIT. Model VF-1U



Specially designed to meet the demand for the maximum possible flexibility from an amateur Transmitter which would otherwise be subject to certain limitations imposed by crystal control. Calibrated for all Amateur bands 160-10 metres, fundamentals on 160 and 40 m. Ideal for Heathkit DX-40U and similar transmitters.

Kit ... £10.17.6 Assembled ... £15.19.6

Q MULTIPLIER KIT. Model QPM-1



A reasonably priced Q Amplifier for the amateur and short-wave enthusiast. This self-powered unit (200-250 v. 50/60 c/s.) may be used with communications receivers to provide both additional selectivity and signal rejection.

Models QPM-1 for 470 kc/s. IF. QPM-16 for 1.6 Mc/s. IF.

Kit, either model £8.10.0
Assembled £12.14.0

By arrangement with **RECORD HOUSING** we can now supply you with any one of their large range of fully finished Equipment Cabinets. ***May we send you details?***

DAYSTROM LTD.

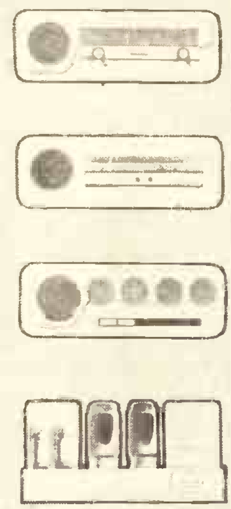
DEPT. W.W.9, GLOUCESTER, ENGLAND

A subsidiary of the Heath Company.

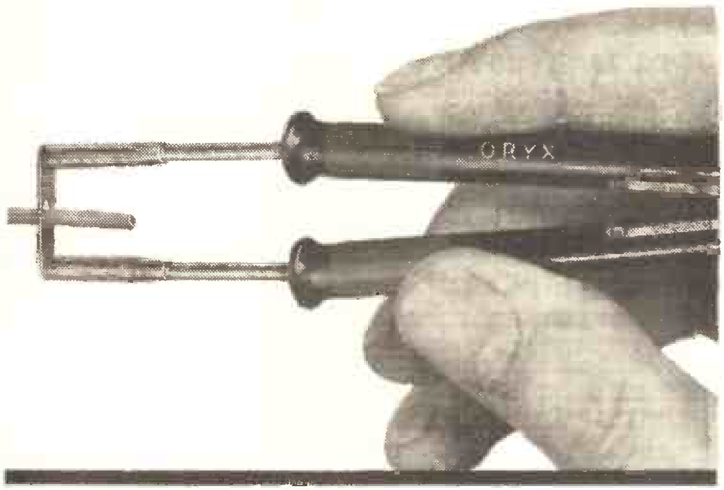
MANUFACTURERS OF THE LARGEST-SELLING KIT-SETS IN THE WORLD

Please send me FREE CATALOGUE (Yes/No)............
Full details of Model(s)..
NAME..
(Block Capitals)
ADDRESS ....
.... WW-9

WW—015 FOR FURTHER DETAILS.



Have you seen our hot stripper?

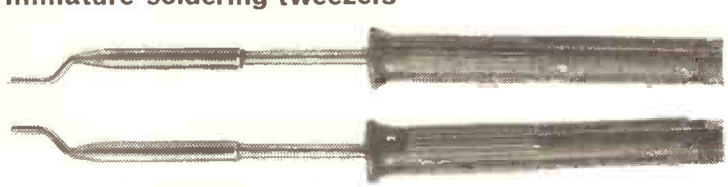


miniature heat wire stripper

one of many ORYX products

miniature mains soldering iron

miniature soldering tweezers



illustrated leaflet from

W.Greenwood Electronic Ltd.

677 FINCHLEY ROAD, LONDON, N.W.2.
telephone: SWIss COTTAGE 3383/4

for electronic components...

ASK PALMERS FIRST

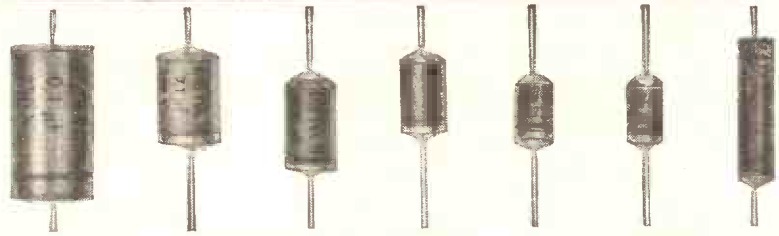
PALMER DATA REFERENCE SHEET FOR

ERO CAPACITORS ROE

A range of paper and plastic film and electrolytic capacitors. Conforming to NATO & I.E.C. specifications.

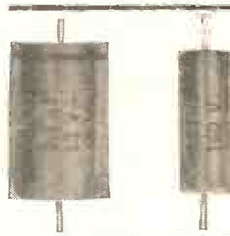
EROFOL II Type HX
Polyester Capacitors

Range of Values	from 33pF to 0.47 μF
Tolerance	from 5% to 10%
Voltage Range	from 100V to 1000V



EROMAK I (Type Hf)
Polycarbonate Capacitors

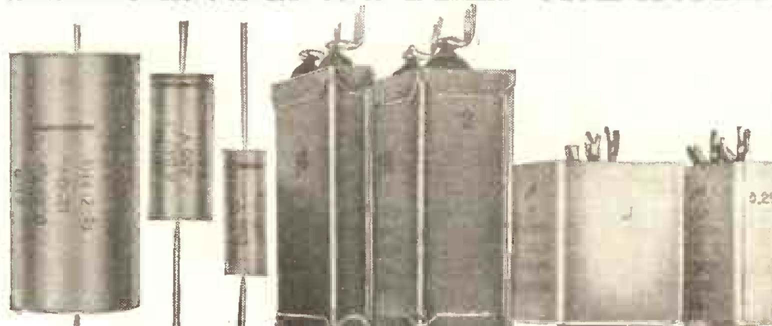
Range of Values	100pF to 1.0 μF
Tolerance	from 1% to 20%
Voltage Range	from 63V to 400V



Paper Capacitors
Tubular & Rectangular Can Styles

Range of Values	from 47pF to 10μF
Tolerance	10% & 20%
Voltage Range	from 250V to 16KV

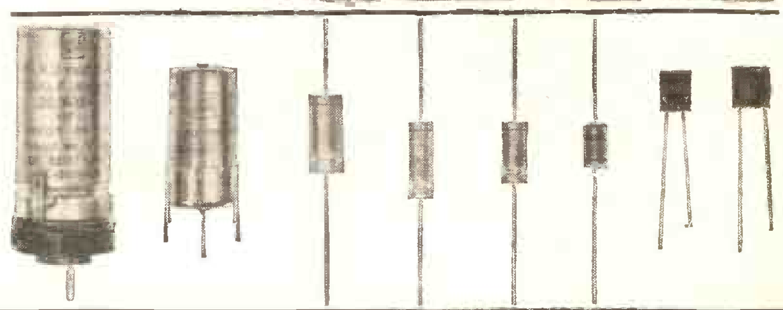
Multiple types also available



ROE
Electrolytic Capacitors
Subminiature, miniature & standard types

Range of Values	from 0.1μF to 25000 μF
Voltage Range	from 3V to 450V

Multiple types and special mountings available



For further details concerning ranges and specifications of capacitors write to:

G. A. STANLEY PALMER LIMITED

Island Farm Avenue, West Molesey Trading Estate, East Molesey, Surrey.

M & P SPE9

WW—018 FOR FURTHER DETAILS.


S.S.White
FLEXIBLE
REMOTE
CONTROL
OUTFIT
INSTRUCTIONS
S.S.White
INDUSTRIAL DIVISION
Third Avenue, Denbigh Road, Bletchley, Bucks.
S.S.White
50 FEET
REMOTE CONTROL

Wireless World

INFORMATION SERVICE FOR PROFESSIONAL READERS

To obtain further details of any of the coded items mentioned in the Editorial or Advertisement pages of this issue, please complete one or more of the attached cards entering the reference number(s). Your enquiries will be passed on to the manufacturers concerned and you can expect to hear from them direct in due course. Cards posted from abroad require a stamp.

PLEASE USE CAPITAL LETTERS

Pour obtenir tout autre renseignement sur tout article mentionné dans l'Editoral ou dans les pages publicitaires de ce numéro, nous vous prions de remplir une ou plusieurs des cartes ci-jointes en inscrivant le numéro ou les numéros de référence. Vos demandes de renseignement seront transmises aux fabricants intéréssés qui, en temps voulu, vous feront parvenir une réponse. Il est nécessaire d'affranchir les cartes postées de l'étranger.

PRIÈRE D'UTILISER DES CARACTÈRES D'IMPRIMERIE

Weitere Einzelheiten über irgendwelche Artikel, die auf redaktionellen oder Anzeigenseiten erscheinen erhalten Sie, indem Sie eine oder mehrere der beigefügten Karten ausfüllen und die Kennummer(n) angeben. Ihre Anfrage wird an den Hersteller weiter geleitet, und Sie werden dann direkt von ihm hören. Karten, die im Ausland aufgegeben werden, müssen frankiert werden.

BITTE IN BLOCKSCHRIFT AUSFÜLLEN

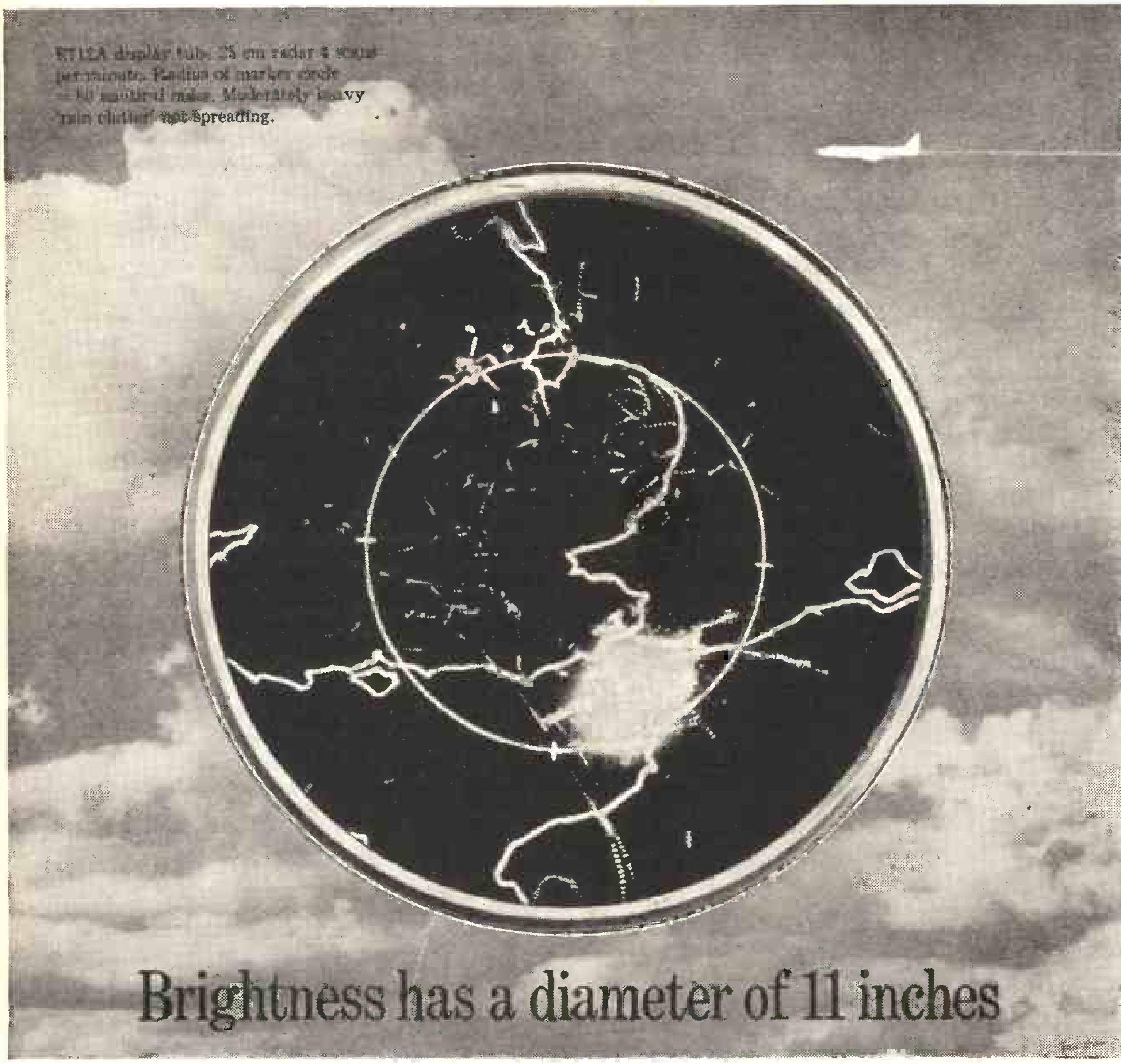
Per ulteriori particolari in merito agli articoli menzionati nel testo o nelle pagine pubblicitarie di questo numero, Vi preghiamo di completare una o piú delle schede allegate citando il numero o i numeri di riferimento. La Vostra richiesta sara inoltrata ai fabbricanti interessati che Vi risponderanno direttamente. Le schede dall'estero devono essere regolarmente affrancate.

SI PREGA DI COMPILARE LE SCHEDE A STAMPATELLO

Con objeto de obtener mas detalles de cualquiera de los articulos mencionados en las paginas editoriales o de anuncios de este numero, sirvase rellenar una o mas de las unidas tarjetas citando el numero o numeros de referencia. Sus consultas seran transmitidas a los fabricantes interesados de quienes tendran noticias directamente a su dedibo tiempo. Las tarjetas enviadas desde el extranjero requieren franqueo.

SIRVASE ESCRIBIR CON LETRAS MAYUSCULAS

WW—003 FOR FURTHER DETAILS.



FOR BROAD-DAYLIGHT VIEWING OF RADAR DISPLAYS— THE EEV HIGH BRIGHTNESS STORAGE TUBE E712A

Adding a new dimension to bright radar displays, the English Electric high brightness 11-inch diameter direct-view storage tube, type E712A, gives a brightness 100 times greater than that available from normal long persistence cathode ray tubes. When used in Air Traffic Control and the majority of other radar display applications, the outstandingly significant increase in brightness of the E712A permits the operator to observe a large area display in broad-daylight, unencumbered by the previously necessary viewing hood. Even with direct sunlight shining upon the face-plate full intelligence can still be attained through the use of a simple light filter.

Full information on the E712A and other high brightness storage tubes, together with CRTs of conventional design, is available on request.

ENGLISH ELECTRIC VALVE CO LTD CHELMSFORD ENGLAND

Telephone:Chelmsford3491,Ex262,Telex99103 | AGENTS THROUGHOUT THE WORLD

EEV

WW—004 FOR FURTHER DETAILS.

TELCON THIN FOILS

Precision rolled from Copper-Nickel, Nickel-Chrome, Nickel-Iron, Beryllium Copper, Tantalum, Zirconium, Mumetal, Radiometal, H.C.R. Alloy, precious metals etc.

Telcon thin foils are rolled on Sendzimir type mills in thicknesses down to 0.00013″ (plus/minus 0.00002″) and in maximum widths of 3″-6″. The high quality, excellent shape, accuracy of width and gauge, freedom from pin holes is achieved by precision rolling techniques, specially developed by Telcon. Materials can be supplied with a thickness record chart taken from beta-ray gauges. The table below shows the more usual materials supplied as foil, but customers' own materials can be rolled by special arrangement.

Material	Typical uses	Min. thickness regularly rolled in inches	*Category
Mumetal	High frequency uses, bobbin cores	0.0005	RM
	for memory devices	0.00012	RM
Radiometal 50	Special cores for pulse transformers	0.0005	RM
H.C.R. Alloy	High frequency pulse transformers	0.0005	RM
Permendur		0.0005	RM
Steels:			
Telmar A1S1.302		0.002	RM
A1S1.316L	Diaphragms	0.001	S
		0.0008	S
Stainless 18/8		0.00015	S
Vicalloy	Magnetic recording tapes	0.00025	SM
Cu-Be 250	Miniature electrical applications	0.000115	RM
Telconstan	Strain gauges	0.00015	SM
Telcalloys	Resistor applications	0.0005	SM
Pyromic 80/20	Aircraft de-icing equipment	0.0002	RM
Calomic 60/16	Resistor applications	0.0002	SM
Telcoseal	Precision glass seals	0.0004	SM
Phosphor Bronze	Fuses and springs	0.00198	R
Zirconium	Flash bulbs	0.0005	R
Titanium		0.0005	S
Molybdenum		0.0005	S
Copper			
(Vacuum melted)	Printed circuits	0.0002	SM
Silver		0.00075	S
Tantalum	Capacitor and complex electronic uses	0.0003	S
Nickel		0.0005	SM

*Categories: R = Regular production, S = To special order, M = Telcon Alloy

For further information please write to:—

TELCON METALS LTD

Manor Royal, Crawley, Sussex.

Tel: Crawley 28800. Grams: Telcon, Crawley, Telex. Telex: 87248

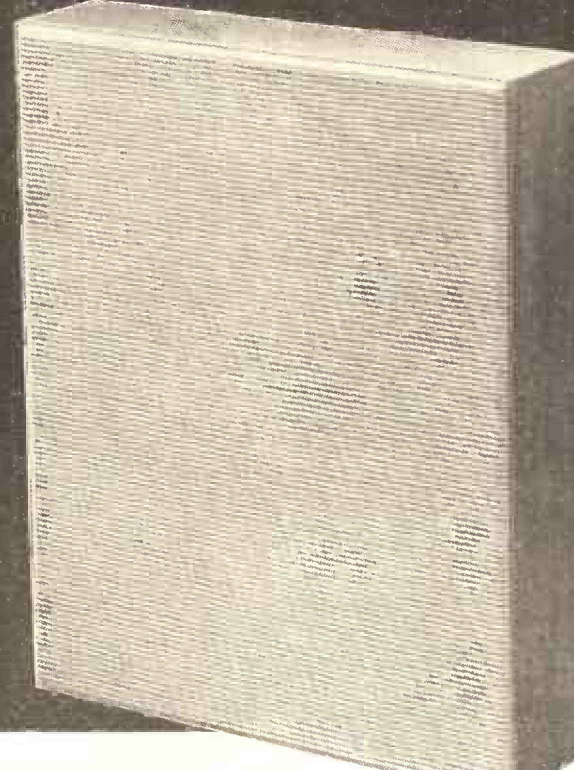
Member of the **BICC** *Group of Companies*

WW—026 FOR FURTHER DETAILS.

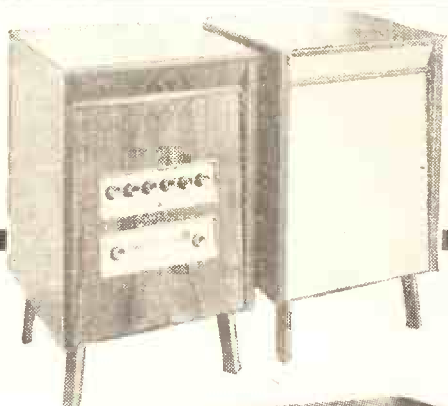
WHITELEY

CABINETS FOR HI-FI REPRODUCTION

THE NEW SLIMLINE
LC.92



- **SLIM CABINET**
  only 6" deep. Height 29". Width 24".
- **A 9", 15 OHMS DRIVE UNIT**
  with graded cone and extended treble response.
- **ACOUSTIC LABYRINTH CABINET**
  gives balanced response throughout the audio spectrum.
- **CLEAN DESIGN**
  Walnut cabinet with satin melamine finish. Weight 25½ lbs.

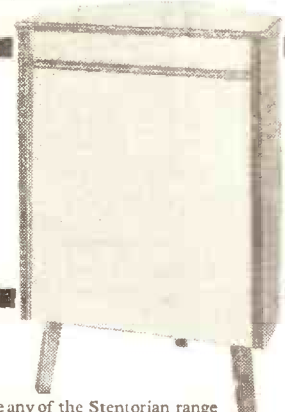


THORESBY BASS REFLEX CONSOLE CABINET (C15)

This cabinet is designed for Stentorian 8" or 10" Loudspeakers and there is also provision for fitting tweeter unit if desired. *Size:* Height 31" × Width 19¾" × Depth 18".
Mahogany (C15) Walnut (C15A)

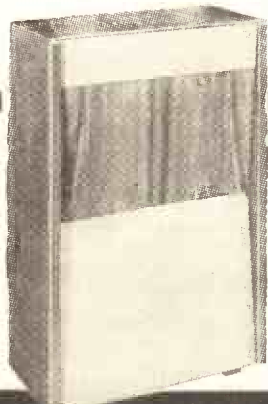
THORESBY HI-FI EQUIPMENT CONSOLE (C16)

This takes most makes of tape-deck or record player, amplifiers, pre-amplifier control unit and radio tuner. *Size:* Height 31" × Width 19¾" × Depth 18".
Mahogany (C16) Walnut (C16A)



THORESBY BASS REFLEX CORNER CONSOLE (C14)

Specially designed to utilise the natural acoustic properties of walls, it is ideally suitable for use where space-saving is a consideration. It is sturdily constructed to take every advantage of Stentorian 8" or 10" units, with provision for tweeter unit. *Size:* Height 31" × Width 19¾" × Depth 17".
Mahogany (C14) Walnut (C14A)



THORESBY SLIM LINE CABINET (C17)

This enclosure has been designed to accommodate any of the Stentorian range of 8" or 10" units. Provision is made for the addition of either pressure or cone type tweeter and a crossover may be used.
The cabinet is substantially constructed and acoustically proportioned to give a balanced reproduction with the chosen units. *Size:* Height 31" × Width 20" × Depth 9¼"
Mahogany (C17) Walnut (C17A)

Ask your dealer for further details of the full range of Whiteley High Fidelity cabinets, or write to address below.

WHITELEY ELECTRICAL RADIO COMPANY LTD MANSFIELD NOTTS
Telephone: Mansfield 1762/5 London Office: 109 Kingsway, W.C.2

WB180

Men with transistors on their minds think of Newmarket

Newmarket are the natural people to think of for all AF transistor requirements. They're specialists. Know what they're about. Deliver on time. Set the pace with new types. Are pioneers of NPN transistors with AF performance characteristics. If you want AF, you'd better specify Newmarket.

AF TRANSISTORS

		Low Noise	*Predriver*	*Driver*	*Output*	*Switch*
PNP	Mid-gain	275 265,	215, 272 225, 262	214, 272 224, 262	218, 273 228, 263	212, 217 222, 227
PNP	High-gain	216, 226,	214, 274 224, 264	213, 274 223, 264	211, 271 221, 261	211, 218 221, 228
NPN	Mid-gain			774	774	
NPN	High-gain			713, 773	713, 773	

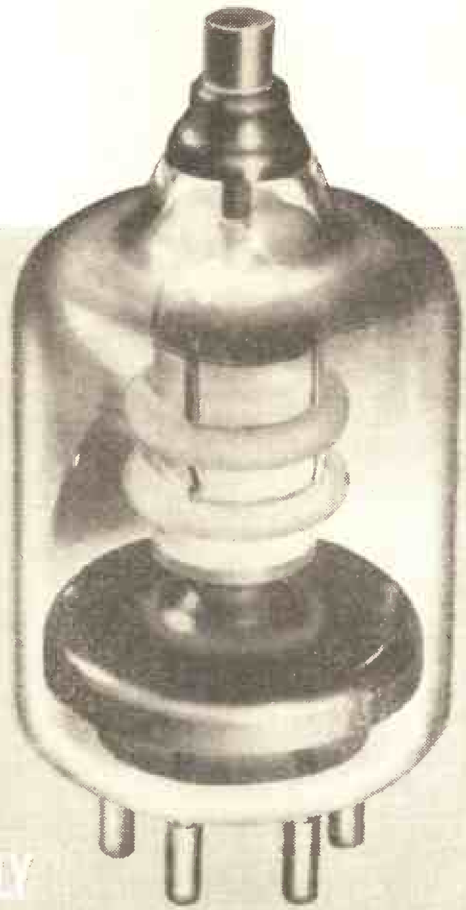
(NKT 210, 270, 710, 770 series = SO21 (TO1) outlines)
(NKT 220, 260, series = SO3 (TO5) outlines)

Newmarket
TRANSISTORS LIMITED

Data on all AF types available from: (NT 3) NEWMARKET TRANSISTORS LIMITED, EXNING ROAD, NEWMARKET. Tel: Newmarket 3381/4
DENMARK: Oskar Pade 4, Ingersvej, Charlottenlund, Copenhagen. FINLAND: Ingenjörsbyran Pluton, Kristinegatan 8 A 13, Helsingfors. SWEDEN: Forslid & Co. A. B. Rådmansgatan 56, Stockholm. NORWAY: H. Meltzer & Co. Rådhusgaten 17, Oslo 1. CANADA Musimart of Canada Ltd, 970 McEachran Avenue, Montreal 8.

WW—030 FOR FURTHER DETAILS.

RADIO VALVES



FOR EXPORT ONLY

HALTRON

WORLD WIDE DISTRIBUTION

Although we carry a permanent stock of 4,000,000, with a range of 3,000 types of receiving, special purpose and transmitting tubes as well as transistors, we offer an unparalleled service on 'the difficult types'—on those types which are sometimes hard to come by. Your enquiries for special types to CV, JAN and MIL specifications will have our immediate attention. The name HALTRON stands for a service unsurpassed in the world to-day.

HALL ELECTRIC LIMITED

Haltron House, Anglers Lane, London N.W.5 Tel: Gulliver 8531 (10 lines) Telex 2-2573 Cables: "Hallectric London NW5".

Ferrograph

SERIES Y RECORDERS

Series "Y" instruments are housed in strong metal cases and, in some instances, can be rack-mounted. They are intended for those engaged in scientific research and industrial pursuits.

YD5 SINGLE CHANNEL RECORDERS

Model	Tape Speeds	Voltage	Frequency
YD5A	$7\frac{1}{2}$, $3\frac{3}{4}$ and $1\frac{7}{8}$ i.p.s.	100/250V	50 c.p.s.*
YD5AH	15 and $7\frac{1}{2}$ i.p.s.	100/250V	50 c.p.s.*
YD5B	$7\frac{1}{2}$, $3\frac{3}{4}$ and $1\frac{7}{8}$ i.p.s.	100/250V	50 c.p.s.*
YD5BH	15 and $7\frac{1}{2}$ i.p.s.	100/250V	50 c.p.s.*

*60 c.p.s. to order

Y500 DOUBLE CHANNEL RECORDERS

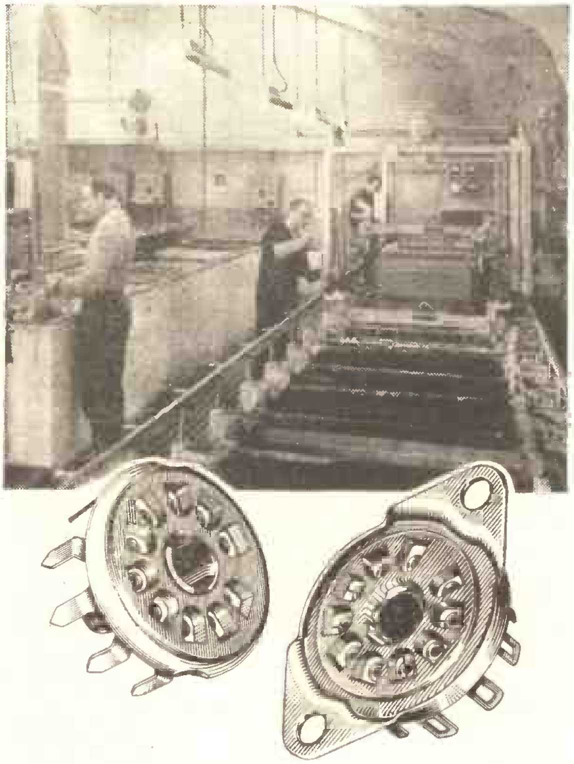
Model	Tape Speeds	Voltage	Frequency
Y532U	$7\frac{1}{2}$, $3\frac{3}{4}$ and $1\frac{7}{8}$ i.p.s.	200/250V	50 c.p.s.
Y532A	$7\frac{1}{2}$, $3\frac{3}{4}$ and $1\frac{7}{8}$ i.p.s.	117V	60 c.p.s.
Y532E	$7\frac{1}{2}$, $3\frac{3}{4}$ and $1\frac{7}{8}$ i.p.s.	110V	50 c.p.s.
Y522UH	15 and $7\frac{1}{2}$ i.p.s.	200/250V	50 c.p.s.
Y522HA	15 and $7\frac{1}{2}$ i.p.s.	117V	60 c.p.s.
Y522HE	15 and $7\frac{1}{2}$ i.p.s.	110V	50 c.p.s.

Send for details to:

THE FERROGRAPH COMPANY LTD

84 BLACKFRIARS ROAD, LONDON, S.E.I

Telephone: WATerloo 1981



B10B Valveholders

McMurdo supply special valveholders for the new 10 pin (Decal) based valves type B10B, moulded in polypropylene and phenol formaldehyde. Available for printed circuits or for chassis mounting.

Plating

A general view of plating shop with multi-tank automation line.

McMurdo

McMurdo Instrument Co. Ltd.
Rodney Rd., Portsmouth, Hants.
Tel. Portsmouth 35555. Telex 8612.
Contact our Sales Office for details of our full range

WW—038 FOR FURTHER DETAILS.

Valradio

TRANSVERTERS

(TRANSISTORISED D.C. CONVERTERS)

the D.C. conversion specialists since 1935

2 KW. Peak Starting. 750 W. Continuous. 50-60-400 c/s. or D.C. from 12-24-50 v. Battery. Up to 93% Efficiency. Polarity Reversal Protection. Square or Sinewave. Up to 300% Instant Overload Capacity. Manually Controlled Frequency. Reed Type Indicator. Remote Control Facilities.

Applications: Static "No-Break" Standby Power Supplies: For Vital System(s) Protection, e.g. V.H.F. Transmitters: Industrial Processes; Control-Alarm-Warning Systems: Mobile Use of Counters; Sig./Gen. Recorders—U/V Sound. Oscilloscopes and Lab. Gear in Marine and Aircraft (K114).

Range of models available with prices from £11-£94.10.0

Please write to department C.10 for transverter leaflet

VALRADIO LIMITED
BROWELLS LANE . FELTHAM . MIDDLESEX
ENGLAND Telephone: FELTHAM 4837-4242

Valradio and Stereosonoscope are the registered trade marks of Valradio Ltd.

WW—039 FOR FURTHER DETAILS.

SEMICONDUCTORS

Your single source of supply. World's leading export semiconductor specialists!

Over 5,000 Types in Stock

American	IRC	Saratoga
AMF	Kemtron	Semicon
Amperex	KMC	S.T.C.
Bendix	KSC	Sprague
Computer Diode	Lansdale	Sylvania
Delta	Micro-Optics	Raytheon
E.T.C.	Microwave Assoc.	RCA
General Electric	Motorola	TRW (SPI)
General Instr.	Mullard	Tung-Sol
HP Associates	National	Westinghouse
Industro	Power Components	

- **New current factory production**
- **MIL Spec devices**
- **Factory certificate of compliance**
- **Full factory warranty**
- **Procurement assignments undertaken**
- **Special prices on quantity requirements**
- **Cable enquiries replied by cable same day**
- **Immediate replies to all enquiries**

ELECTRON TUBES

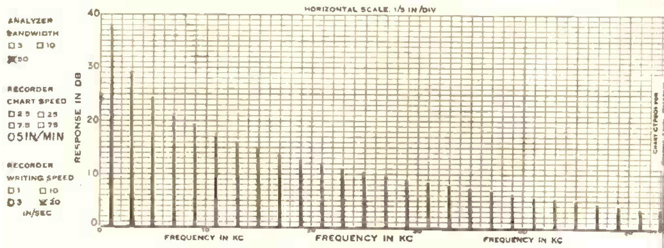
All major brands.
More than 4,000 types in stock.

Are we on your mailing lists? Are we on your bidders' list? Write or cable today.

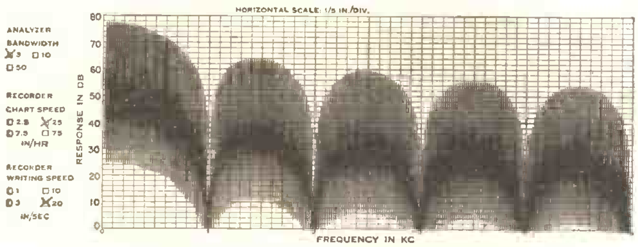
HARWIT INTERNATIONAL INC.
8549 Higuera St., Culver City, Calif. 90231 USA
Phone: (213) UPton 0-2256 Cable: HARINTER

WW—040 FOR FURTHER DETAILS.

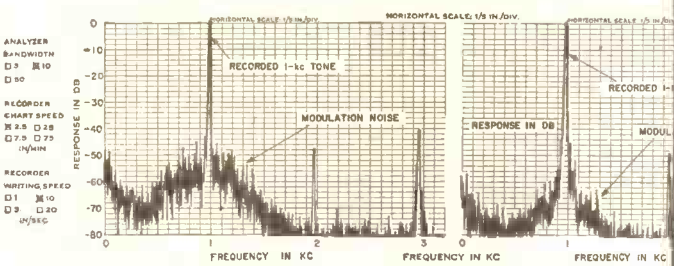
M. Fourier would have liked this Recording Wave Analyzer



Harmonic components of a 1-kc square wave.



Analysis of a 1-ms pulse with a 20-cycle repetition rate.



Graphic plot of modulation noise on a 1-kc tone for two different types of magnetic tape. Note that one tape has 10dB less noise. The Recording Analyzer is ideal for this type of measurement since its 80-dB dynamic range permits uninterrupted recording over wide ranges.


Type 1910-AQ1 Recording Wave Analyzer comes complete with Type 1900-A Wave Analyzer, Type 1521-B Graphic Level Recorder, and all accessories.

- Three bandwidths let you choose the best selectivity for each measurement . . . 3 c/s or 10 c/s for detailed measurements, 50 c/s for rapid analysis or for measurement of drifting signals. Bandwidth skirts are better than 80-dB down at ±25 c/s, ±80 c/s, and ±500 c/s for 3-, 10-, and 50-cycle bandwidths, respectively.
- Linear frequency scale from 20 c/s to 54 kc/s.
- Two outputs for recording, 100 kc/s with 80-dB dynamic range for inputs above 0.1 V, and 1-mA dc.
- 80-dB dynamic range for recording. You can make uninterrupted recordings . . . no attenuator switching in the midst of measurements.
- High input impedance (1-MΩ) on all ranges.
- Voltage range is 30μV to 300V, full scale, in 15 ranges. Accuracy, ± (3% of reading +2% of full scale).
- As a "Tracking Generator," instrument is both a signal source (delivering 2V across 600Ω) and a detector tuned to each other exactly.

For point-by-point measurements where the recorder is not used, these additional wave analyzer features add versatility and convenience

- Easy-to-read in-line frequency readout graduated in 10-cycle increments. ±0.5% calibration accuracy. Output for counter where extreme accuracy is desired.
- Incremental-frequency dial lets you fine-tune any component, covers ±100-cycle range independently of analyzer setting.
- AFC follows slowly drifting signals.
- Choice of 3 meter speeds – meter does the averaging.
- Excellent tunable filter. For example, the instrument can be used to produce 3-, 10-, and 50-cycle bands of noise over a tunable range from 20 c/s to 54 kc/s when a random-noise generator is connected to the analyzer.
- Price: Type 1900-A Wave Analyzer alone, £885; Type 1910-AQ1 Recording Wave Analyzer, £1395 duty free in U.K.

We believe M. Fourier's disciples will like this Analyzer, too.

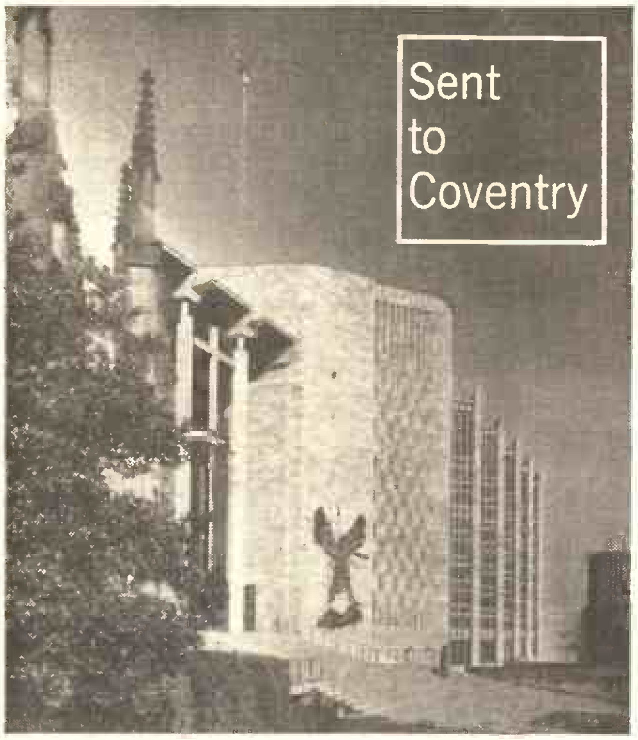
Write for Complete Information.

GENERAL RADIO COMPANY (U.K.) Limited

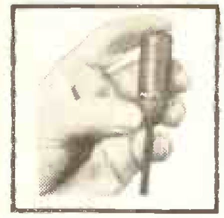
Bourne End, Buckinghamshire, England

Telephone: Bourne End 2567

WW—041 FOR FURTHER DETAILS.



Installation by G.E.C. Illustration: Coventry Cathedral, East side. Architect: Sir Basil Spence, O.M., R.A. Photograph: Henk Snoek.



649B, the smallest dynamic lavalier microphone, was sent to Coventry Cathedral (and also to BBC and ITV studios) because of its incomparably smooth and full-bodied response; its ability to mix outputs with any standard microphone; its lack of bulk and weight; and because of its history of trouble-free operation in the USA.

This tiny handful answers studio requests for a truly miniaturised, omni-directional microphone. Its performance, whether stand mounted, or as a neck-mike, is remarkable.

Send for literature, and see for yourself.

Length: 2½″ Weight: 31 gm. Output: −61 dB

PRICE: £24

Made in the U.S.A. by Electro-Voice

Distributed in Europe by KEF

Electro-Voice

KEF

Write to: KEF Electronics Ltd., Tovil, Maidstone, Kent. Tel: Maidstone 58361 Grams KEF Maidstone

WW—042 FOR FURTHER DETAILS.

---

get your gen

The first *three* Gen Books in Marconi Instruments new series are now available free on request. They are:

The Q-Meter Book WW—260 **The Sig-Gen Book** WW—261 **The AF Book** WW—262

Please use the Reader Service forms to obtain a complimentary copy of any of these useful publications.

Marconi Instruments Ltd · St. Albans · Herts · England

WW—043 FOR FURTHER DETAILS.

SOCKETS
in short supply?

You need a

Lexor

DIS–BOARD

DIS–BOARD is a registered trade mark.

THERE ARE OVER 1000 COMBINATIONS IN ALL TYPES OF FITTINGS

AVAILABLE FROM STOCK

Full literature and price list from

LEXOR DIS-BOARDS LTD

Allesley Old Road, Coventry. Tel. 72614.

WW—044 FOR FURTHER DETAILS.

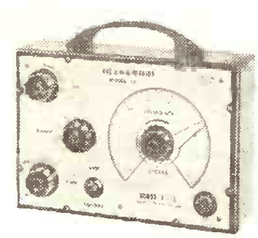
SIGNAL GENERATOR MODEL 27

NOMBREX TRANSISTORISED INSTRUMENTATION

- ★ Signal Generator 27 ... ... £9.16.9
- ★ Power Supply Unit 61 ... ... £6.14.6
- ★ C.R. Bridge 62 ... ... £8.11.9
- ★ Audio Generator 63 ... ... £17. 1.9
- ★ Inductance Bridge 66 ... ... £18. 6.9

All prices include battery, post and packing. Prompt Delivery.

S.A.E. FOR TECHNICAL LEAFLETS ● TRADE & EXPORT ENQUIRIES INVITED

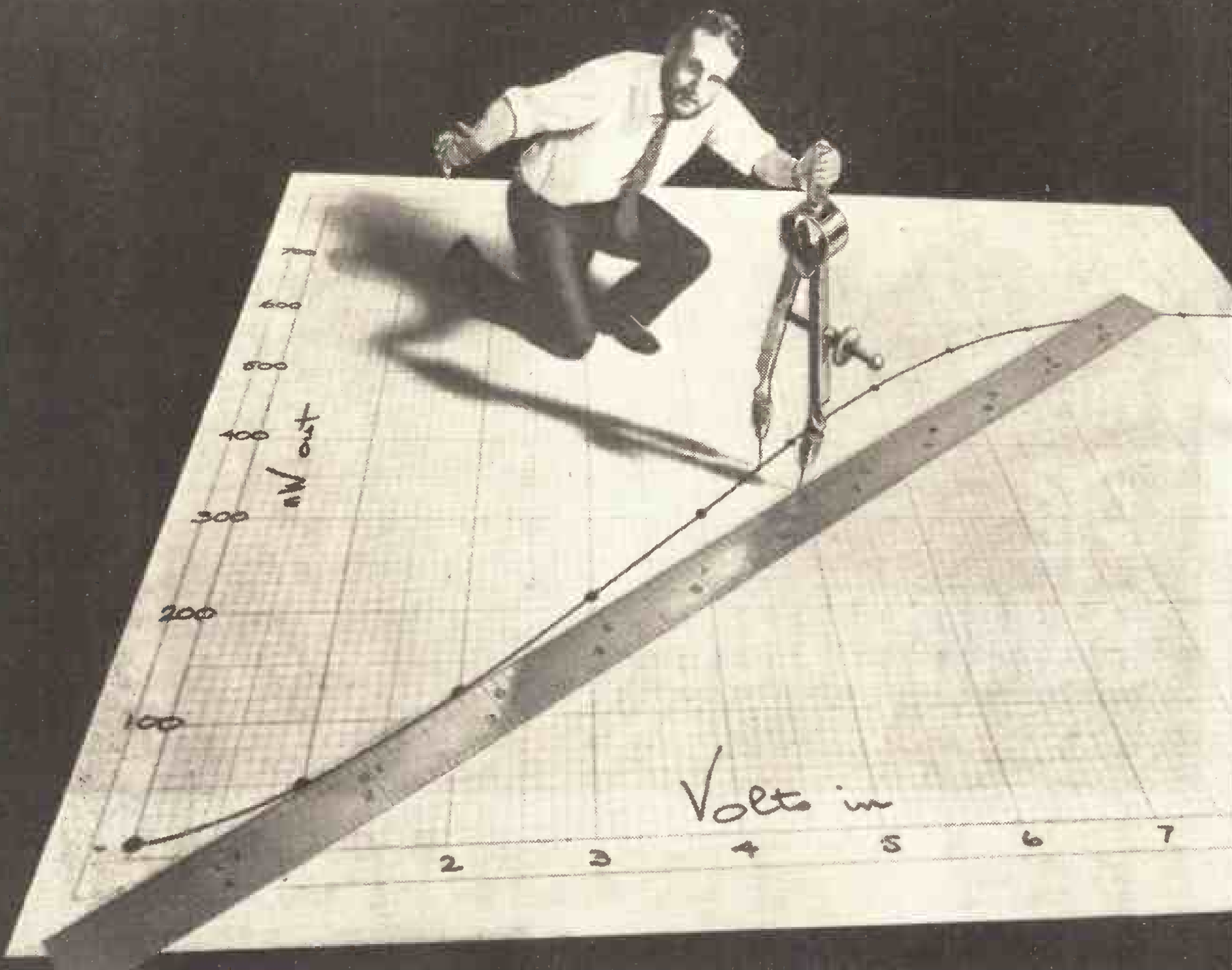


AUDIO GENERATOR MODEL 63

NOMBREX LTD. ESTUARY HOUSE, CAMPERDOWN TERRACE, EXMOUTH, DEVON. *Phone: 3515*

WW—045 FOR FURTHER DETAILS.

HOW DO YOU MEASURE NON-LINEARITY?



Harmonic analysis and measurements of distortion factor, noise, and intermodulation distortion are described in a new Marconi Instruments publication.

If you work with a.f. amplifiers or transmission networks, please ask for your complimentary copy

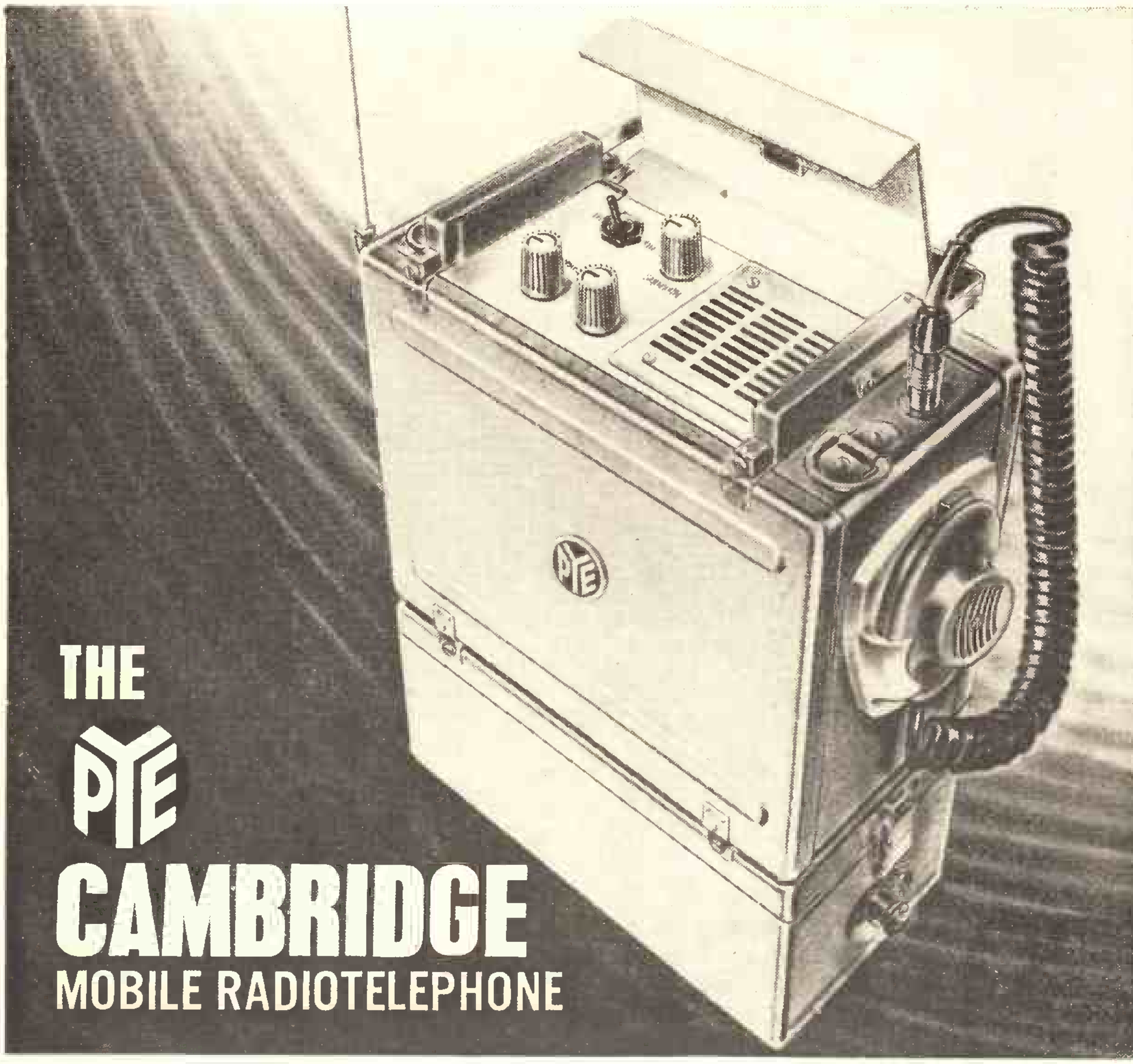
A GOOD NAME FOR GOOD MEASURE

MARCONI INSTRUMENTS

Marconi Instruments Limited, St. Albans, Herts.
Tel: St. Albans 59292 · Telex 23350

TC293

WW—046 FOR FURTHER DETAILS.



NOW–A high powered Portable!

At last—a compact, transistorised V.H.F. radio-telephone with all the power and performance of vehicle mobiles. The rechargeable battery gives up to *60 hours* duration on receive and about *18 hours* with normal use of the transmitter. The whole unit is completely weatherproofed, and is available for A.M. or F.M. systems. There is also a marine version. The answers to your questions are waiting at the address below.

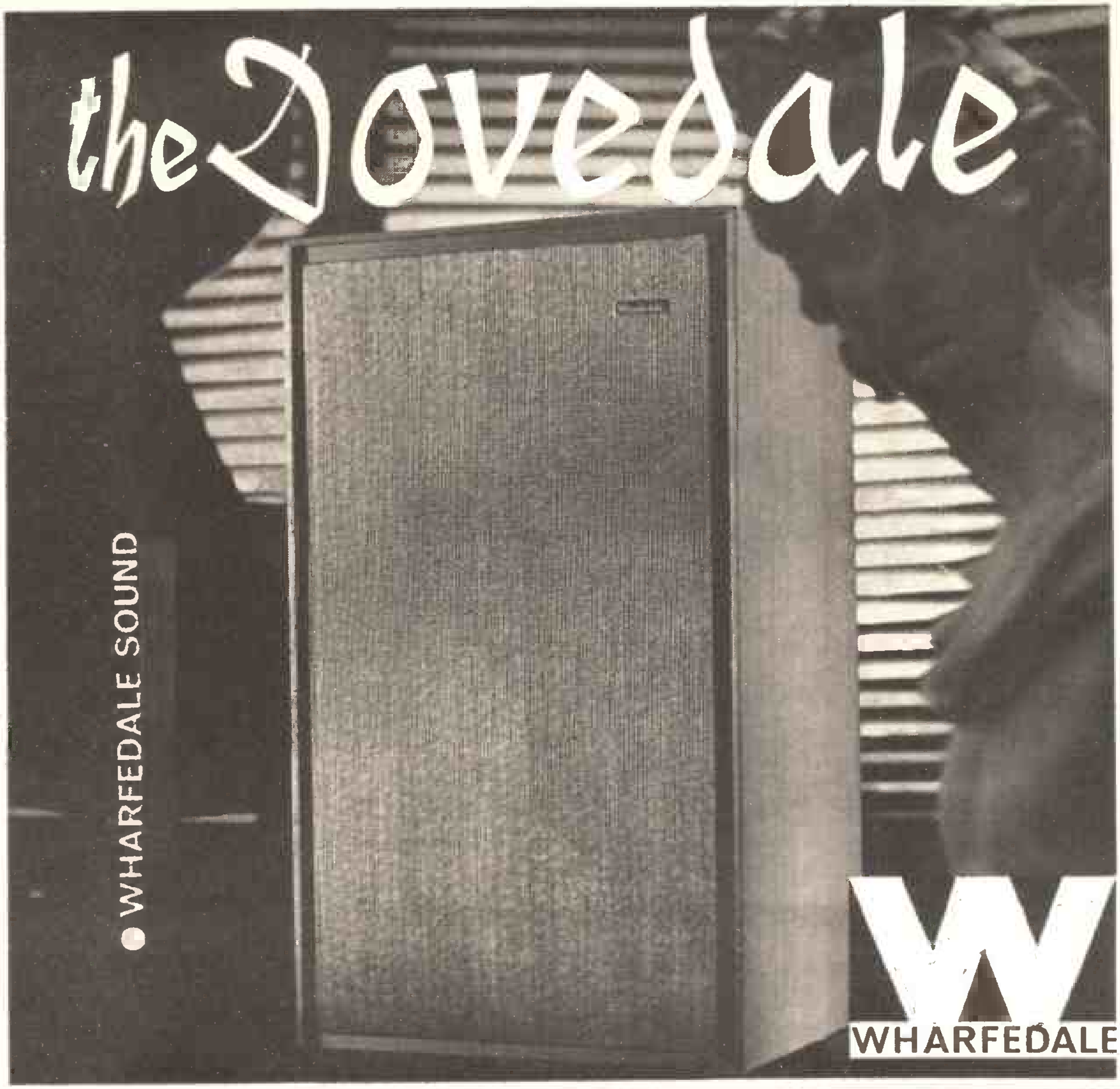
- **Frequency range 25 to 174 Mc/s.**
- **Fully transistorised receiver.**
- **Standby battery drain—200mA.**
- **5 Watts R.F. output.**
- **Sealed I.F. block filters.**
- **Electronic Squelch**
- **25 or 50 Kc/s channelling by change of filter.**
- **1 to 6 channels as required.**
- **Available with an additional A.C. Power Unit.**
- **Designed to meet British, American and European specifications.**

PYE TELECOMMUNICATIONS LTD.

CAMBRIDGE · ENGLAND · TELEPHONE: TEVERSHAM (CAMBRIDGE) 3131 · TELEX 81166.

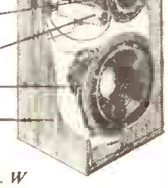
WW—047 FOR FURTHER DETAILS.

WHARFEDALE SOUND **stereo/mono**



The DOVEDALE is a restyled and improved version of the famous Wharfedale W 2. Research has proved that an enclosure of 2 cu. feet like the Dovedale is tunable and with a bass unit of very low resonance can produce 25 c/s easily and clearly. Hand built and finished in the Wharfedale tradition the Dovedale is possibly the most sensitive speaker available with this performance. To achieve these outstanding results it was necessary to develop the Flexiprene surround, producing a bass unit with a resonance of 20 c/s. Units—WLS/12 bass units with a 2" pole diameter having a flux density of 13,000 oersteds plus the well known Super 5 mid and treble range unit retained from the earlier W 2. Both speaker units face forwards and give tremendous presence. The treble balance is adjusted by volume control fitted to rear of enclosure.

- Treble Control.
- Crossover network ½ section 1 kc/s.
- Special Wharfedale 5" Tweeter unit with ceramic magnet.
- Tuning port.
- 12" bass unit with flexiprene roll surround and ceramic magnet.
- Cabinet of high density man made timber for reduced panel resonance.



Free technical folder on the Dovedale from Dept. W

Frequency range 25 c/s—17,000 c/s.
Impedance 10/15 ohms output.
Power Handling Capacity 15 watts (30 watts peak)
Size 24" x 14" x 12"   Weight 37 lb.
Finish zebrano, mahogany, walnut or teak veneers.

£31.10.0

WHARFEDALE WIRELESS WORKS LTD.
IDLE, BRADFORD, YORKSHIRE
Tel. Bradford 612552/3   Grams. 'Wharfdel' Bradford

Insulators have a list of satisfied customers as long as your arm . . .

TR114 Transistor Radio Case
in H.I. Polystyrene for
Rank Bush Murphy Ltd.

And what can Insulators mould for you?

With first-class design engineering facilities and three factories specialising in injection, compression and fibreglass mouldings respectively, Insulators are unusually well equipped to tackle any size or shape of problem in plastics. Ask any of the companies listed on this page.

- A.E.I. Hotpoint Ltd.
- Associated Automation Ltd.
- Belling & Co. Ltd.
- Belling & Lee Ltd.
- Champion Sparking Plug Co. Ltd.
- E. K. Cole Ltd.
- Electrolux Ltd.
- Hoover Ltd.
- Magnavox Electronics Co. Ltd.
- M. K. Electric Ltd.
- Morphy-Richards (Astral) Ltd.
- Philips Electrical Ltd.
- P. O. Contracts Dept.
- Satchwell Controls Ltd.
- Simplex Electric Co. Ltd.
- Smith Meters Ltd.

COMPRESSION • INJECTION • FIBREGLASS MOULDINGS

Insulators Limited

Leopold Road, Angel Road, Edmonton, London N.18. (EDMonton 1195-8)
Grams: Mermould Southtot London.

Send for FREE 16-page booklet which shows exactly why so many of Britain's leading manufacturers come to Insulators for their plastic mouldings.	NAME .... COMPANY .... ADDRESS ....

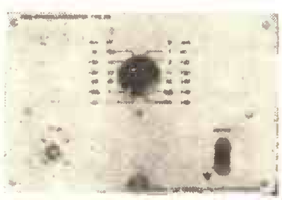
WW—049 FOR FURTHER DETAILS.

Meter Unit Type 70 *with* Wideband Millivoltmeter Type 701.

3 NEW UNITS join the range of plug-in instruments built to THE DYMAR SYSTEM

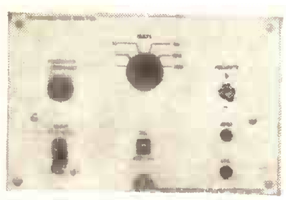
Introduced only in February, our range of high-grade laboratory instruments, using plug-in techniques, has met with an immediate and enthusiastic reception. *Three new instruments* now available begin the planned extension of the Dymar range and have all the in-built virtues of the original plug-ins.

The basis of the system is the Type 70 Meter Unit (also available for 19" rack mounting) which provides a precision 5" meter movement and comprehensive, well regulated power supply facilities. The meter unit will accept any one of the range of plug-in instruments, giving maximum flexibility and instrument variation at greatly reduced cost.

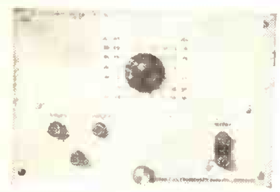


Wideband Millivoltmeter Type 701.
Frequency: 10 c/s—4 Mc/s
Sensitivity: 1mV—300 V f.s.d.
Accuracy: 2% **Price: £40**

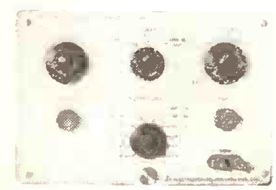
D.C. Microvoltmeter Type 721.
Sensitivity: 100 μV—300 V f.s.d.
Impedance: 100 MΩ
Accuracy: 3% **Price: £56**



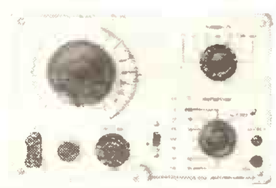
D.C. Kilovoltmeter Type 722.
Sensitivity: 1V—30 kV f.s.d.
Impedance: 3000 MΩ
Accuracy: 3% **Price: £35**



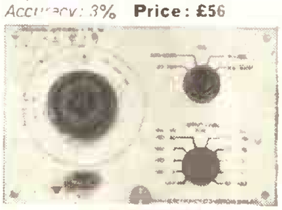
A.F. Microvoltmeter Type 705.
Sensitivity: 100 μV—30 V f.s.d.
Input: Balanced or Unbalanced
Frequency: 10c/s—100 kc/s **Price: £58**



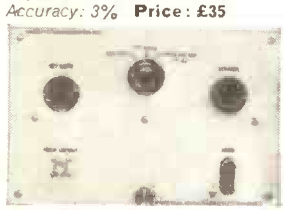
2 Tone A.F. Signal Generator Type 745
Frequency Ranges: 300 c/s—3 kc/s
Intermodulation: better than 80 db
Output: 30 μV—3 V (600Ω) **Price: £57**



Distortion Factor Meter Type 765.
Frequency Range: 20 c/s—20 kc/s
Distortion Range: down to 0.1% f.s.d.
Max. Sensitivity: 300 mV **Price: £64**



A.F. Signal Generator Type 741.
Frequency Range: 30 c/s—300 kc/s
Frequency Stability: 0.1%
Output: 100 μV—10 V (600Ω) **Price: £36**



Noise Factor Meter Type 761.
Frequency: 1 Mc/s—220 Mc/s
Impedance: 50 or 75Ω
Noise Factor: up to 15 db **Price: £37**

Meter Unit Type 70R
Price for 70 or 70R **£49**

DYMAR

Full details from

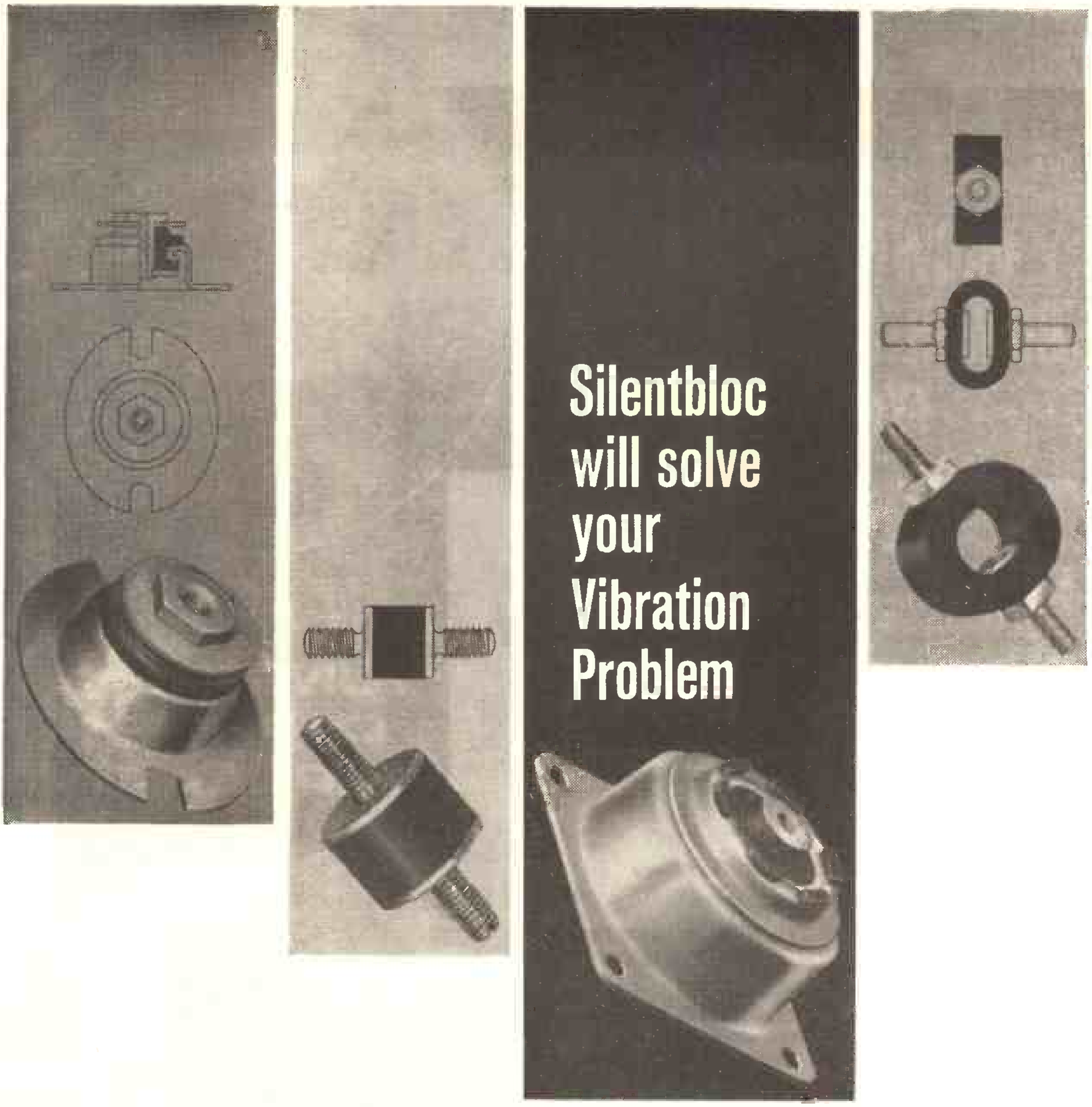
DYMAR ELECTRONICS LIMITED

REMBRANDT HOUSE · WHIPPENDELL ROAD · WATFORD · HERTS
Telephone: Watford 21297

U.K. Prices quoted.

WW—050 FOR FURTHER DETAILS.

Broadway DY/502



Take a Frustex instrument mounting . . . like the one featured on the left; or the bonded stud next to it. Perhaps the pedestal flange type in the centre and the ring stud mounting to its right command your interest? What do they all *mean?*
They, and the thousands of other components which SILENTBLOC design and manufacture, *mean* the end to most of those vibration troubles.
Combating vibration is SILENTBLOC'S business . . . but we're not dogmatic about it, low-frequencies constitute a special challenge. But, whatever your problem, give it to us — and you can be sure of one thing: if it can be solved we'll find the *correct* answer to it.

ANTI-VIBRATION DEVICES BY

SILENTBLOC

SILENTBLOC LTD · MANOR ROYAL · CRAWLEY · SUSSEX

Telephone: Crawley 27733 Telegrams: Silentbloc Crawley Telex No. 87177

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

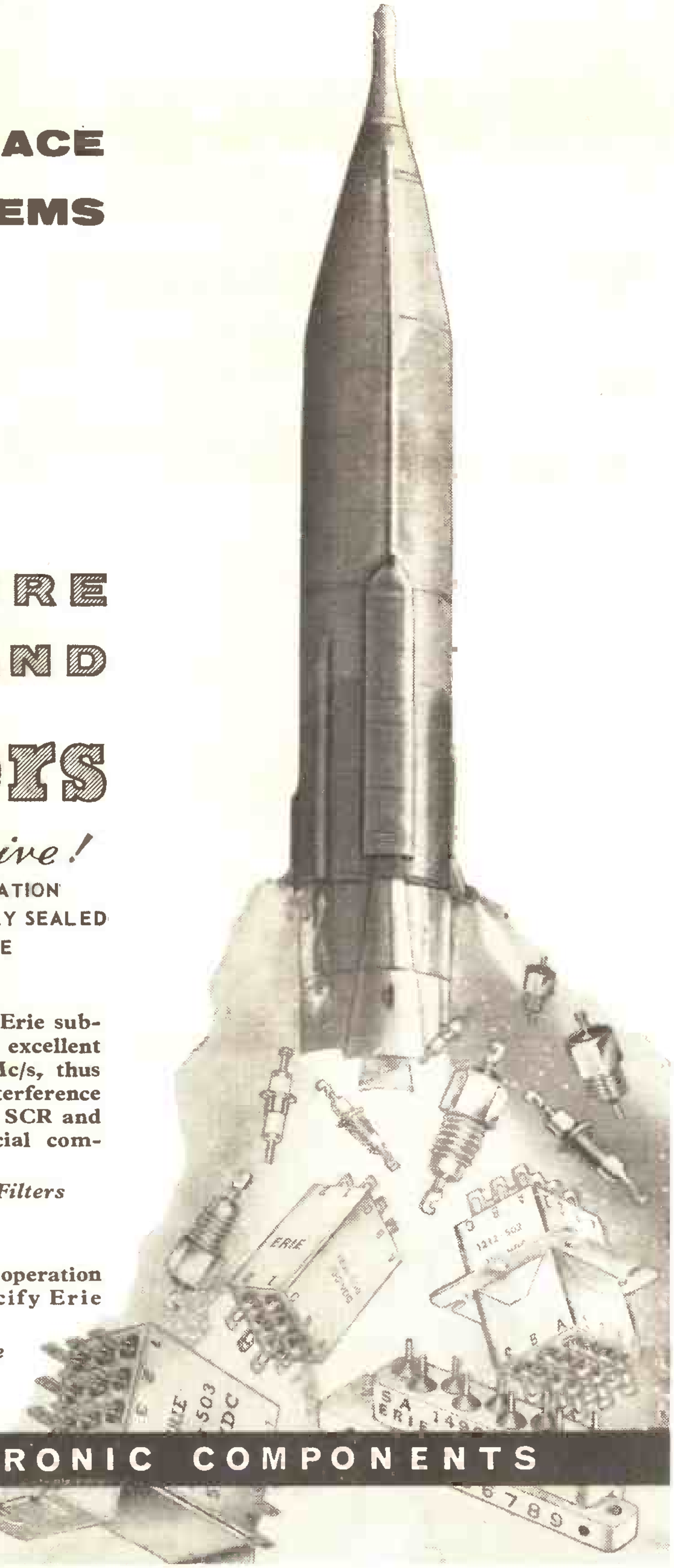
WW—052 FOR FURTHER DETAILS.

Broadway S/503

Selected

FOR MAJOR AEROSPACE SYSTEMS

ACTUAL SIZE



ERIE®

SUB-MINIATURE BROAD BAND RFI Filters

Exclusive!

HIGH ATTENUATION
HERMETICALLY SEALED
SUB-MINIATURE
RELIABLE

Only one-fourth the size of conventional filters, Erie sub-miniature Broad Band RFI Filters provide excellent attenuation performance from 10kc/s to 10,000Mc/s, thus eliminating the problem of Electro-Magnetic interference caused by switches, relays, motor commutators, SCR and transistor switching in military and commercial communications circuitry.

Write for literature on Erie Broad Band RFI Filters

and Filtercons®

For applications demanding higher frequency operation coupled with higher working voltages, specify Erie FILTERCON High Frequency Low-loss Filters.

Write also for Erie 'Filtercon' literature

ERIE ®

® Registered Trade Marks

ELECTRONIC COMPONENTS

ERIE RESISTOR LIMITED GREAT YARMOUTH NORFOLK Telephone 4911 TELEX 97421

Photograph by courtesy of Associated Automations Ltd.

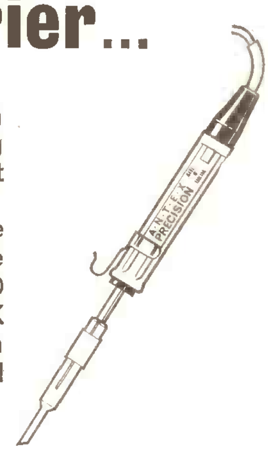
and now... ANTEX break through the heat barrier...

ANTEX have solved the problem of providing miniature soldering irons with really 'heavy-duty' heat capacity —by introducing their new 18 watts model G240.

G240 . . . a precision soldering iron possessing all the well-known advantages of ANTEX miniaturisation—yet capable of providing an intensified heat capacity.

G240's extra speed and precision opens up many new and exciting production possibilities in small-part soldering.

The G240 is available now with a choice of four different 'Ferraclad' long-life interchangeable bits*. The G240 coupled with the standard ANTEX range means there is an ANTEX iron exactly right for your requirements!



Write or phone for full details.

ANTEX *PRECISION SOLDERING IRONS

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

GROSVENOR HOUSE · CROYDON · SURREY Tel: MUN 2774

WW—056 FOR FURTHER DETAILS.

QA FOR TR

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

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

Electrosil Type	DEF 5115-1 Reference	Ratings (Watts 70°C)	Approved Range
TR4	RFG5-F	$\frac{1}{16}$, $\frac{1}{8}$, $\frac{1}{4}$	51 ohms-47K
TR5	RFG5-E	$\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{2}$	20 ohms-470K
TR6	RFG5-D	$\frac{1}{4}$, $\frac{1}{2}$, 1	20 ohms-1 meg

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

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

Electrosil LIMITED

Triple Rating means Triple Economy

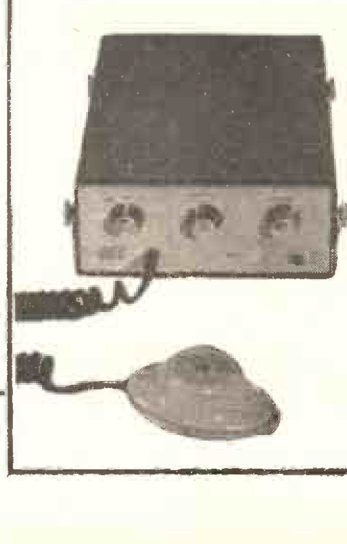
ELECTROSIL LIMITED
PALLION SUNDERLAND CO. DURHAM
Tel: Sunderland 71557 Telex 53273

The vital role of reliable communication

When reliability is of the first importance—as with ambulance or patrol car work—BCC equipment is chosen time and time again. The BCC 81 mobile VHF transmitter-receiver is so compact that the whole unit can be fitted under the dashboard of almost any vehicle, without taking up valuable passenger space, thereby adding prestige and efficiency. Transistors are used throughout the receiver and power supply unit and in all but the final stages of the transmitter; current consumption is low—equal to only one instrument panel lamp on 'receive'; no standby facility is necessary as quick heating valves are used in the transmitter.
With six channels in any frequency range between 37 and 174 Mc/s and 6 watt A.M. output, the advanced design of the BCC 81 makes it quite unbeatable in its class.

WINGS DAY
SEPT. 18th
GIVE FOR THOSE WHO GAVE

BCC 81



BCC

BRITISH COMMUNICATIONS CORPORATION LTD.

EXHIBITION GROUNDS, WEMBLEY, MIDDLESEX
Telephone: Wembley 1212 Telegrams: BEECEECEE WEMBLEY

MEMBER OF THE CONTROLS AND COMMUNICATIONS GROUP

WW—059 FOR FURTHER DETAILS.

BSR C1 CERAMIC cartridge

FOR PROFESSIONAL QUALITY

Outstanding performance and dependability make the C1 Ceramic Cartridge the natural choice of the professional because, to him, quality is absolutely essential. You, too, can buy this remarkable cartridge which has a performance comparable with designs costing twice as much.

Technical Data

Compliance	5.2×10^{-6} cm/dyne
Sensitivity at 1 Kc/s using Decca SXL 2057 record — 1 cm/sec.	0.110 volts ± 2 db
Stylus pressure	2-3 grammes
Equivalent capacity . . .	600 pF
Loading	2 MΩ 100 pF
Channel difference . . .	less than 3 db
Channel separation at 1 Kc/s .	20 db.

C1ST3 **£2 . 6 . 5** incl. tax. Stereo cartridge with double tipped sapphire stylus.
C1ST4 **£3 . 0 . 11** incl. tax. With diamond LP/S tip.

UA15 SS 3B fitted with C1ST3 **£10 . 18 . 11** incl. tax.
UA15 SS 3B fitted with C1ST4 **£11 . 13 . 5** incl. tax.

UA15 SS 3B 4 speed Automatic Record Changer

Tubular, low mass pick-up arm for featherweight pressure. Large turntable for stability. Manual play facilities. Wow and flutter lowest ever. The ultimate in quality performance and dependability.

Send for details of the complete range of BSR equipment and address of your nearest BSR stockist.

BSR LIMITED/MONARCH WORKS/OLD HILL/STAFFS
The world's largest manufacturers of Record Changers & Tape Decks.

CHASSIS and CASES

by Smith's of EDGWARE ROAD

H. L. SMITH & CO. LTD.
ELECTRONIC COMPONENT DISTRIBUTORS
287/289 EDGWARE ROAD, LONDON, W.2.
Tel: PADdington 5891/7595

We shall be pleased to quote for all your component requirements

BLANK CHASSIS

SAME DAY SERVICE

Of over 20 different forms made up to **YOUR SIZE.**
(Maximum length 35in., depth 4in.)

SEND FOR ILLUSTRATED LEAFLETS
or order straight away, working out total area of material required and referring to table below, which is for four-sided chassis in 16 s.w.g. aluminium.

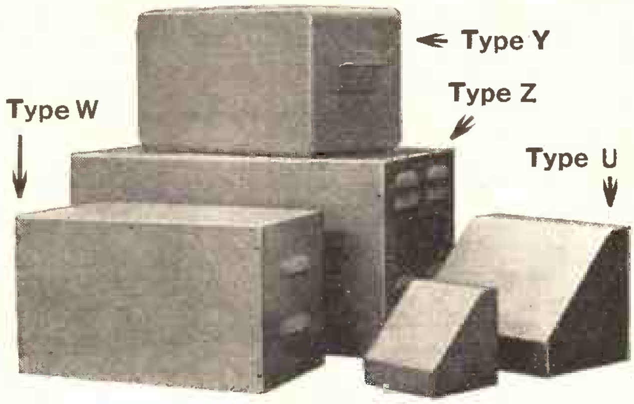
48 sq. in.	**4/3**	176 sq. in.	**9/-**	304 sq. in.	**13/6**
80 sq. in.	**5/6**	208 sq. in.	**10/-**	336 sq. in.	**14/9**
112 sq. in.	**6/6**	240 sq. in.	**11/3**	368 sq. in.	**15/9**
144 sq. in.	**7/9**	272 sq. in.	**12/6**	and pro rata.	
P. & P. 2/6		P. & P. 2/9		P. & P. 3/-.	

Discounts for quantities. More than 20 sizes kept in stock for callers.

FLANGES (¼in., ⅜in.), **6d.** per bend.

STRENGTHENED CORNERS 1/- each corner.

PANELS: Any size up to 3ft. at 5/3 sq. ft. 16 s.w.g.; (18 s.w.g. 4/6). Plus post and packing



CASES

ALUMINIUM SILVER HAMMERED FINISH

Type	Size	Price	Type	Size	Price
U	4 x 4 x 4*	10/-	Y	8 x 6 x 6*	26/6
U	5½ x 4½ x 4½	15/6	Y	12 x 7 x 7	41/-
U	8 x 6 x 6	21/-	Y	13 x 7 x 9	46/-
U	15 x 9 x 9	44/6	Y	15 x 9 x 7	48/6
W	8 x 6 x 6	21/-	Z	17 x 10 x 9	66/-
W	12 x 7 x 7	34/-	Z	19 x 10 x 8½	71/-
W	15 x 9 x 8	44/-		*Height.	

Plus post and packing

Type U has removable bottom or back, Type W removable front, Type Y all-screwed construction, Type Z removable back and front.

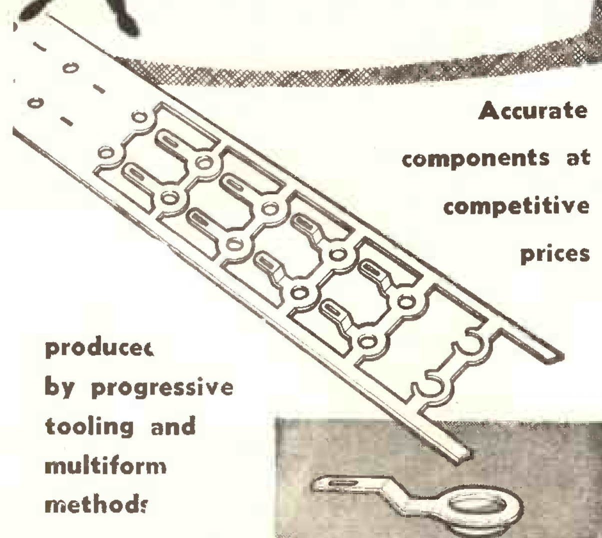
ORCHARD & IND LIMITED
PRESENT A SELECTION OF

Loose Leaf Binders

Write for New Catalogue to:
Head Office:
NORTHGATE · GLOUCESTER
TELEPHONE: (OGL2) 22111 (5 LINES)
TELEX: GLOUCESTER 43192

WW—061 FOR FURTHER DETAILS.

PRECISION PRESSINGS



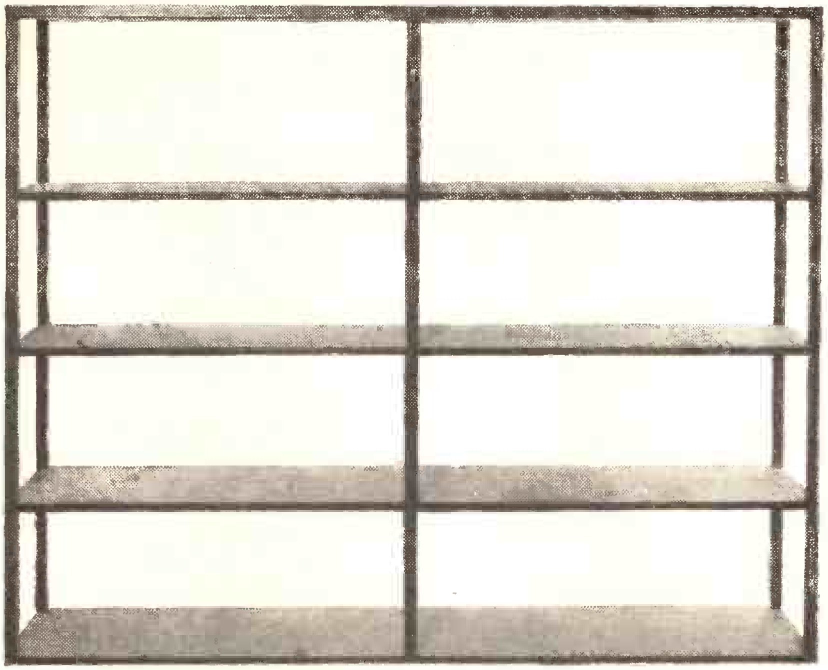
Accurate components at competitive prices

produced by progressive tooling and multiform methods

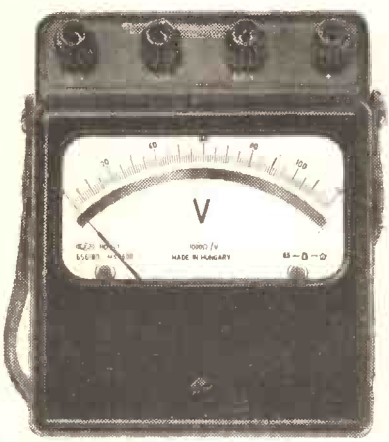
JOHN SMITH LTD.

209 SPON LANE · WEST BROMWICH · STAFFS. TELEPHONE WES 2516
"MITRE MILLS" RICHARD STREET · BIRMINGHAM 7
TELEPHONE ASTon Cross 2218 (4 lines)

WW—062 FOR FURTHER DETAILS.



We have extended our shelf space to take a new range of portable meters



These new meters, manufactured for us by a famous Hungarian factory, have a very definite place in industry, research and education. The place . . . *all* the places . . . where the equation 'accuracy + robustness = high cost' has hitherto been as depressing as it was inevitable. Here, *now*, is a range which includes portable D.C. and rectified A.C. moving coil meters, moving iron ammeters and voltmeters, and dynamometer wattmeters — all built to educational standards of robustness, laboratory standards of accuracy and *realistic* standards of costs. Consignments are currently going out too fast for us to use the shelf space we've provided but of course you won't mind delivery ex-packing case instead of "off the shelf". Either way, meters from Anders always reach you via a thoroughly painstaking inspection and testing department. If you haven't got details of this new Anders range, drop us a line today.

■ Meters of all kinds from stock ■ Meter calibration/Meter modification/Ancillary equipment ■ Custom-designed meter circuitry and components □ *Sole U.K. distributors of FRAHM vibrating reed frequency meters and tachometers*

ANDERS METER SERVICE

ANDERS ELECTRONICS LTD · 103 HAMPSTEAD ROAD · LONDON NW1
TELEPHONE EUSTON 1639 *MINISTRY OF AVIATION APPROVED*

WW—066 FOR FURTHER DETAILS.

An invention of the utmost importance in the field of sound reproduction

THE SHACKMAN ELECTROSTATIC UNIT

PROVISIONAL PATENTS Nos. 06155, 22716

Virtually eliminating distortion in Loudspeakers

The "SHACKMAN" Unit. Incorporated in the new Dyna-Static Mk. II loud speaker, which is priced at £48 in order to place the speaker within the sensible reach of all High Fidelity Enthusiasts. A DYNA-STATIC STEREO SYSTEM is available for approximately £160, giving a standard of performance unapproachable by any other system at any price. Come for a demonstration.

The SHACKMAN Electrostatic is the world's first practical major invention in loudspeakers for over 35 years.

The SHACKMAN Electrostatic reproduces with an unbelievable clarity and purity.

The SHACKMAN Electrostatic renders the moving coil completely obsolete as a reproducer of middle and upper frequencies. The intermodulation distortion which can never be eliminated from the moving coil, is completely absent and musical instruments are reproduced with a fidelity that has never before been approached. The transient response is fantastic.

The SHACKMAN Electrostatic unit is now the **finest electrostatic unit in the world,** and all Hi-Fi specialists in the U.K. are challenged to expose their years of experience and standards of acceptance to its impact. "Realism that is staggering" has been the reaction at every demonstration.

The SHACKMAN Electrostatic unit in the

DYNA-STATIC Mk. II:-

To match the efficiency of the electrostatic the unit is paired with a high flux 16,000 Gauss, 13 × 8 moving coil bass unit of 20W power handling capacity. Designed by Dr. Dutton of E.M.I., this unit has a half metal cone and crosses over to the electrostatic unit at 800 cycles.

The Shackman Electrostatic has been subjected to 45 Watts RMS steady state without suffering damage.

Continuous demonstrations of the DYNA-STATIC Mk. II are taking place at our New Barnet Showroom and at STUDIO 99, 57 FAIRFAX ROAD, SWISS COTTAGE, N.W.6. Hi-Fi Dealers of repute in the provinces are invited to apply for agencies.

AUDIO SERVICES are at present preparing a brochure giving full specifications of these units. Write or telephone at any time to reserve a copy. (Trade enquiries are invited.)

Write or ring BARnet 6605 for a brochure

No parking problems
Open Saturday until 7 p.m.

CALL FOR A DEMONSTRATION AT

AUDIO SERVICES LTD

82, EAST BARNET ROAD, NEW BARNET, HERTS.

WW—067 FOR FURTHER DETAILS.

TECHNICAL TRAINING by ICS

IN RADIO, TELEVISION AND ELECTRONIC ENGINEERING

First-class opportunities in Radio and Electronics await the **I C S trained man.** Let I C S train YOU for a well-paid post in this expanding field.

I C S courses offer the keen, ambitious man the opportunity to acquire, quickly and easily, the specialized-training so essential to success. Diploma courses in Radio/TV Engineering and Servicing, Electronics, Computers, etc. Expert coaching for:

* **INSTITUTION OF ELECTRONIC AND RADIO ENGINEERS.**
* **C. & G. TELECOMMUNICATION TECHNICIANS' CERTS.**
* **C. & G. SUPPLEMENTARY STUDIES.**
* **R.T.E.B. RADIO AND TV SERVICING CERTIFICATE.**
* **RADIO AMATEURS' EXAMINATION.**
* **P.M.G. CERTIFICATES IN RADIOTELEGRAPHY.**

Examination Students Coached until Successful.

NEW SELF-BUILD RADIO COURSES.
Build your own 5-valve receiver, transistor portable, signal generator and multi-test meter—all **under expert tuition.**

POST THIS COUPON TODAY and find out how I C S can help YOU in your career. Full details of I C S courses in Radio, Television and Electronics will be sent to you by return mail.

MEMBER OF THE ASSOCIATION OF BRITISH CORRESPONDENCE COLLEGES.

INTERNATIONAL CORRESPONDENCE SCHOOLS

A WHOLE WORLD OF KNOWLEDGE AWAITS YOU!

International Correspondence Schools (Dept. 222), Intertext House, Parkgate Road, London, S.W.11.

NAME ....

ADDRESS ....
Block Captials Please

....

.... 9.65

WW—068 FOR FURTHER DETAILS.

Radiomic-a completely portable microphone/transmitter

Transmitter slips into pocket

The Radiomic microphone/transmitter system has no wires, is very compact—the transmitter weighs only 6 ozs and slips into a pocket. It is available as a single band system or fixed multi-channel installation. The Radiomic is extremely efficient and reliable and has been type tested and approved by the G.P.O.

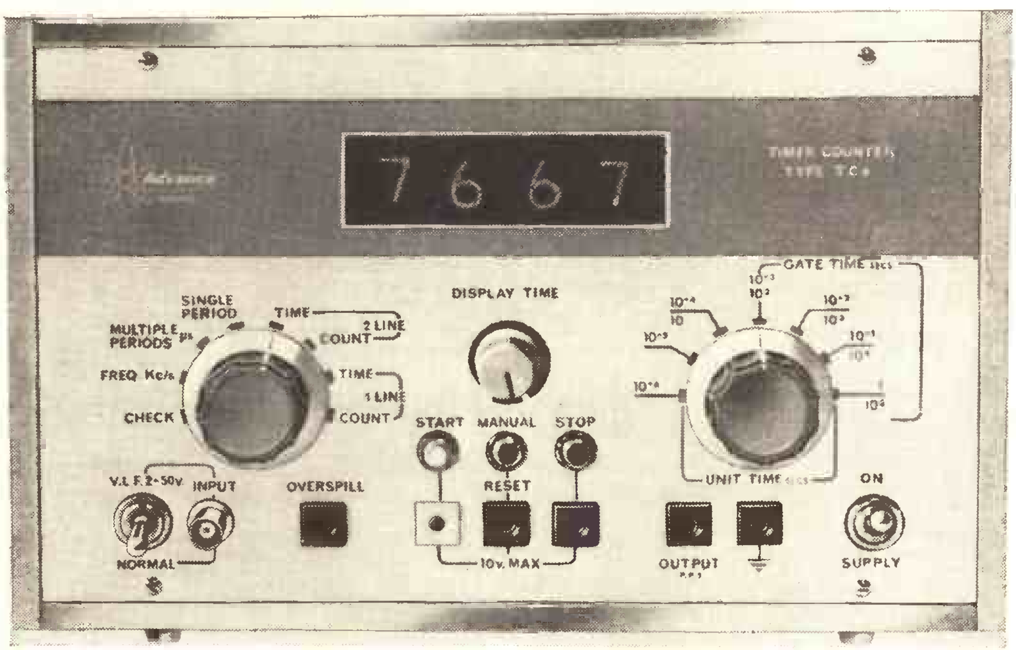
RADIOMIC portable microphone/transmitter - a product of

LUSTRAPHONE

the foremost name in sound equipment.
LUSTRAPHONE LTD., ST. GEORGE'S WORKS, REGENT'S PARK ROAD, LONDON, N.W.1. PRImrose 8844

WW—069 FOR FURTHER DETAILS.

a NEW standard in low cost counters....



the Advance 5Mc/s TC4

- FREQUENCY (0 to at least 5Mc/s, direct reading)
- PERIOD (Single and multiple period measurements up to 10^5 periods)
- TIME (3μS - 10^4S)
- COUNT (1-9999, regular or random pulses)

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

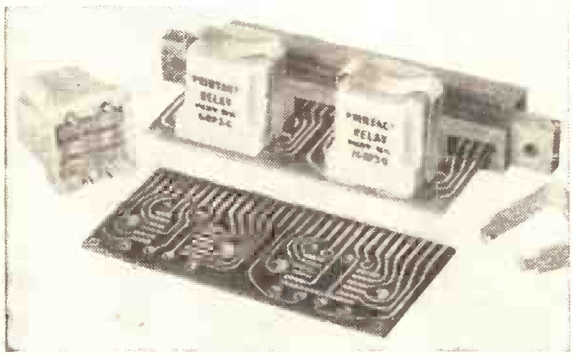
Write now for fully descriptive leaflet and specification

Advance

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

WW—070 FOR FURTHER DETAILS.

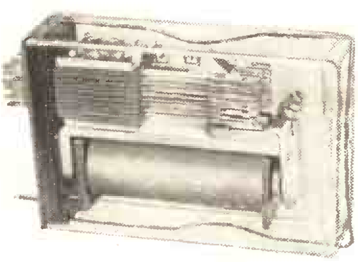
THE
MIGHTY MIDGET
Printed Circuit Relay

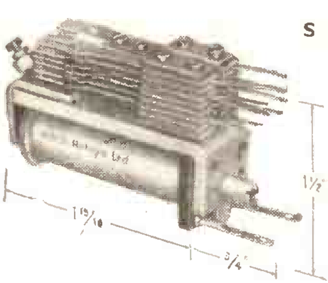


Supplied as standard or latching type, single or double winding. Size ⅞in. cube, weight 0.8 oz.
Contact Rating 24 v. D.C. 3 pole double throw. Voltage: 6, 12, 24, v. D.C. Power: 500 mW. Speed 10mS.
Temperature: 70° C max.

3000 TYPE PLUG-IN

Size 4in. x 2⅞in. x 1⅞in. Specification as 3000 type 6 change overs. Light duty maximum.





S 1500 MINIATURES

A.C. or D.C. operating. Coil up to 10,000 ohms. Single or double winding. Contact material — Silver, Platinum, Spring Set — 6 change overs. Light duty maximum. Size: 2 11/16in. x 1⅝in. x ⅜in.

We are manufacturers of full ranges of 3,000 type, 600 type, and plug in relays, also 12 way mounting rack 19in. x 3½in. Further details available on request to Mr. Clemens.

FULLY APPROVED HOUSE
7 DAY PROTOTYPE SERVICE

A.D.S. RELAYS LTD.

89-97, ST. JOHN STREET, LONDON, E.C.1
Telephone: CLErkenwell 3393

WW—076 FOR FURTHER DETAILS.

QUARNDON

Offer immediate delivery of over 300 types of

TEXAS INSTRUMENTS SEMICONDUCTORS

Including:-

2S321-325 SILICON TRANSISTORS
(EQUIVALENT TO OC200 SERIES)
STOCKED IN QUANTITY

MANY NEW PLANAR DEVICES
(FROM LOW LEVEL TO HIGH POWER)
ARE NOW AVAILABLE

Send for a copy of our new
SILICON TRANSISTOR SUMMARY

QUARNDON ELECTRONICS LTD.

SLACK LANE, DERBY. *Tel: 46695.*

WW—077 FOR FURTHER DETAILS.

EDDYSTONE
DIECAST INSTRUMENT BOXES

The largest of the range—the Cat. No. 903—is illustrated above, of aluminium alloy, it has internal dimensions of 7¼in. by 4½in. by 3in., and weighs 21 ozs. Details of the other boxes are as follows:—

Cat. No. 896. 4¼in. x 2¼in. x 1in. 11½ ozs.
Cat. No. 650. 4½in. x 3½in. x 2in. 18 ozs.
Cat. No. 845 } 7¼in. x 4½in. x 2in. { 32 ozs.
Cat. No. 6827P } { 16 ozs.

Cat. No. 6827P is of aluminium alloy, the others of Mazak alloy. All are complete with close-fitting flanged lids and are supplied in natural metal. Data sheets on request.

Eddystone Radio Limited

Eddystone Works, Alvechurch Road, Birmingham 31
Telephone Priory 2231 Cables Eddystone Birmingham Telex 33708

WW—078 FOR FURTHER DETAILS.

EXCEL in ELECTRONICS

Through this ICS 3-way Training Method:

1 MASTER THE THEORETICAL SIDE
From basic principles to advanced applications, you'll learn the theory of electronic engineering, quickly and easily through ICS. That's because each course is set out in easy-to-understand terms.

2 MASTER THE PRACTICAL SIDE
ICS show you how to develop your practical abilities in electronic engineering—*alongside* your theoretical studies. It's the only sure way to success. All training manuals are packed with easy-to-follow illustrations.

3 MASTER THE MATHEMATICAL SIDE
To many this aspect is a bitter problem. Even more so because no electronic engineer is complete without a sound working knowledge of maths. But new ICS teaching makes mathematics easier to learn.

Wide range of courses available including:
Radio/T.V. Engineering and Servicing, Colour Television, Electronics, Electronic Maintenance, Instrumentation and Servo-mechanisms, Telemetry, Computers, etc.
NEW! Programmed Course on Electronic Fundamentals.

EXPERT COACHING FOR:
INSTITUTION OF ELECTRONIC & RADIO ENGINEERS
CITY & GUILDS TELECOMMUNICATION TECHNICIANS
CITY & GUILDS SUPPLEMENTARY STUDIES
R.T.E.B. RADIO/T.V. SERVICING CERTIFICATE
RADIO AMATEURS' EXAMINATION
P.M.G. CERTIFICATES IN RADIOTELEGRAPHY

And there are practical " learn as you build " radio courses as well.

Member of the Association of British Correspondence Colleges.

FOR **FREE** HANDBOOK POST THIS COUPON TODAY
I.C.S., Dept. 227, INTERTEXT HOUSE,
PARKGATE ROAD, LONDON, S.W.11

NAME ....
ADDRESS ....
....
OCCUPATION .... AGE 9.65

INTERNATIONAL CORRESPONDENCE SCHOOLS

WW—079 FOR FURTHER DETAILS.

VARIABLE D.C. POWER UNIT WITH ACCUMULATOR PERFORMANCE FROM A.C. MAINS

EFFECTIVE RESISTANCE LESS THAN ·1 ohm.

TYPE
250VRU/30/20
250VRU/60/10
PRICE
£131-5-0

FEATURES
0-30 VOLTS Variable up to **20 AMPS.**
0-60 VOLTS Variable up to **10 AMPS** also available.
RIPPLE CONTENT negligible, **IMPEDANCE** and **REGULATION** equivalent to accumulator performance. **SILICON RECTIFIERS.** Inadvertent " **SHORT** " protection.
OVERLOAD 100% capacity for short periods.

APPLICATIONS
Operating and Servicing transistorised equipment. 12v. Mobile radio/tel. operation, D.C. Motors, relays, industrial power, etc., from any point of A.C. **WITHOUT THE USE OF ACCUMULATORS.**

12 or 24v. FIXED OUTPUTS up to 24 Amps also available.
AVOID THE EXTRA EXPENSE OF SUPER REGULATION YOU MAY NEVER NEED. PRICES £14-16-0 to £131-5-0.

Valradio
LIMITED

Please write to department C 3b. for current literature.

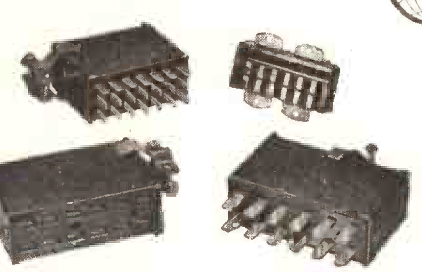
BROWELLS LANE, FELTHAM, MIDDX. ENGLAND

Tel.: FEL 4837-4242

VALRADIO and STEREOSONOSCOPE are the registered trade marks of VALRADIO LTD.

WW—080 FOR FURTHER DETAILS.

NUMBER ONE IN ELECTRICAL CONNECTORS... 1



JONES MINIATURE & STANDARD SERIES

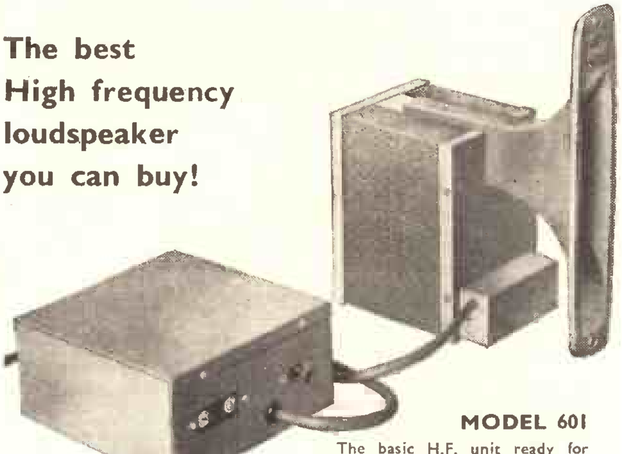
General purpose connectors with five or fifteen amp contacts. Insert arrangements from two to thirty-six contacts.

CANNON ELECTRIC (GREAT BRITAIN) LTD.
25-27 Bickerton Road,
London N.19.
Tel: ARChway 3088

CANNON PLUGS

WW—081 FOR FURTHER DETAILS.

The best High frequency loudspeaker you can buy!



MODEL 601

The basic H.F. unit ready for building into a speaker assembly. It will handle the treble of 20 watts of music.

28 GNS.

THE NEW SUPERB IONOFANE LOUDSPEAKER

The IONOFANE operates on the Ionophone principle invented by Klein of Paris, and is covered by British Letters Patent No. 756546. It is a high frequency loudspeaker having a perfectly uniform response from 3 to 30 kilocycles, quite free from resonances and colourations and with perfect reproduction of transients. It is fully guaranteed.

WRITE NOW FOR ILLUSTRATED LEAFLET

MODEL 603

A full range speaker assembly of the highest quality, consisting of the Ionofane H.F. unit, new 5in. mid-range and new 15in. bass unit. Will handle up to 20 watts. **75 GNS.**

SEE AND HEAR THESE REMARKABLE SPEAKERS AT

IMHOFS, 112-116 New Oxford Street, London, W.C.1

LARGS of HOLBORN, 76-77 High Holborn, London, W.C.1

NORTHERN RADIO SERVICES LTD 16 King's College Road, London, N.W.3

FANE acoustics LIMITED HICK LANE, BATLEY, YORKSHIRE

Enquiries for these Speakers including the Wholesale and Retail Trade may be sent direct to :-
FANE ACOUSTICS LTD., BATLEY, YORKSHIRE, or to LINEAR PRODUCTSLTD., ARMLEY, LEEDS

WW—090 FOR FURTHER DETAILS.

THE WEAKEST LINK?

Since the beginnings of high quality sound reproduction, the loudspeaker has been considered as one of the fundamentally weak links in the reproducing chain. This may no longer be true.

For the past few years Radford engineers have been studying loudspeaker systems from first principles and have evolved new standards of performance from a more radical design approach.

New loudspeakers have been designed entirely from scientific principles, completely eliminating the ear in subjective evaluation. This approach is possible only by a complete appreciation of the factors which control the performance of a loudspeaker system. As all the parameters are precisely measurable, a new standard of performance that is considerably better than present standards has been made possible.

If you are about to buy a loudspeaker it is vital that you hear these new products before purchasing conventional and colourful outdated systems.

Bookshelf. Dimensions 21 × 12 × 8in. Uses 2 drive units equalised and integrated by an 11-element network. £27/10/-.

Executive. Dimensions 26 × 15 × 11½ in. Uses 2 drive units and network identical with the Bookshelf unit but fitted in the Monitor cabinet for extended low frequency response. £35

Monitor. Dimensions 26 × 15 × 11½in. Uses 3 drive units, equalised and integrated by an 18-element network. The most advanced loudspeaker design available today. £45

Studio. Dimensions 35 × 17½ × 15in. Drive system identical with the 'Monitor' but with the rear of bass driver coupled to acoustic transmission line for reproduction of frequencies below 40 c/s. £65

A leaflet describing these loudspeakers will be available shortly on request.

RADFORD ELECTRONICS LTD.

Ashton Vale Road, Bristol 3. Tel. 662301

WW—091 FOR FURTHER DETAILS.

NUMBER ONE IN ELECTRICAL CONNECTORS... 1

UHF-COAXIAL/TWINAXIAL

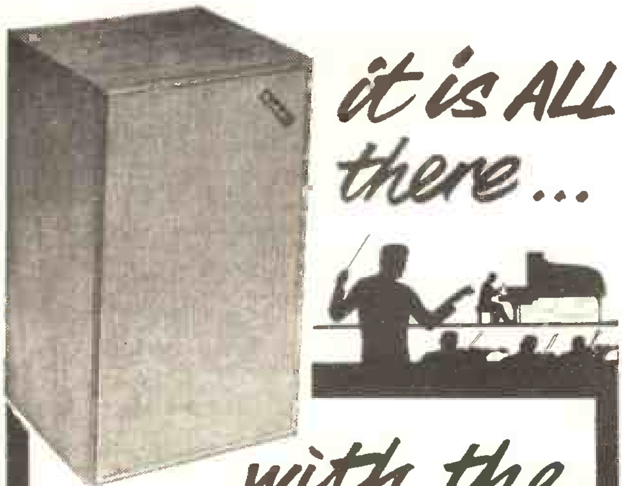
General Purpose Coax/Twinax. Six basic shell styles. Up to 500V Peak.

CANNON ELECTRIC (GREAT BRITAIN) LTD.
25-27 Bickerton Road,
London N.19.
Tel: ARChway 3088

CANNON® PLUGS

WW—092 FOR FURTHER DETAILS.

it is ALL there...



...with the

Minette

★ **Concert Hall Performance**
★ **Audio Frequency Response 45 - 20,000 c.p.s.**
★ **Compact, Elegant Design**
★ **Unique Integrally Constructed Drive System**

The bass unit is five inches in diameter, the heavy moulded cone being suspended on an extremely flexible Neoprene surround resulting in the low free air resonance of 40 cps. The movement of the cone at low frequencies is thus controlled by the stiffness of the air in the enclosure, and is linear.

An extra long voice coil is used to accommodate the necessary increase in cone excursion and the flux density of 14,000 gauss on a 1in. pole is provided by a large ceramic magnet.

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

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

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

SPECIFICATION: *Frequency response: 45-20,000 c.p.s. Handling capacity: 10 Watts. Impedance: 15 Ohms. Finish: Satin Walnut. Nett weight: 9lbs (4.1 kg), Gross weight: 11lbs (5 kg). Dimensions: 11½" high, 7" wide, 6½" deep.*

PRICE **£15. 0. 0.** + £2.10.6. tax.

For Further Details Contact: **Richard Allan**

RICHARD ALLAN RADIO LIMITED . BRADFORD ROAD · GOMERSAL · NR LEEDS · YORKSHIRE
TELEPHONE CLECKHEATON 2442

WW—093 FOR FURTHER DETAILS.

TRANSFORMERS
COILS
CHOKES

LARGE OR SMALL QUANTITIES
TRADE ENQUIRIES WELCOMED

SPECIALISTS IN

FINE WIRE WINDINGS

MINIATURE TRANSFORMERS
RELAY AND INSTRUMENT COILS, ETC.
VACUUM IMPREGNATION TO APPROVED STANDARDS

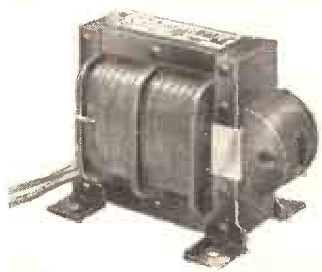
ELECTRO-WINDS LTD.

CONTRACTORS TO G.P.O., A.W.R.E., L.E.B., B.B.C., ETC.

123-5-7 PARCHMORE ROAD, THORNTON HEATH, SURREY
LIVINGSTONE 2261 EST. 1933

WW—094 FOR FURTHER DETAILS.

A. C. SOLENOID TYPE SBM



Now fitted with stainless steel guides—six times the life
Continuous 3¾ lbs. at 1'
Instantaneous to 16 lbs.
Larger and smaller sizes available
Also—transformers tc 8kVA 3 phase.

R. A. WEBBER LTD.

KNAPPS LANE, CLAY HILL, BRISTOL 5 PHONE 65-7228/9

WW—095 FOR FURTHER DETAILS.

LEARN **ELECTRONICS** AS YOU

BUILD 25 CIRCUITS EXPERIMENTS TEST GEAR

including:

- **MINIATURE CATHODE RAY OSCILLOSCOPE**
- VALVE EXPERIMENTS
- BASIC AMPLIFIER
- BASIC RECTIFIER
- PHOTO ELECTRIC CIRCUIT
- TIME DELAY CIRCUIT
- SQUARE WAVE GENERATOR
- SIMPLE TRANSMITTER
- TRANSISTOR EXPERIMENTS
- BASIC OSCILLATOR
- ELECTRONIC SWITCH
- SIGNAL TRACER
- BASIC COMPUTER CIRCUIT
- BASIC RADIO RECEIVER
- MORSE CODE OSCILLATOR, ETC., ETC.

This complete practical course will teach you all the basic facts of electronics by making experiments and building apparatus. You learn how to recognise and handle all types of components—their symbols and how to read a circuit diagram. You see how circuits are built and how they work BY USING THE OSCILLOSCOPE PROVIDED. Applications of all the main electronic circuits are demonstrated—radio reception and transmission; photo-electrics; computer basics; timers; control circuits; etc., including servicing techniques. NO MATHS USED OR NEEDED. NO THEORY NEEDED. NO PREVIOUS KNOWLEDGE OR EXPERIENCE NEEDED. Tutor service available. No extras needed—tools provided. Send, now, for FREE DETAILS without obligation, to address below.

To: RADIOSTRUCTOR, Dept. K1, Reading, Berks.

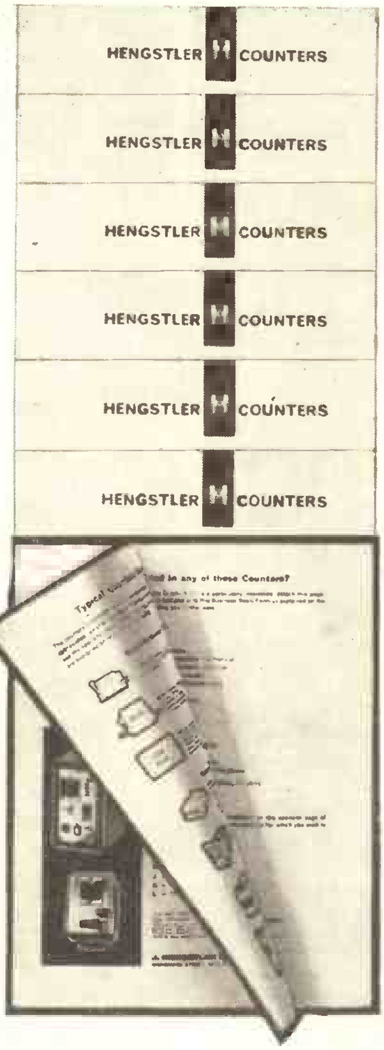
Please send free details of your 25 circuit kit course—

NAME..

ADDRESS...

....

WW—096 FOR FURTHER DETAILS.



to help you...

. . . to choose the right counter for your application, we have produced this leaflet

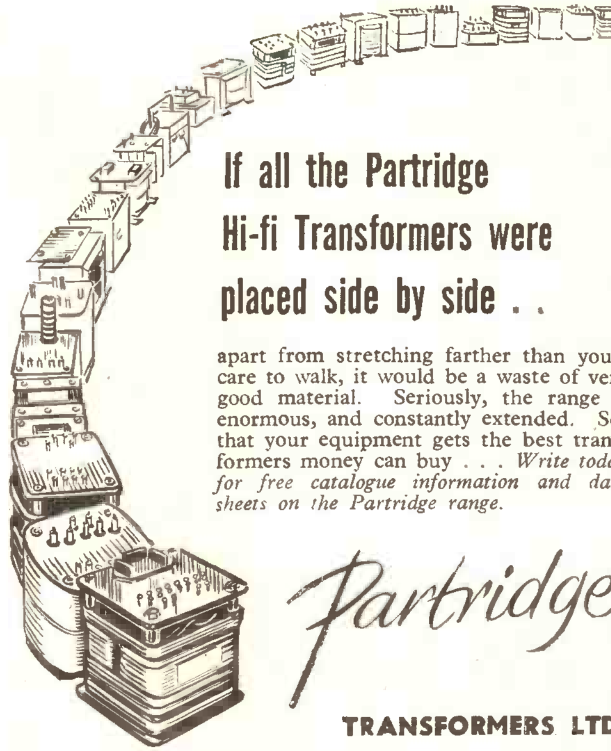
- **It illustrates** a wide variety of types in general use.
- **It specifies** briefly the functions and features of each counter.
- **It lists** applications and requirements that most frequently arise.
- **It assists** you to specify your needs so that we can give you the fullest information relevant to the purpose you have in mind.

Please ask for Publication WW/403

When you think of a number— think of **HENGSTLER!**

J. HENGSTLER CO. Great Britain LTD
BROOKER ROAD · WALTHAM ABBEY · ESSEX
Waltham Cross 26166/7

WW—097 FOR FURTHER DETAILS.



If all the Partridge Hi-fi Transformers were placed side by side . .

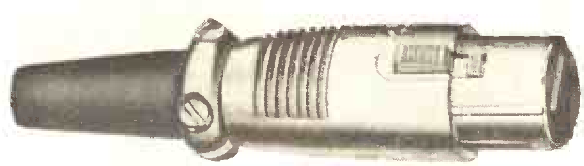
apart from stretching farther than you'd care to walk, it would be a waste of very good material. Seriously, the range is enormous, and constantly extended. See that your equipment gets the best transformers money can buy . . . *Write today for free catalogue information and data sheets on the Partridge range.*

Partridge

TRANSFORMERS LTD.
ROEBUCK ROAD, CHESSINGTON, SURREY
Tel: LOWer Hook 4353/4/5

WW—098 FOR FURTHER DETAILS.

NUMBER ONE IN ELECTRICAL CONNECTORS... 1



XLR AUDIO PLUGS

The industry standard for low-level sound circuitry requirements. Attractively styled with satin nickel finish.

CANNON ELECTRIC (GREAT BRITAIN) LTD.
25-27 Bickerton Road,
London N.19.
Tel: ARChway 3088

CANNON® PLUGS

WW—099 FOR FURTHER DETAILS.

TRANSIPACK® PROFESSIONAL

STATIC INVERTERS AND FREQUENCY CHANGERS

- 1% FREQUENCY STAB. AS STANDARD
- SINUSOIDAL WAVEFORM
- INPUT & SHORT-CIRCUIT PROTECTION
- FREQUENCIES: 50, 60, 400 & VARIABLE

• UP TO 20 K.V.A. •

TYPICAL PRICES

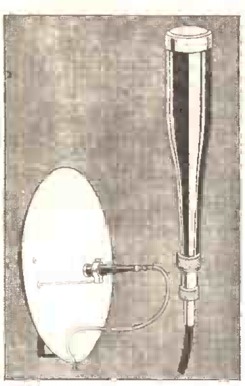
100VA	£85
200VA	£130
350VA	£175
600VA	£355
1KVA	£420

INDUSTRIAL INSTRUMENTS LIMITED

STANLEY ROAD, BROMLEY, KENT TEL: RAV 9212/3
TELEGRAPHIC ADDRESS: TRANSIPACK BROMLEY

WW—100 FOR FURTHER DETAILS.

a Whole World of users can't be wrong!



One of the really outstanding microphones in the medium-price range, the **DP/4** is enjoying unparalleled success. Small wonder, for the **DP/4** is wonderfully reliable and sensitive to an extremely wide range of sounds. Uniform frequency response from 50 c/s to 15 Kc/s.
It is in world-wide use for high-quality broadcasting, recording and public address both by the amateur and professional.
The **Parabolic Reflector**, its natural partner, focuses a distant sound-source onto the microphone head, greatly amplifying it without loss of realism and without unwanted side-noises.
The DP/4 comes in three impedances—Low, medium and high—and is supplied complete with connector and 18ft. screened lead. The 2ft. dia. Parabolic Reflector is complete with microphone holder.

Further details from your dealer or from:—

GRAMPIAN REPRODUCERS LTD.
Hanworth Trading Estate,
Feltham, Middx. FELtham 2657

Grampian
Sound equipment—
integrity that you hear

WW—101 FOR FURTHER DETAILS.

YOUR CAREER IN RADIO?

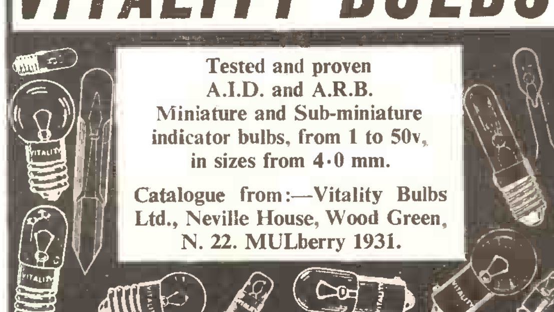
Big opportunities and big money await the qualified man in every field of Electronics today—both in the U.K. and throughout the world. We offer the finest home study training for all subjects in radio, television, etc., especially for the **CITY & GUILDS EXAMS.** (Technicians' Certificates); the Grad. Brit. I.R.E. Exam.; the **Radio Amateur's Licence;** P.M.G. Certificates; the R.T.E.B. Servicing Certificates, etc. Also courses in Television; Transistors; Radar; Computers; Servomechanisms; Mathematics and Practical Transistor Radio course with equipment. We have **OVER 20 YEARS'** experience in teaching radio subjects and an unbroken record of exam. successes. We are the only privately run British home study Institute specialising in electronic subjects only. Fullest details will be gladly sent without any obligation.

SEND FOR FREE BROCHURE TO :-

BRITISH NATIONAL RADIO SCHOOL
DEPT 1 RADIO HOUSE RUSSELL ST · READING · BERKSHIRE

WW—102 FOR FURTHER DETAILS.

VITALITY BULBS



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

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

WW—103 FOR FURTHER DETAILS.

Marconi self-tuning H.F system—the first in the world to be station planned from input to output.

breakthrough

MST 30kW transmitter type H1200

An h.f linear amplifier transmitter for high-grade telecommunications.
Frequency range: 4-27.5 Mc/s.
Output power: 30 kW p.e.p, 20 kW c.w.
Meets all CCIR Recommendations.

saves 80% floor space

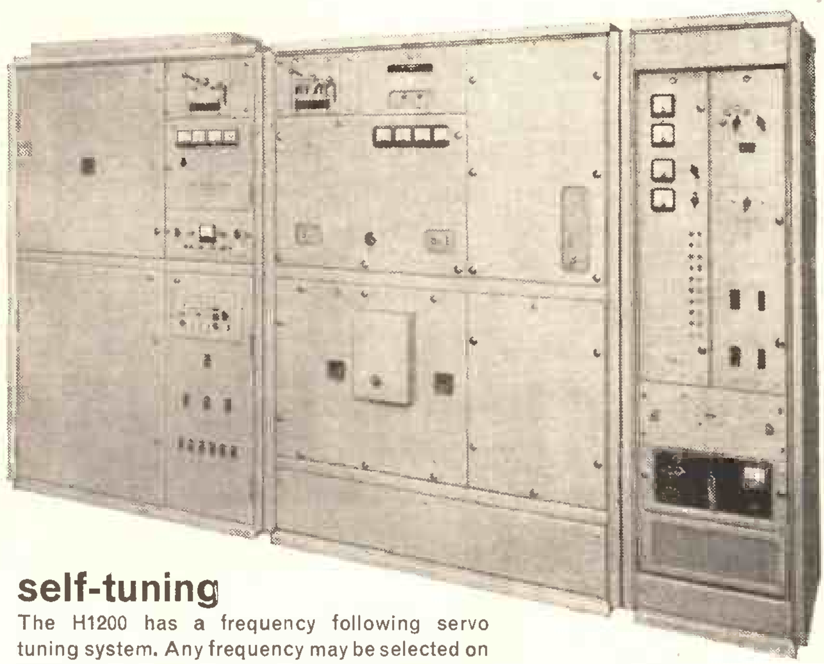
Transmitters can be mounted side by side and back to back or against a wall. Floor-ducts are eliminated and all power supply components are built-in. These features lead to smaller, simpler, cheaper buildings or more services in existing buildings.

rugged reliability

R.F circuits have been simplified and the number of mechanical parts reduced to a minimum. Highest engineering standards are applied to the design of these parts: stainless steel shafts in ball-bearings in heavy, rigid, machined castings; stainless steel spur gears meshing with silicon bronze; heavy r.f coil contacts with high contact pressure. Specified performance is maintained with ample margins.

simplicity

MST reliability allows continuous unattended operation with extended or remote control, saving maintenance and operating staff. Any fault in the servo control circuits can quickly be located with simple test routines. Transistors and printed wiring give these circuits maximum reliability.



self-tuning

The H1200 has a frequency following servo tuning system. Any frequency may be selected on the synthesizer decade dials in the associated MST drive equipment; the unattended transmitter automatically tunes itself in an average time of twenty seconds. Final stage tuning and loading servos continuously ensure automatic compensation for changes in aerial feeder impedance caused by weather conditions. Self-tuning gives *one-man* control of an entire transmitting station.

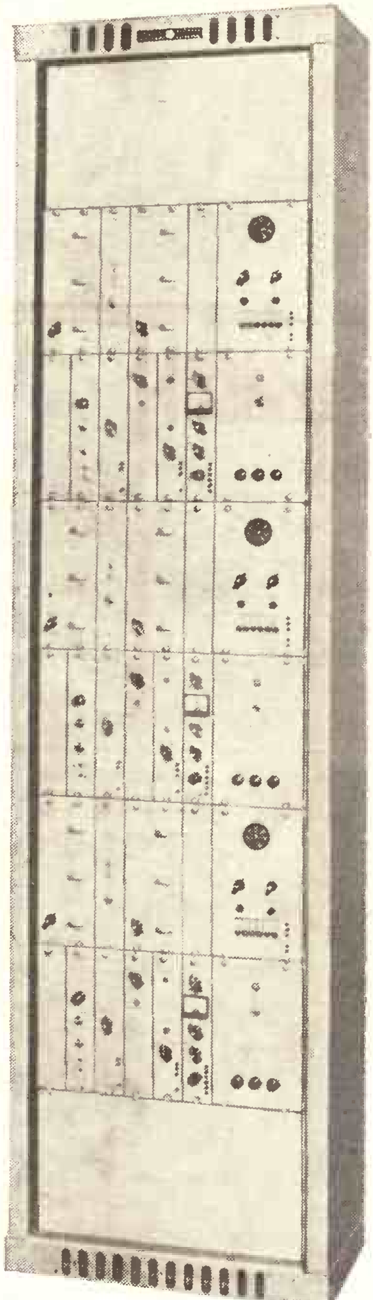
Marconi telecommunications systems

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

LTD/H61

WW—105 FOR FURTHER DETAILS.

Marconi SELF-TUNING h.f. receivers



Three double-diversity H2002 receivers

The H2002 Series of MST receivers for high grade point-to-point h.f. communication services.
H2002 double diversity f.s.k.
H2102 double diversity i.s.b. or s.s.b.
H2112 single path i.s.b. or s.s.b.

NO OSCILLATORS
NO VARIABLE CAPACITORS
NO MECHANICAL TELEGRAPH RELAYS
NO TUNING SCALES

The new range of MST transistorized receivers uses synthesizers to provide accurate selection of **250,000 frequencies.**

Elimination of manual tuning by **a unique self-tuning system (using servo controlled varactor diodes) allows centralized** extended control.

Exceptionally good frequency stability renders **a.f.c.** unnecessary on stable transmissions.

One-man control of an entire receiving station.

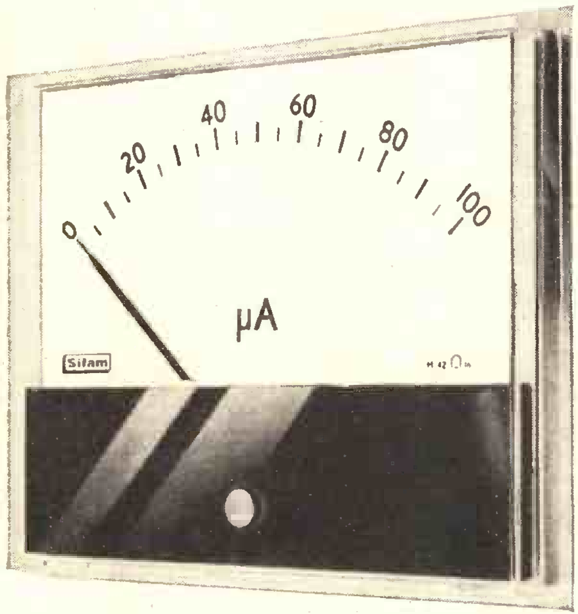
60% space saved by much smaller equipment and back-to-back and side-by-side installation.

RECEIVER MST BREAKTHROUGH

Marconi telecommunications systems

The Marconi Company Limited, Communications Division, Chelmsford, Essex, England LTD/H55

no shadow of doubt...



why Sifam 'CLARITY' instruments are specified, so often

The elimination of any solid surround to Sifam 'CLARITY' instruments eliminates top shadow, especially when instruments are mounted above eye level. This feature also provides greater readability, thereby minimising the risk of human error in recording readings.
The use of a completely transparent moulded front provides for a *greater scale length* for a given front area of instrument. Interchangeable masks are available in a choice of contemporary colours to blend with customers' equipment. Designed with special reference to ergonomic considerations, Sifam 'CLARITY' instruments have a clean, modern appearance, combining contemporary styling with consistent accuracy. Sifam 'CLARITY' instruments are normally supplied to meet the requirements of B.S.S.89 (1954) but other accuracies, i.e. the now obsolete B.S.S.89 (1937) can be supplied on request. Scale arcs, mountings and pointers can be supplied in accordance with the new B.S.S.3693 Part 1, 1964, or to customers' requirements.

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

Sifam INSTRUMENTS

SIFAM ELECTRICAL INSTRUMENT CO. LTD.
Woodland Road, Torquay, Devon
Telephone: Torquay 63822 6

SI.51/1

WW—107 FOR FURTHER DETAILS.

One company in Britain makes ALL these types of capacitor

LEMCO

MICA
CERAMIC
POLYSTYRENE

The capacitor specialists

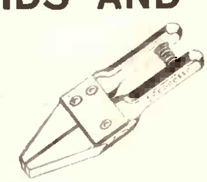
POLYESTER
ELECTROLYTIC

For further information write to:
LONDON ELECTRICAL MANUFACTURING COMPANY LIMITED
81 Bridges Place, Parsons Green Lane, London, S.W.6
Tele: Renown 7071

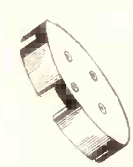
TAS/LEM.1

WW—108 FOR FURTHER DETAILS.

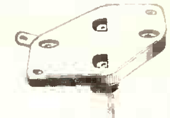
SPEARETTE
AIDS AND COMPONENTS



THERMAL SHUNT CLAMPS



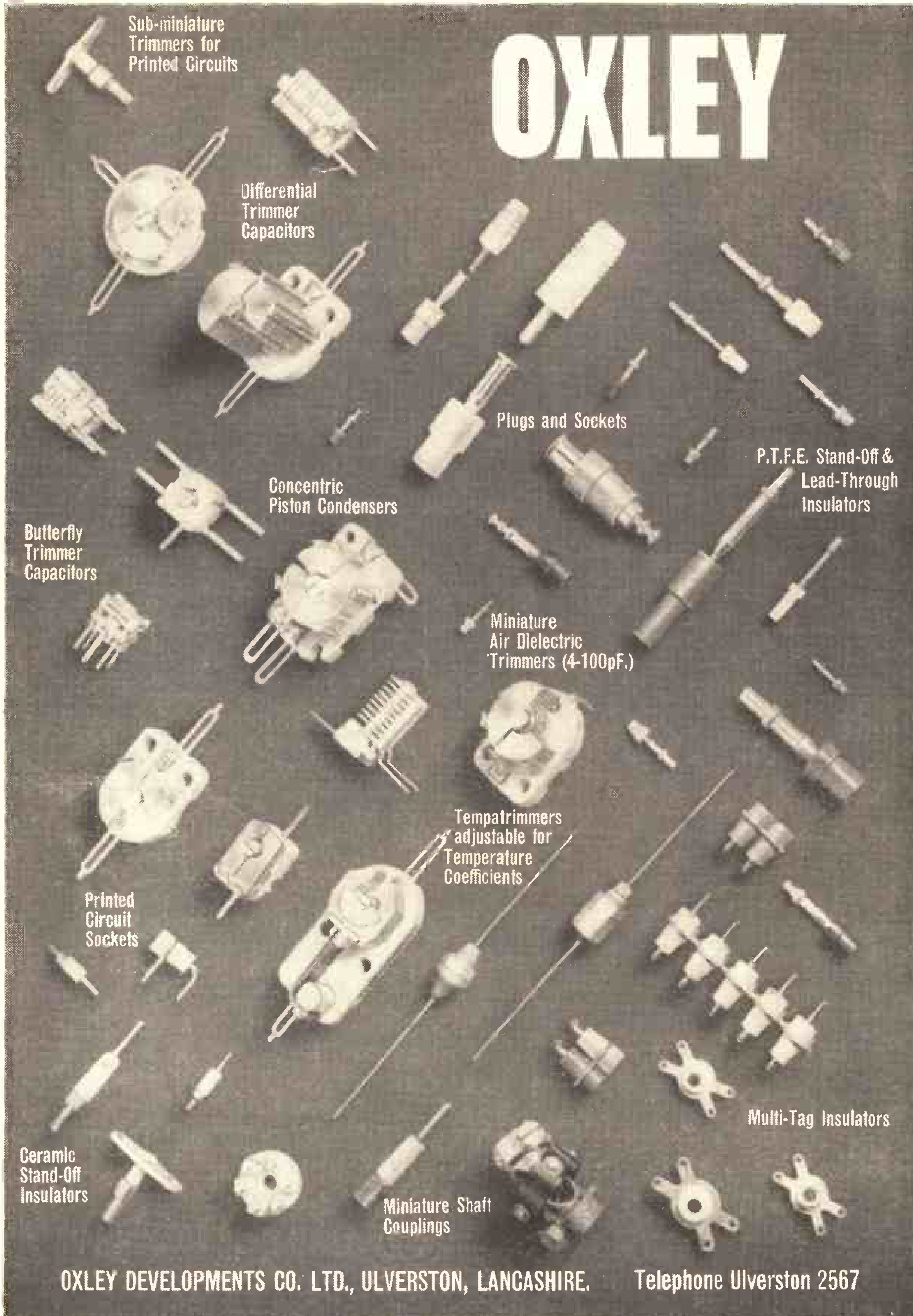
TRANSISTOR MOUNTING PADS



POWER TRANSISTOR SOCKETS

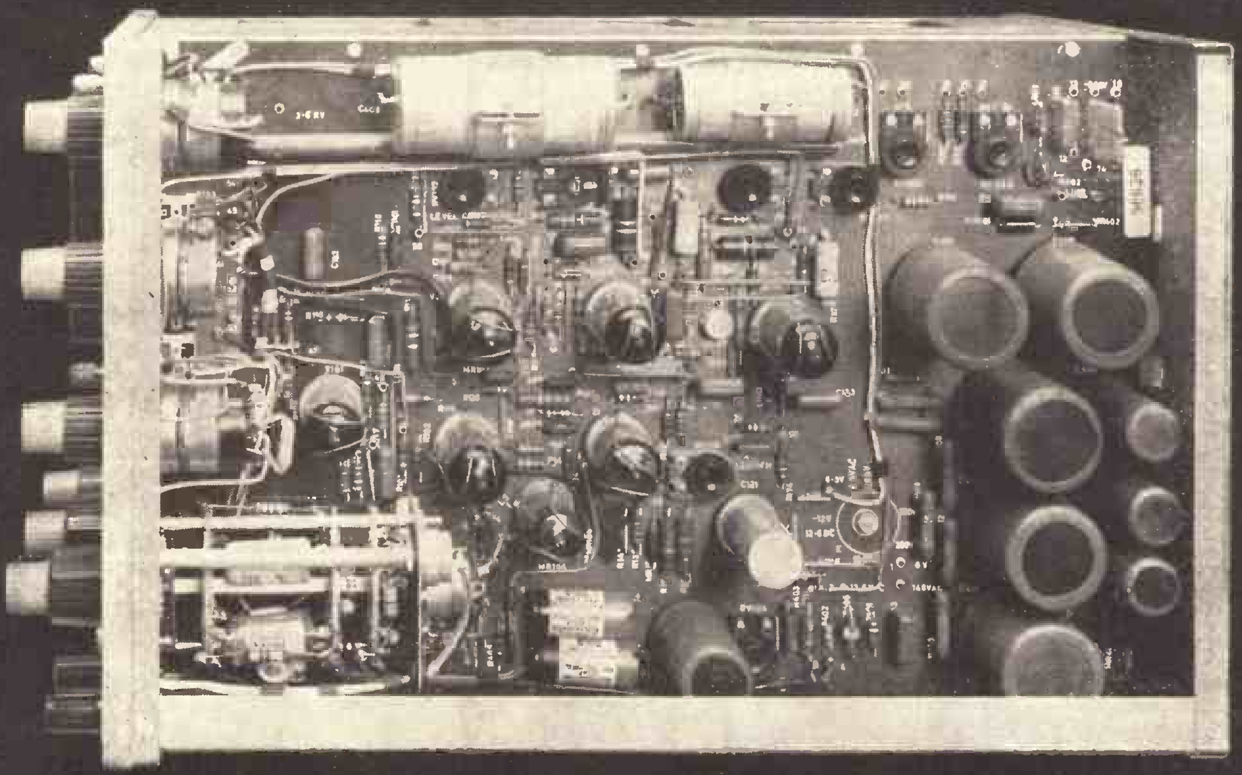
SPEAR ENGINEERING CO. LTD.
WARLINGHAM
SURREY
Telephone U.A.O. 2774

WW—109 FOR FURTHER DETAILS.



WW—111 FOR FURTHER DETAILS.

workmanship



No sealed-off secrets inside a Telequipment oscilloscope . . . . it's all good practical engineering. Compact as they are, every model is simply and soundly constructed for efficient operation and easy servicing. From specially developed tube with bright linear display to individually tested components—every detail in a Telequipment 'scope must meet the same high standard. There's no secret about Telequipment 'Tracemanship', just skill in design and . . . . workmanship. See for yourself!

Illustrated is the type D52 double-beam Serviscope— £99. Send for a short form catalogue of the complete range.*

TELEQUIPMENT

**Serviscope is a registered trade mark of*

Telequipment Limited · 313 Chase Road · Southgate · London · N.14 · Fox Lane 1166
Scottish Office: 30 Castle Street · Edinburgh · Tel: Balerno 3120

WW—112 FOR FURTHER DETAILS.

" Wireless World "
Iliffe Electrical Publications Ltd.,
Dorset House, Stamford Street,
London, S.E.1

Managing Director:
W. E. MILLER, M.A., M.I.E.R.E.

Editor-in-Chief:
W. T. COCKING, M.I.E.E.

Editor:
H. W. BARNARD

Technical Editor:
T. E. IVALL

Editorial:
D. C. ROLFE
G. B. SHORTER, B.Sc.

Drawing Office:
H. J. COOKE

Production:
D. R. BRAY

Advertisements:
G. BENTON ROWELL
(*Manager*)
J. R. EYTON-JONES

VOLUME 71 No. 8
PRICE: 3s.

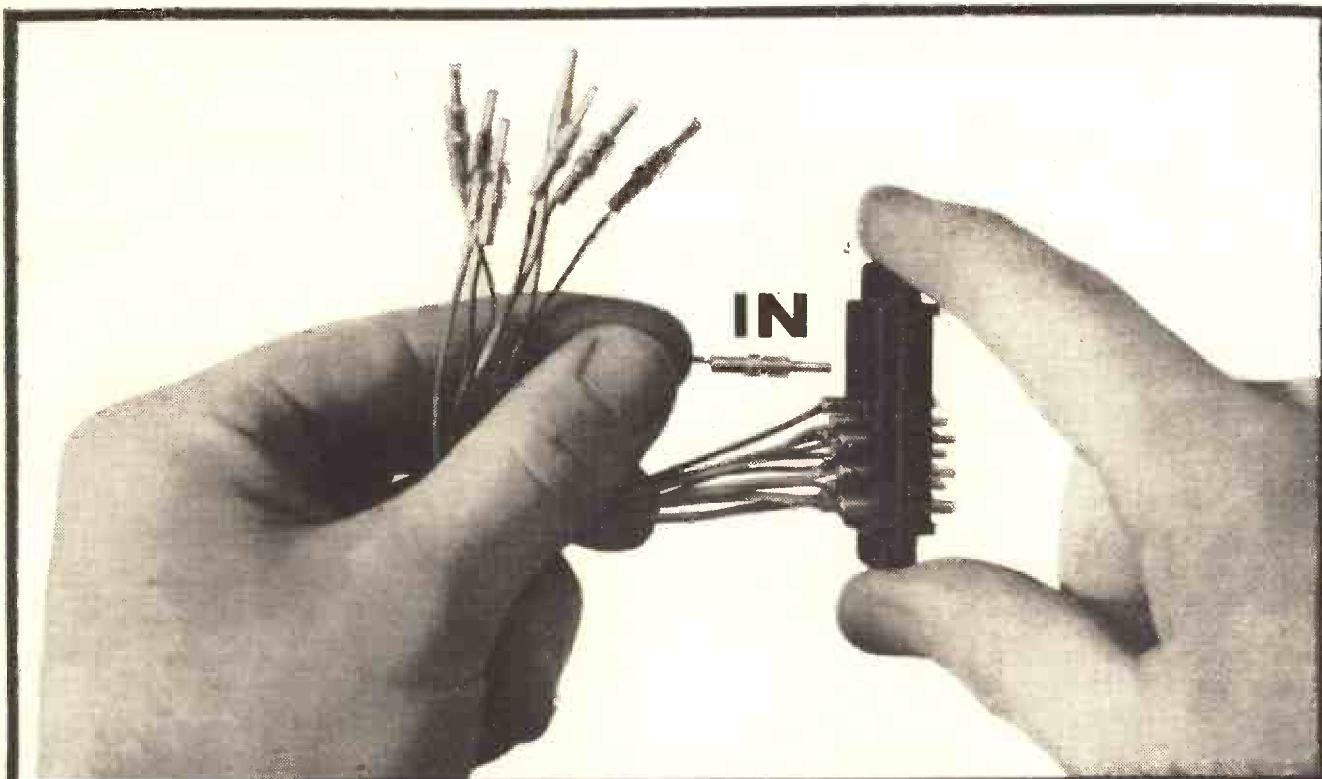
FIFTY-FIFTH YEAR
OF PUBLICATION

Wireless World

ELECTRONICS, TELEVISION, RADIO, AUDIO

SEPTEMBER 1965

PUBLISHED MONTHLY (4th Monday of preceding month). *Telephone:* Waterloo 3333 (70 lines). *Telegrams/Telex:* Wiworld Iliffepres 25137 London. *Cables:* "Ethaworld, London, S.E.1." *Annual Subscriptions: Home* £2 6s 0d. *Overseas:* £2 15s 0d. *Canada and U.S.A.* $8.00. Second-class mail privileges authorised at New York N.Y. BRANCH OFFICES: *BIRMINGHAM:* King Edward House, New Street, 2. *Telephone:* Midland 7191. *BRISTOL:* 11, Marsh Street, 1. *Telephone:* Bristol 21491/2. *COVENTRY:* 8-10, Corporation Street, *Telephone:* Coventry 25210. *GLASGOW:* 123, Hope Street, C.2. *Telephone:* Central 1265-6. *MANCHESTER:* 620, Deansgate, 3. *Telephone:* Blackfriars 4412. NEW YORK OFFICE U.S.A.: 111 Broadway, 6. *Telephone:* Digby 9-1197.

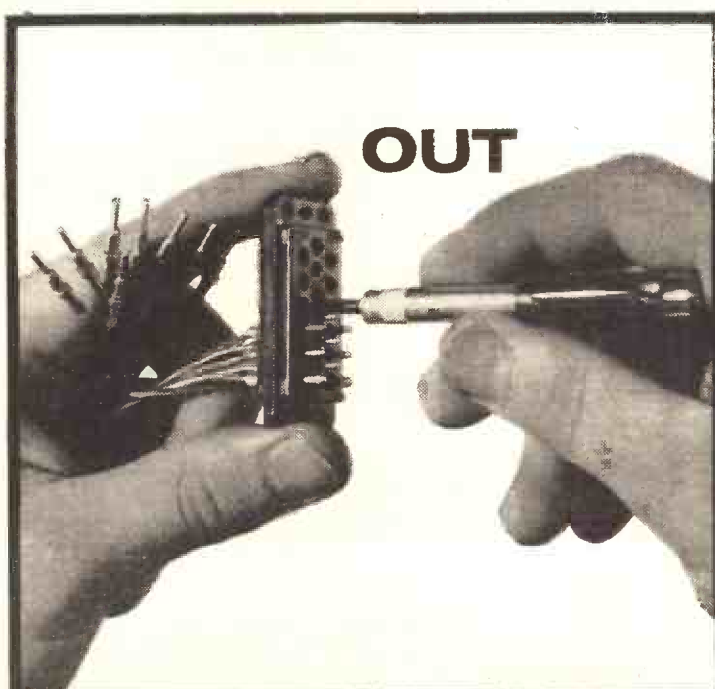


NEW PUSH-HOME UNITOR

developed from type 102

- Robust, slim, glass filled Diallyl-phthalate moulding
- Contacts simply soldered or crimped, then loaded into rear of moulding
- Contact inserts designed to international crimping standards—need little force to insert and withdraw
- Contact springs of beryllium-copper
- Closed-entry sockets
- Ambient temperature range —55°C plus —200°C
- High current ratings, 10 and 20 amp
- Simple removal tool supplied with contacts

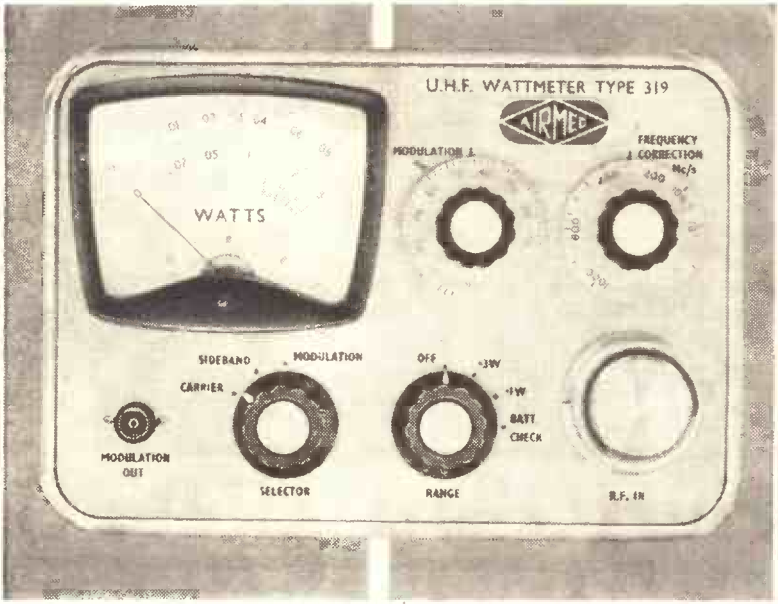
Write for leaflet P661—
or telephone Miss Woolgar at
Enfield 5393 Ext. 27.



BELLING-LEE

Belling & Lee Ltd · Great Cambridge Rd
Enfield · Middx. Telex: 263265

To measure C. W. Power . . . Sideband power . . . Modulation depth



- Frequency Range: 10-1000 Mc/s
- Ranges: 0-100mW, 0-300mW
- Input Impedance: 50 ohms.

The U.H.F. Wattmeter Type 319 is a light and compact instrument for measuring C.W. power, sideband power, and modulation depth in the frequency range 1-1000Mc/s. Carrier and sideband powers are indicated directly on a $3\frac{1}{2}''$ scale meter in two ranges. Percentage modulation depth is shown on a potentiometer scale.

For carrier measurement no additional power is necessary; internal dry batteries provide power for sideband and modulation measurement. This instrument is one of the units in the Airmec range of U.H.F. equipment which includes connectors, adaptors, attenuators, reactance lines, slotted lines etc.

Airmec UHF Wattmeter Type 319

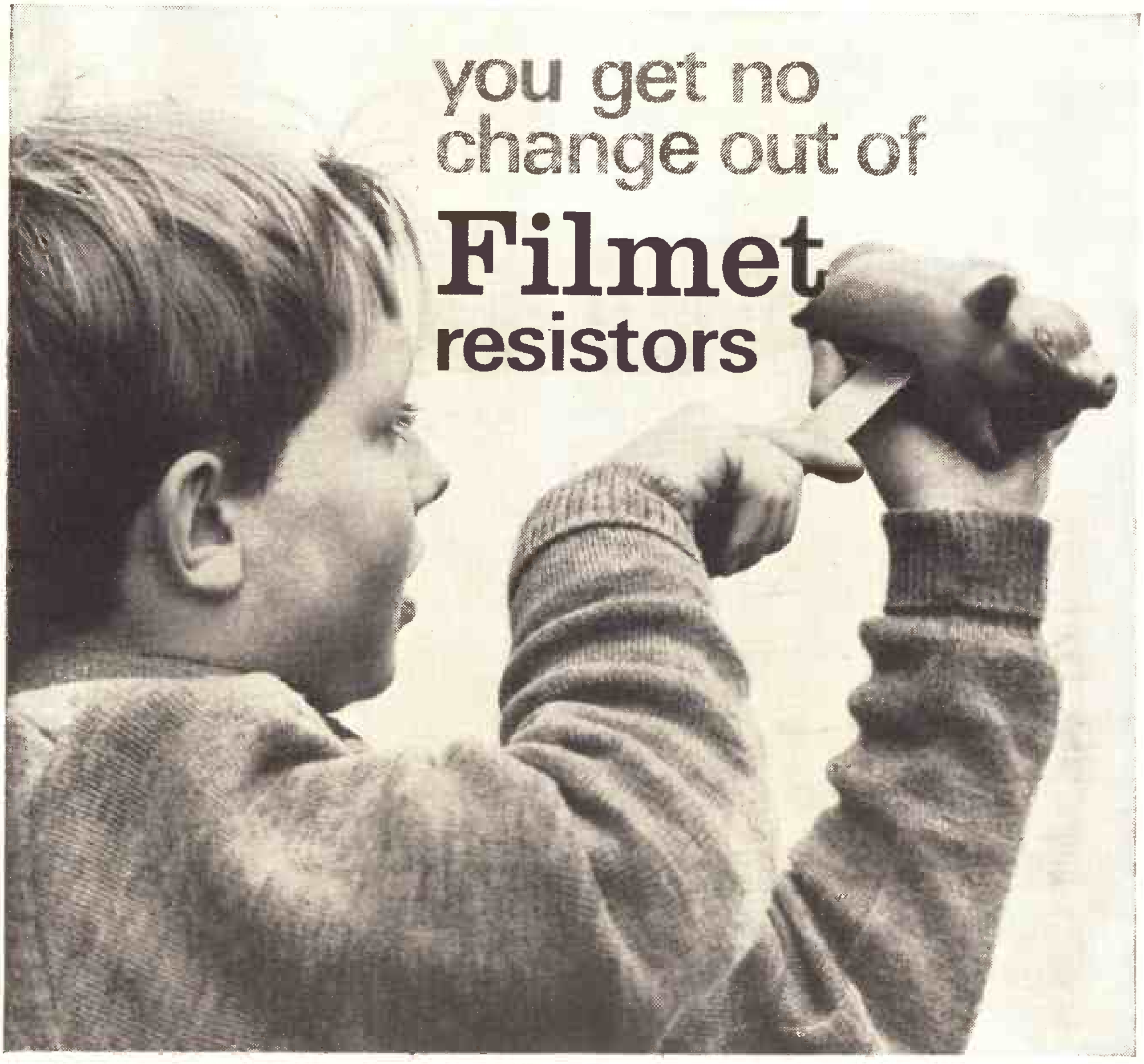
Airmec for peak performance consistently

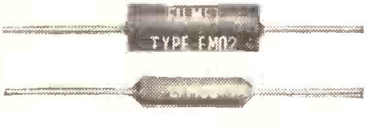
LABORATORY INSTRUMENTS DIVISION
Oscilloscopes, Wave Analysers, Signal Generators, Phase Meters, Valve Voltmeters, Ohmmeters, High Speed Counters, etc.
AIRMEC LIMITED, HIGH WYCOMBE, BUCKS, ENGLAND
TELEPHONE: HIGH WYCOMBE 21201 (10 LINES)

WW—116 FOR FURTHER DETAILS.

AP286A

STABILITY OF ±0.5% even under the most testing conditions, makes Morganite Filmet Resistors perfect for your radar, analogue computers, automation and electronic instrumentation. Complete protection against atmospheric action is ensured by encapsulation in epoxy resin or by moulded cases of high mechanical and electrical strength.





Actual resistance is within ±0.1% of nominal value. Dimensions are constant over the entire resistance range of 100 ohms to 1 Megohm. The temperature coefficient is unusually low at 15 p.p.m. per degree C.

Filmet Resistors are made to stable and precise limits by depositing a very thin film of metallic resistance material on to a high grade ceramic former in a vacuum—a technique pioneered in this country by Morganite Resistors Limited.

A Member of The Morgan Crucible Group

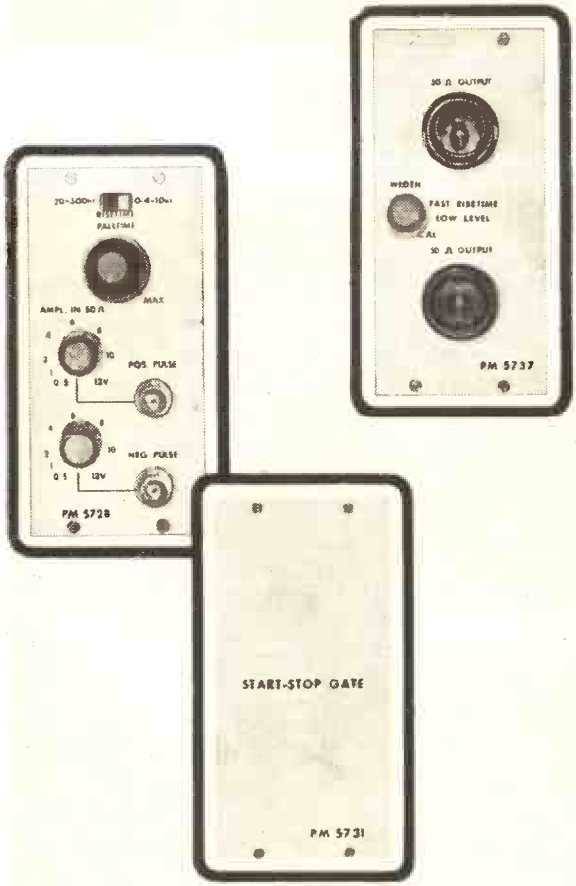
Send off to-day for full technical specifications of the Filmet range to:

MORGANITE RESISTORS LIMITED

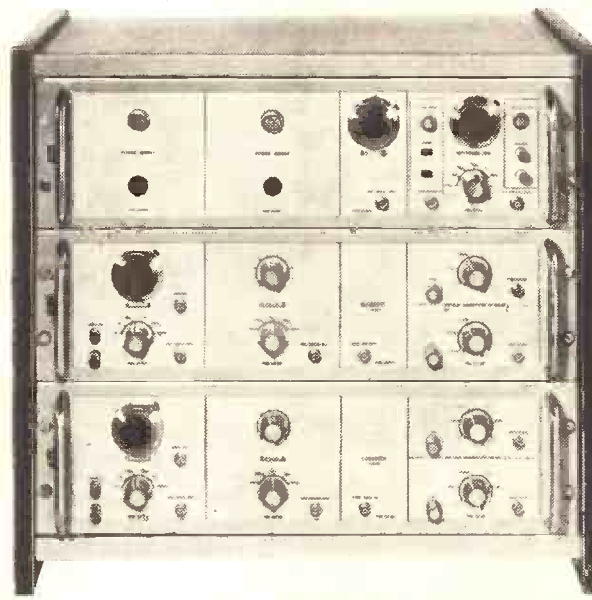
BEDE TRADING ESTATE JARROW CO DURHAM TEL: JARROW 89-7771, TELEX: 53353

1323 MR

WW—117 FOR FURTHER DETAILS.



Three new modules...



added to Philips modular pulse generator PM5720-40

Two new output modules and a new gate module have been added to the modular pulse generator PM 5720-40. The power output module PM 5728 provides pulses with a maximum amplitude of 12 V into a load of 50 Ω or higher at 100% duty cycle. Lower loads can be connected at reduced duty cycles. Simultaneous positive and negative pulses are available. Rise and fall time are linearly variable from 20 ns (typical value 15 ns) to 10 μs.

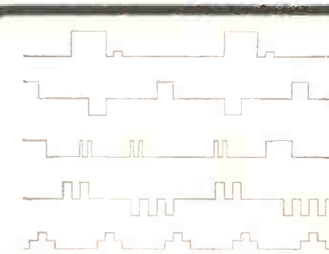
The fast rise time unit PM 5737 provides two identical pulses of 1 V into 50 Ω. The twin outputs can be utilised for reflection and similar measurements, one output being applied to an oscilloscope and the other to the network being studied. No power is wasted in resistive tee connectors. The twin outputs also provide a simple method of obtaining double pulses, one pulse is obtained direct from one output, the second from a simple open-circuited cable acting as a delay line. In this way repetition rates of up to 200 Mc/s can be simulated.

The gate unit PM 5731 performs an AND-function, the gate-open time of which can be defined by a start and a stop pulse. This unit is particularly useful to provide more complex pulse programmes.

Additional modules are under continuous development and these three new modules are additional to the already existing units; together they make up a system which can be programmed to provide almost any required pulse or pulse sequence on one or several channels.

A survey of the available output units and some examples of pulses which can be obtained are given below.

Output units	PM 5727	PM 5728	PM 5737
Rise time	7 ns	15 ns . . . 10 μs	0.3 ns
Fall time	7 ns	15 ns . . . 10 μs	1.5 ns
Amplitude into 50 Ω	max. 5 V	max. 12 V	1 V
Attenuation	1000x	24x	- - -
Main characteristics	Fast rise time Bandwidth of stepattenuators 300 Mc/s	High amplitude; Variable rise and fall time	Very fast rise/fall time



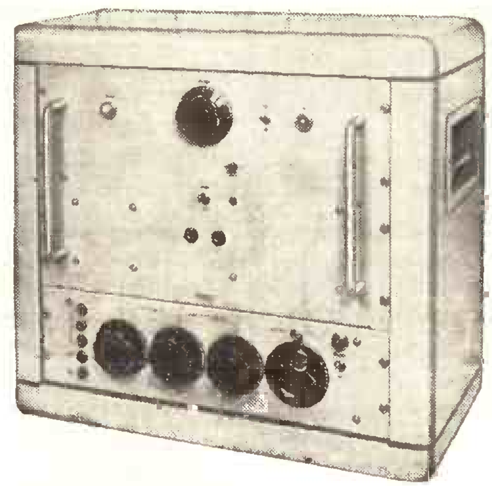
PHILIPS
electronic measuring instruments

For the U.K.:
Philips Electronics and Control
The M.E.L. Equipment Company Ltd.,
207 Kings Cross Road,
London WC1 TERminus 2877.

WW—120 FOR FURTHER DETAILS.

—Vortexion quality equipment

120/200 WATT AMPLIFIER



The 120/200 watt Amplifier can deliver its full power at any frequency in the range of 30 to 20,000 c.p.s. for which the response is accurate within 1 db with less than 0.2% distortion at 1,000 c.p.s. Noise level —90 db. It can be used to drive mechanical devices, i.e., synchronous capstan or projector motors, etc., for which the power is over 140 watts on continuous sine wave. A floating series parallel output is provided for 100-120v. or 200-250v., and additional matching transformers for other impedances are available. The input is for 1 mW. 600 ohms.

30/50 WATT AMPLIFIER

The Vortexion 30/50 watt Amplifier can deliver 50 watts of speech and music or over 30 watts of continuous sine wave and the main amplifier has a response of 30 to 20,000 cps within 1 db at 0·1% distortion and outputs for 4, 7.5, 15 ohm and 100 volt line. Models are available with two, three or four mixed inputs which may be low impedance balanced line microphones, P.U. or Guitar inputs.

ELECTRONIC MIXER AMPLIFIER

This high fidelity 10/15 watt Ultra Linear Amplifier has a built-in mixer and Baxandall tone controls. The standard model has 4 inputs, two for balanced 30 ohm microphones, one for pick-up C.C.I.R. compensated and one for tape or radio input. Alternative or additional inputs are available to special order. A feed direct out from the mixer is standard and output impedance of 4-8-16 ohms or 100 volt line are to choice. All inputs and outputs are at the rear and it has been designed for cool continuous operation either on 19 × 7in. rack panel form or in standard ventilated steel case.

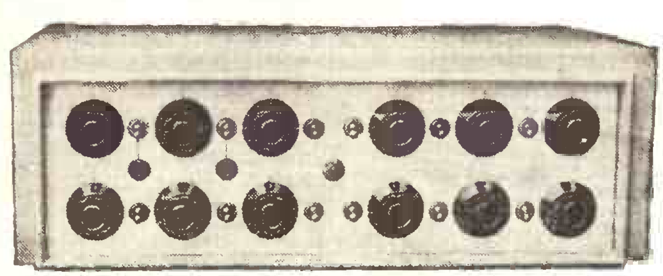
Size 18 × $7\frac{1}{2}$ × $9\frac{1}{2}$in. deep.

Price of standard model **£49.**

12-WAY ELECTRONIC MIXER

The 12-way electronic mixer has facilities for mixing 12 balanced line microphones. Each of the 12 lines has its own potted mumetal shielded microphone transformer and input valve, each control is hermetically sealed. Muting switches are normally fitted on each channel and the unit is fed from its own mumetal shielded mains transformer and metal rectifier.

Also 3-way mixers and Peak Programme Meters.
Price **£60.**
4-way Mixers from **£40/8/6.**
2 × 5-way stereo mixers with outputs for echo chambers, etc., available.



Price of standard model **£98.**

Full details and prices of the above on request

VORTEXION LIMITED, 257-263 The Broadway, Wimbledon, London, S.W.19

Telephone: LIBerty 2814 and 6242-3 **Telegrams: "Vortexion London S.W.19"**

WW—121 FOR FURTHER DETAILS.

WAYNE KERR

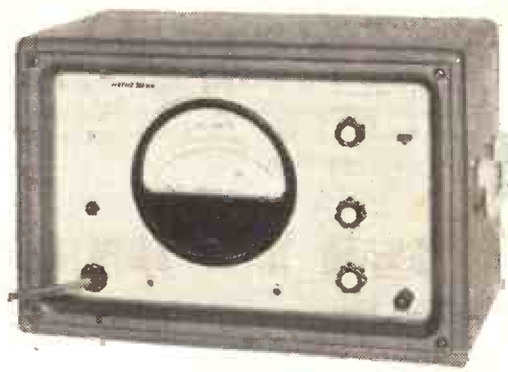
INNOVATIONS IN INSTRUMENTATION

audio-video instrumentation

Wayne Kerr, makers of the world's most comprehensive range of electronic bridges, have also developed many precision signal-generating, attenuating, measuring and analysing instruments for frequencies from DC to 60 Mc/s. These instruments combine maximum versatility with simplicity of operation, and are in widespread use throughout Government Establishments, Broadcasting Authorities, the Armed Services and all types of scientific and industrial laboratories.

INSTRUMENT-OF-THE-MONTH

VTVM measures 30µV-100V from 20 c/s to 300 kc/s



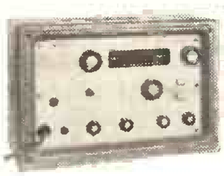
The Wayne Kerr M121 AF Voltmeter has open, linear scales for the accurate measurement of voltages with negligible loading on the source. The mirror-scale movements are individually calibrated in r.m.s. values and in dB relative to 1 mW in 600 ohms. Exceptional linearity and stability have been achieved by including the rectifying elements in a current-feedback loop. The h.t. supply for *all* stages is fully stabilised, eliminating any undesired effects of mains fluctuations. A cathode-follower output stage is included to permit feed-through amplification of up to 60dB.

Brief Specification:

Ranges 1, 3, 10, 30, 100 and 300mV, 1, 3, 10, 30 and 100V r.m.s. (Multiplier for 300V.)

Accuracy Better than 1% f.s.d.

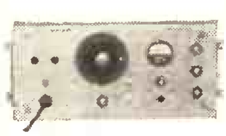
Input Impedance
1 mV to 10V (direct): ≥ 15 MΩ shunted by 20pF
1 mV to 10V (transformer): 600Ω and 100kΩ, balanced or unbalanced
30V and 100V (direct): 1 MΩ shunted by 15 pF



AUDIO SIGNAL GENERATOR S121

Very low harmonic content, 13-ft. tuning scale.

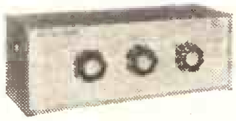
Frequency	10 c/s to 120 kc/s
Stability	100 ppm
Accuracy	1% ± 0.5 c/s
Output (600Ω)	—70 dBm to + 10 dBm
Hum level	at least 60 dB down



COMPLEX-WAVEFORM ANALYSER A321

High selectivity plus simple operation

Frequency	20 c/s to 20 kc/s
Stability	1%
Response	± 1 dB
Accuracy	Frequency: 2% Level: 5% or ± 1 dB



WIDE-BAND ATTENUATOR Q251

Compact, high accuracy and stability

Frequency	DC to 60 Mc/s
Range	0-61.5 db (0.5-dB steps)
Impedance	50Ω or 75Ω
Accuracy	±0.1 dB

VIDEO OSCILLATOR O22D

Output level unaffected by frequency changes

Frequency	10 kc/s to 10 Mc/s, plus mains-frequency square wave
Accuracy	1%
Output	—51.5 to +10 dB on 1 Vp-p across 75Ω (alternatives: 1mW in 75Ω, or 1mW in 50Ω)
Stability	± 0.5 dB

FOR MORE INFORMATION use the coupon below (faster) or the reader enquiry service (easier).

	Reader enquiry service code no.
'Instrument-of-the-month'	220
AF Voltmeter M121	221
Audio Signal Generator S121	222
Complex-Waveform Analyser A321	223
Wide-band Attenuator Q251	224
Video Oscillator O22D	225
Electronic Bridges	226

WAYNE KERR

The Wayne Kerr Laboratories Limited
Sycamore Grove, New Malden, Surrey
Telephone: MALden 2202 Telex 262333
Cables: Waynkerr, New Malden

Please send me further information about the instruments I have indicated (tick appropriate box)

- 'Instrument-of-the-month' AF Voltmeter M121 ☐
- Audio Signal Generator S121 ☐
- Complex-Waveform Analyser A321 ☐
- Wide-band Attenuator Q251 ☐
- Video Oscillator O22D ☐
- Electronic Bridges ☐

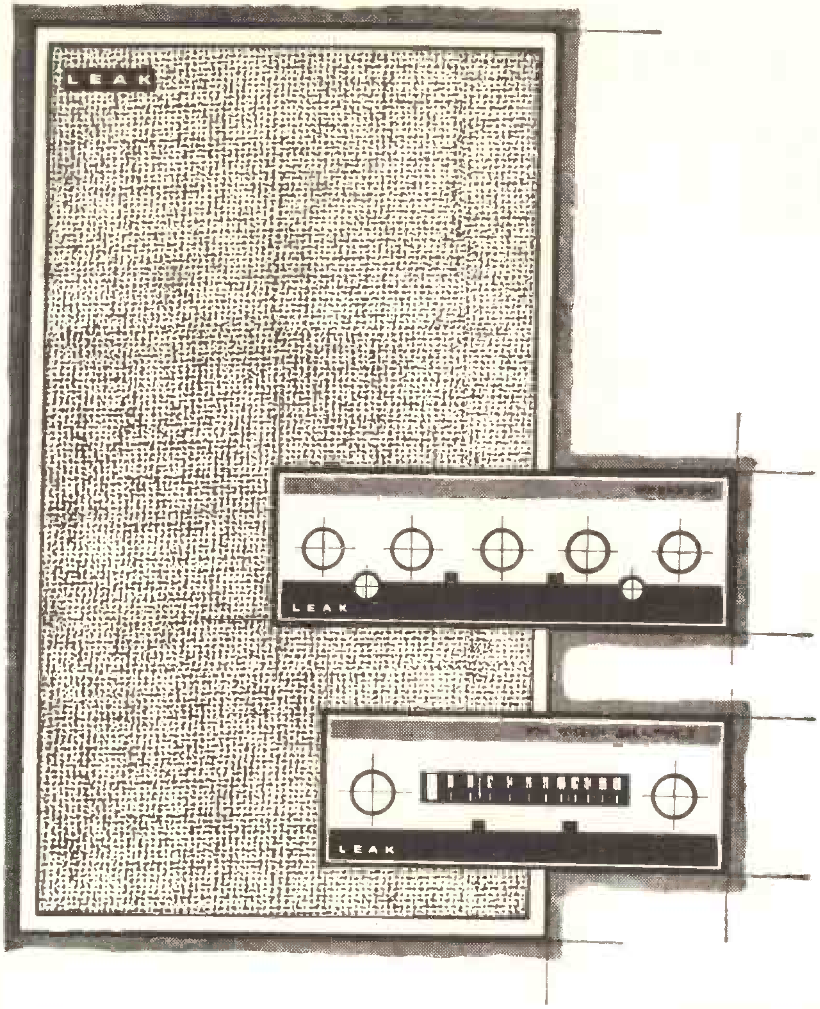
Name__________

Position__________

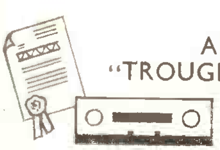
Firm__________

Address__________

WK72a

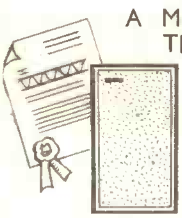


A TRIPLE FIRST FOR LEAK



A SUCCESSOR TO THE FAMOUS "TROUGHLINE II": FM "TROUGHLINE 3"
Price £31: 14: 6d.

HI-FI NEWS—*"To sum up, the Leak Troughline II belongs to the very limited class of aristocrats in the tuner world."*



A MAJOR LOUDSPEAKER INVENTION THE "SANDWICH" Price £39: 18: 0d.

AUDIO AND RECORD REVIEW—*". . . This design must be regarded as a breakthrough of fundamental and far-reaching importance."*

ANOTHER MILESTONE IN AUDIO ENGINEERING "STEREO 30" TRANSISTORISED AMPLIFIER
Price £49: 10: 0d.

WIRELESS WORLD Editorial, May 1963—*"Last autumn during his presidential address to the British Sound Recording Association, H. J. Leak demonstrated a prototype high-quality transistor amplifier which gave results indistinguishable from those of his valve amplifiers . . ."*

"People sometimes ask why there is any necessity to change to transistors. The elimination of the output transformer is, in our view, sufficient reason now that solutions of the problem of linearity in the response of the rest of the transistor circuit have been found. As additional bonuses we get smaller size, cooler running and the prospect of longer life."

If you are interested in Hi-Fi equipment combining faultless presentation with audio engineering to impeccable standards offering studio quality reproduction at reasonable cost . . .

WRITE NOW FOR FULLY ILLUSTRATED AND DETAILED LITERATURE.

LEAK . . . the first name in High Fidelity since 1934

H. J. LEAK & CO. LTD., BRUNEL ROAD, WESTWAY FACTORY ESTATE, LONDON, W.3

Telephone: SHEpherds Bush 1173 (PBX). Telegrams: Sinusoidal, London, W.3

in step with the

20 WATTS RMS OUTPUT

SIZE — $8\frac{1}{4}'' \times 3\frac{1}{4}'' \times 1''$

WEIGHT — $4\frac{1}{2}$ OUNCES

THE NEW APPROACH TO BETTER SOUND

By the use of Pulse Width Modulation in circuitry developed exclusively by Sinclair Radionics, the unique X-20 achieves standards never before reached by any audio amplifier in the world. From the input of the integrated pre-amp through to the power output stage, this amazing amplifier gives quality and power far ahead of anything in its class to make it the most original and interesting design in years. You use your X-20 like any conventional quality amplifier, but it occupies far less space, costs less, behaves perfectly and brings a refreshingly new approach to audio that is setting the standard for the whole industry.

A USER WRITES:

"Please send me another X-20 amplifier. I received one last week and it works very well." (signed) J.B., Ellesmere.

★ Easily built in an evening
★ No. of transistors—12
★ Output stage—silicone epitaxial planars
★ Constant square wave amplitude
★ 95% conversion efficiency factor at output stage
★ Frequency response—From 20 to 20,000 c/s ±1dB
★ Total harmonic distortion—0.1% at 10 watts R.M.S.
★ Input sensitivity—1mV into 5kΩ
★ Signal to noise ratio—better than 70dB
★ Output into 7.5 ohms—
20 watts R.M.S. music power
15 watts R.M.S. continuous
★ Output into 15 ohms—
15 watts R.M.S. music value
10 watts R.M.S. continuous
★ Makes an ideal guitar or P.A. amplifier
★ Built-in low-pass filter in output stage ensures wide tolerance to load connected to the output
★ Power requirements—36V d.c. at 700mA
★ Add tone and volume control systems to choice, mono or stereo, as described in the X-20 manual

SINCLAIR X-20

20 WATT INTEGRATED PULSE WIDTH MODULATED AMPLIFIER AND PRE-AMP

Complete kit inc. 12 Transistors instructions and free X-20 manual. **£7.19.6**

Built and tested, with free X-20 manual. **£9.19.6**

X-20 Mains Power Unit. **£4.19.6**

X-20 Manual available separately — 2/- post free.

FULL SERVICE FACILITIES ALWAYS AVAILABLE TO SINCLAIR CUSTOMERS

sinclair

SINCLAIR RADIONICS LTD.
COMBERTON, CAMBRIDGE. Telephone: COMBERTON 682

WW—124 FOR FURTHER DETAILS.

SPACE AGE!

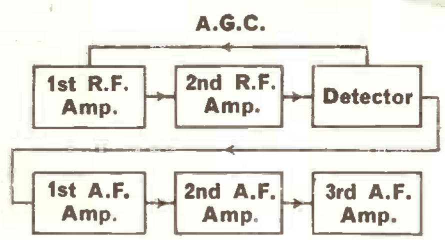
SINCLAIR
P.W.M. AMPLIFIERS
MICRO-RECEIVERS
MICRO DESIGNS
MICRO-ALLOY TRANSISTORS

- **THE SMALLEST RADIO IN THE WORLD**
- **HAS FANTASTIC RANGE AND POWER**
- **UNSURPASSED FOR PERSONAL LISTENING**

SINCLAIR MICRO-6

- *Measures $1\frac{4}{5}'' \times 1\frac{3}{10}'' \times \frac{1}{2}''$ — Weighs 1oz.*

Until you have built and used this set which is smaller than a matchbox, you will never know how exciting the British-designed Micro-6 is. Its range and power will amaze you as station after station pours in; you will find yourself able to enjoy radio where other sets often cannot be used at all. The two self-contained batteries will give 70 hours or more working life. Bandspread tuning over the higher frequency end of the M.W. Band enables Luxembourg to be tuned in with the ease and power of a local station. By now more than 20,000 Micro-6 sets have been built with outstanding success by constructors all over the world ranging from advanced electronic engineers to beginners. So start yours today.



In the Micro-6 *only three* Micro-Alloy Transistors are used in a unique and highly efficient 6-stage circuit as follows: Two stages of RF amplification are followed by an efficient double-diode detector which drives a high-gain 3-stage AF Amplifier. Powerful A.G.C. applied to the first RF stage ensures fade-free reception from the most distant stations tuned in. Everything including ferrite rod aerial and batteries contained within the elegant tiny white, gold and black case. Inserting the earphone plug switches the set on.

BUILD IT IN AN EVENING

Building is simple. All parts including lightweight earpiece, case and dial, and 8-page instructions manual come to **59/6**

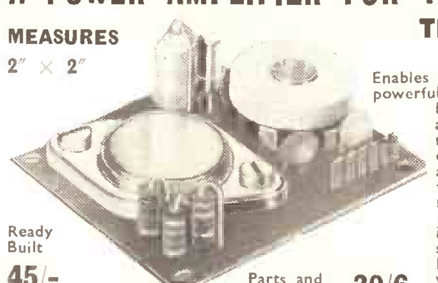
Mallory Mercury Cell Type ZM312 (2 required), each **1/11** Pack of 6 10/6.

Sinclair "Transrista" well-styled, strong black nylon wrist strap .. **7/6**

A POWER AMPLIFIER FOR YOUR MICRO-6

- **MEASURES** 2″ × 2″

THE SINCLAIR TR750



Ready Built **45/-**

Parts and instructions. **39/6**

Enables the Micro-6 to be used as a powerful car, domestic or portable loudspeaker set. The TR750 also has many other applications such as a record reproducer, inter-com or baby alarm. An output of 750 milliwatts for feeding into a standard 25-30Ω loudspeaker requires only a 10mV input into 2kΩ. Frequency response 30-20,000 c/s ± 1dB. Power required—9 to 12 volts with built-in volume control and switch.

SINCLAIR MICRO-AMPLIFIER

- **AMAZING SIZE AND PERFORMANCE**
- **IDEAL FOR EXPERIMENTERS**

This Sinclair Amplifier is smaller than a 3d. piece! It has a frequency response from 30 to 50,000 c/s ±1dB and a gain of 60dB (1,000,000 times). The instructions supplied with each set of parts show how it can be used in a variety of ways which include a hi-fi amplifier which will even drive a loudspeaker, a broadband RF amplifier, an FM transmitter and a radio receiver, etc. It is also invaluable to modellers and experimenters. Building the micro-amp is simple.

28/-

- **THE MOST ADVANCED TRANSISTORISED DESIGNS FOR CONSTRUCTORS IN THE ENTIRE WORLD.**
- **FULLY DETAILED AND ILLUSTRATED BUILDING AND OPERATING INSTRUCTIONS WITH ALL DESIGNS**
- **THE NAME SINCLAIR GUARANTEES SATISFACTION.**

GUARANTEE ORDER FORM

NAME................................

ADDRESS................................

....

....

Please send me

....

....

....

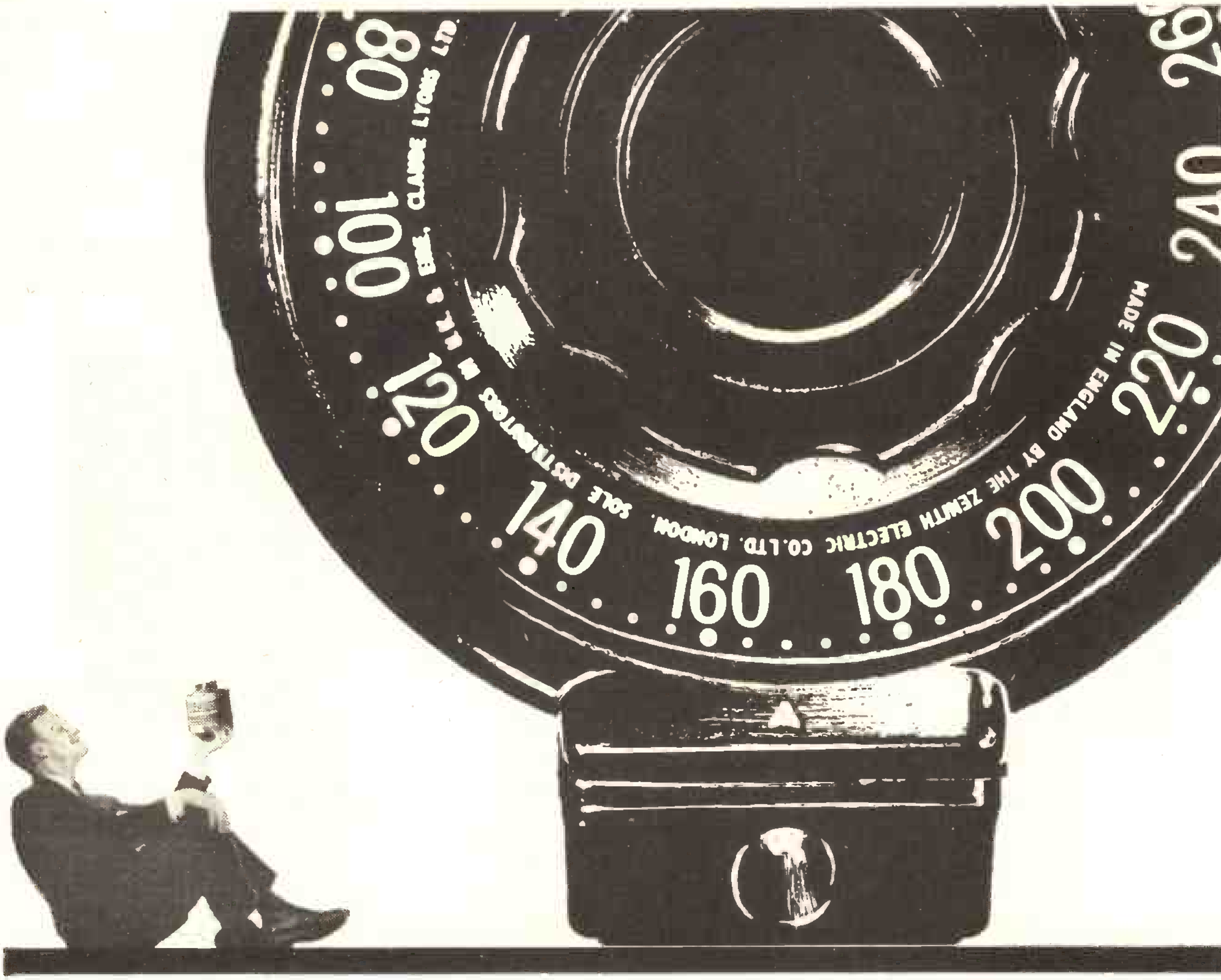
....

for which I enclose Cash/Cheque/Money Order value £..........s...........d...........

Guarantee

Should you not be completely satisfied with your purchase when you receive it from us, your money will be refunded in full and at once without questions. It is important to quote W.W.8 should you prefer to write your order instead of cutting out this coupon.

WW—125 FOR FURTHER DETAILS.



Variac

variable transformers[REGD] for infinitely variable voltage control

THE VARIAC* variable transformer is the most useful and versatile device ever developed for the control of a.c. voltage, or of current, power, heat, light, speed. It provides smooth continuous adjustment of output voltage from zero to line voltage and above, either hand-operated or motor-driven.

Only Variac has Duratrak* – a patented track surface giving longer life, increased overload and surge capacity and maximum economy in maintenance.

There are over 600 Variac models and assemblies to suit virtually every possible requirement, ranging from small units for laboratory or instrument use to large ganged assemblies for high power 3-phase operation. The range includes low-voltage, high-frequency, dual-output and narrow-range types, open, covered, portable, metalclad and oil-immersed constructions, plus many special models. This is the largest range of variable transformers available today.

The technical superiority and dependability of Variac are the result of over 30 years of development and refinement since the introduction of the first Variac models – the *original* variable transformers.

**'Variac' and 'Duratrak' are registered trade marks*

Variacs are made in England by the Zenith Electric Co. Ltd. London, and exclusively distributed in the U.K. Eire and British Colonies by Claude Lyons Ltd.

Write for comprehensive catalogue to Publicity Department, Hoddesdon

CLAUDE LYONS LTD

Valley Works, Hoddesdon, Herts *Hoddesdon 4541 Telex 22724*
76 Old Hall Street, Liverpool 3 *MARitime 1761 Telex 62181*

WW—126 FOR FURTHER DETAILS.

CL47/408

15 AMPS IN ONLY $7\frac{3}{4}''$ DIA

0-275 VOLTS

MODEL 74

REGAVOLT

variable transformer with trouble-free brush gear

Another winner for BERCO DESIGNERS . . .

Model 74 delivers twice as much KVA as any other variable transformer of equivalent size . . .

. . . only £25 · 15 · 0

. . . delivery from stock

Please phone Mr. Love, or write for List 625H/MT for full details.

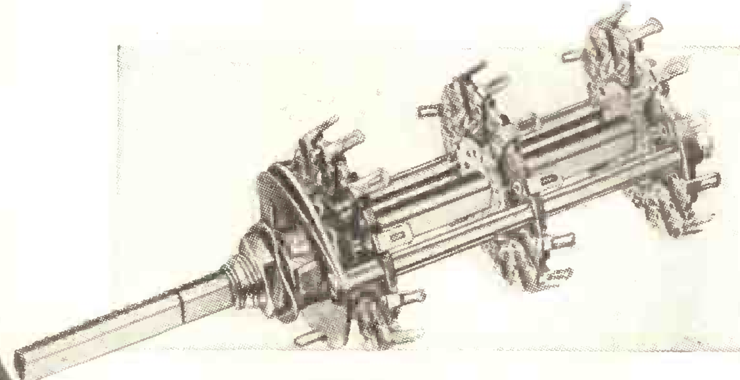
BERCO group of companies

THE BRITISH ELECTRIC RESISTANCE CO LIMITED

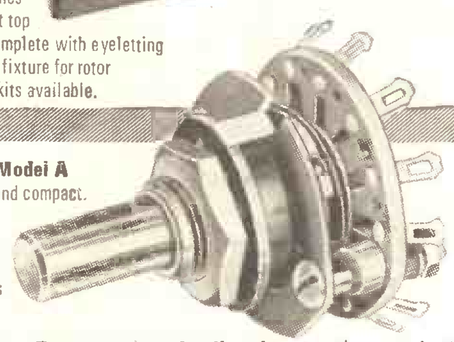
Queensway · Enfield · Middx · Tel: HOW 2411 · Grams: Vitrohm Enfield

NSF for ALL Rotary Wafer Switch needs

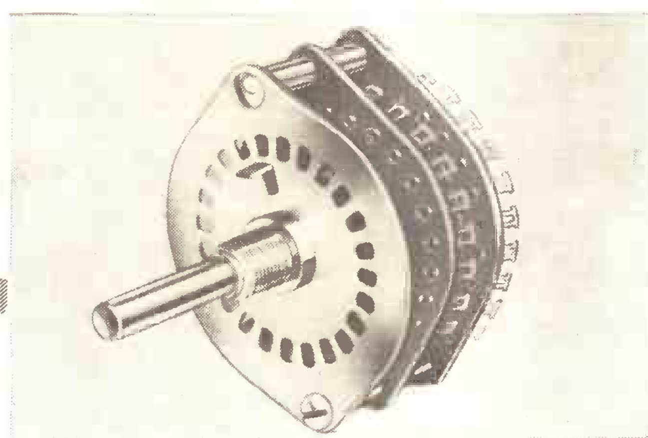
There are few – if any – Rotary Switch requirements that cannot be met, and adequately met, from the wide NSF range which includes more than 30 basic types, and many variants in each. NSF Rotary Switches are among the most extensively used in the radio, television, instrumentation and electronics fields.



NSF Model JK SWITCH KIT Includes over 7,800 parts for easy assembly of 12-position, multi-section switches similar to that at top right. Supplied complete with eyeletting pliers and filing fixture for rotor blades. Other kits available.



NSF Model A Extremely small and compact. 1" dia. section. Double contact clip and floating rotor. 18 contacts per section.



NSF Model MF A 24-position switch with exceptional flexibility. Available with plain dual concentric, or with hollow shafts.

For complete details, please write or telephone

NSF LIMITED

31-32 ALFRED PLACE, LONDON W.C.1
Telephone: Langham 9561 (10 lines) Telegrams: ENESEF, TELEX, LONDON Telex: 21907

WORKS, KEIGHLEY, YORKSHIRE
Telephone: Keighley 4221 Telegrams: ENESEF, TELEX, KEIGHLEY Telex: 51270

A MEMBER OF THE Simms GROUP OF COMPANIES

WW—129 FOR FURTHER DETAILS.

Linstead Electronics

LOW FREQUENCY SIGNAL GENERATOR TYPE G.1

10c/s to 100kc/s in four decade ranges

Three Outputs:

1) 0 to 6v. r.m.s. SINE WAVE with low distortion

2) 0 to 9v. peak to peak SQUARE WAVE with no droop and good H.F. rise time.

3) 0 to 1 Watt into 3 ohms, 50c/s to 20kc/s

£20-0-0 Nett U.K.

Send Coupon, deleting as required.

To, LINSTEAD ELECTRONICS Ltd., 35c, Newington Green, London, N.16.
Please supply Low Frequency Signal Generator Type G.1. Cheque for £20 enclosed.
Please send Type G.1. Technical Leaflet.

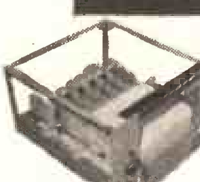
Name ....

Address ....

WW—130 FOR FURTHER DETAILS.

LATEST CATALOGUE NOW READY

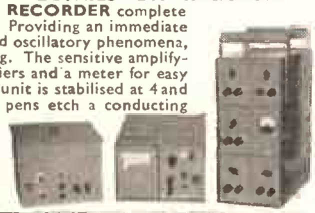
HIGH SPEED PEN RECORDERS



SEFRAM "RAPIDGRAPH" HIGH SPEED 5-PEN RECORDERS. Five channels, seven chart speeds, fully interchangeable pen units, particularly suitable for general use in research establishments and a wide range of applications in industry and medicine. Dual voltage 110/240 volts, rack mounting, size 19in. x 12in. x 18in. Current list price £690; Our Price £270 brand new.

DETAILS ON REQUEST.

HIGH SPEED 4-CHANNEL PEN RECORDER complete with amplifiers and rotary convertor. Providing an immediate and permanent record of transient and oscillatory phenomena, without the need of further processing. The sensitive amplifying unit consists of five plug-in amplifiers and a meter for easy reference. The two-speed recording unit is stabilised at 4 and 8 c.m. per second. The high voltage pens etch a conducting layer on the 3in. paper roll. A rotary transformer 12 volt D.C. makes this into a semi-portable unit, complete with carrying case. **£195 0 0**



DETAILS ON REQUEST.

COSSOR 1039 DOUBLE BEAM OSCILLOSCOPE

10 cm. calibrated screen ideal for f measurements. Separate y y controls. 10 time base speeds with fine control. External sync. and trigger facilities, 50 c/s. Cal. internal. All connections to front, 50 c/s. 230 volt input requirements. **£19.19.0** guar. working and fully overhauled.

MARCONI 'S' BAND SPECTRUM ANALYSER

Covering 2900-3150 mc/s. with a spectrum width of 1-10 mc/s. and sweep of 4-10 mc/s. 3" c.r.t. with monitor meter and vernier dial. Sensitivity 40 mW/cm.

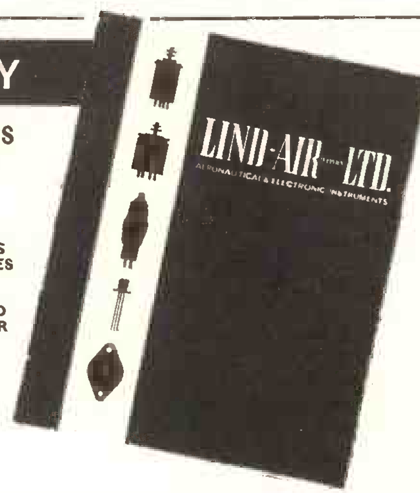
Price £75.0.0

Covering:
SERVO MOTORS AND SYNCHRO EQUIPMENT

also
**BLOWERS MOTORS
PRECISION SWITCHES
TRANSISTORS
AND DIODES
GEAR BOXES AND
MOTORS • MOTOR
TACHOMETERS
RECTIFIERS
AND VALVES**

FULLY ILLUSTRATED

SEND **2'6** *FOR YOUR COPY!*



SEPARATE LISTS AVAILABLE covering **INDUSTRIAL PLUGS, SOCKETS AND CONNECTORS. PLESSEY MK4, THORN, CANNON, AMPHENOL, BELLING-LEE, etc. PANEL METERS, TRANSISTORS, RECTIFIERS, VALVES AND DIODES.** Sent on receipt of large S.A.E.

Large range of **MICROWAVE TEST EQUIPMENT** and **WAVE GUIDE SECTIONS** in stock also the best range of **HI-STAB RESISTORS.** Enquiries invited.

All orders and enquiries to Dept. W.W.

LIND-AIR (SUPPLIES) LTD.
53, TOTTENHAM COURT ROAD · LONDON · W.1
LANGham 3653

WW—131 FOR FURTHER DETAILS.

DE LUXE RECORD PLAYER KITS

4-Speed Players 2-tone Cabinets 17 × 15 × 8½in. High flux loudspeaker and 3 watt 2 valve 2 stage amplifier ready built. Quality output. Volume and Tone controls. All items fit together perfectly. Special instructions enable assembly in 30 minutes, only 5 wires to join. 12 months' written guarantee.

PLAYER KITS

Complete as above

B.S.R. Superslim Autochange	£10/10/0	P.P. 5/-
Garrard Autoslim Autochange	£10/19/6	P.P. 5/-
Garrard SRP10 Single play	£9/19/6	P.P. 5/-
Garrard AT5 .... £12/10/0; AT6	£14/15/0	P.P. 5/-

ALL AVAILABLE SEPARATELY

Cabinet with board cut to choice	£3/9/6	P.P. 3/6
Amplifier with speaker	£2/12/6	P.P. 3/6
AUTOCHANGERS (Stereo 15/- extra)		
B.S.R. UA25 Superslim Mono	£5/19/6	P.P. 3/6
Garrard Autoslim Mono	£6/10/0	P.P. 3/6
Garrard AT5 £8/10. Garrard AT6	£10/10/0	P.P. 3/6
SINGLE PLAYERS		
Garrard SRP10 auto. stop/start	£4/17/6	P.P. 2/6
E.M.I. Latest Model Auto. Stop	£3/19/6	P.P. 2/6
B.S.R. with separate P.U.	£3/7/6	P.P. 2/6

Q MAX CHASSIS CUTTER

Complete: a dia., a punch, an Allen screw and key.

½in.	14/6	1 1/16in.	18/-	1¾in.	22/6
⅝in.	14/6	1⅛in.	18/-	2in.	34/3
¾in.	15/6	1¼in.	18/6	2 3/32in.	37/9
⅞in.	15/9	1⅜in.	20/-	2½in.	44/9
1in.	18/-	1½in.	20/6	1in. sq.	31/6

BM3 CRYSTAL MIKE INSERTS. 1 × ⅝in.	7/6
ACOS MIKE INSERT. 1¾ × ⅜in.	8/6
TANNOY CARBON MIKE, with switch	5/6

BARGAIN XTAL PICK-UP ARM Complete with ACOS LP-78 Turnover Head and two styli 20/-; Stereo 30/-

NEW ELECTROLYTICS FAMOUS MAKES.

TUBULAR		TUBULAR		CAN TYPES	
1/350 v.	2/-	100/25 v.	2/-	8/600 v.	9/-
2/350 v.	2/3	250/25 v.	2/6	16/600 v.	12/-
4/350 v.	2/3	500/12 v.	3/-	16 16/500 v.	7/6
8/350 v.	2/3	1,000/12 v.	3/-	32 32/350 v.	5/6
16/450 v.	3/-	8+8/450 v.	3/6	32 32/450 v.	6/-
32/450 v.	3/9	8+16/450 v.	3/9	50 50/350 v.	7/-
25/25 v.	1/9	16+16/450 v.	4/3	64 120/350 v.	11/6
50×50 v.	2/-	32+32/350 v.	4/6	100 200/275 v.	12/6

PAPER TUBULARS. 350 v. 0.1 9d.; 0.5 1/9. 1 mFd. 3/-.
500 v. 0.001 to 0.05 9d.; 0.1 1/-; 0.25 1/6; 0.5 2/6.
1.000 v. 0.001, 0.002, 0.005 0.01, 0.02, 1/6; 0.05, 0.1, 2/-; 0.25, 0.5 3/-.
2,000 v. 0.005. 0.01, 0.02 2/6; 0.05 3/6.
PAPER CONDENSERS. 7 kV. 0.001 6/6; 20 kV. 0.001 10/6.

CERAMIC, 500 v. 1 pF. to 0.01 mFd. 9d. DISC CERAMICS 1/-. PULSE CERAMICS, 15 to 155 pF., 12 kV. 2/6.
SILVER MICA. Close tolerance (plus or minus 1 pF.) 2.2 to 47 pF. 1/-; ditto 1% 50 to 815 pF. 1/-; 1,000 to 5.000 pF. 1/9.
TWIN GANG. "0-0" 208 pF.+176 pF. 10/6; 365 pF. miniature 10/-; 500 pF. standard with trimmers. 9/-, midget. 7/6; midget with trimmers, 9/-; 500 pF. slow motion, standard 9/-; small 3-gang 500 pF. 17/6. Single "0" 365 pF. 7/6.
SHORT WAVE. Single 10 pF., 25 pF., 50 pF., 75 pF., 100 pF., 160 pF., 5/6 each. Can be ganged together. Couplers 9d. each.
TUNING. Solid dielectric. 100 pF., 300 pF., 500 pF., 3/6 each.
TRIMMERS. Compression ceramic 30, 50, 70 pF., 9d.; 100 pF., 150 pF., 1/3; 250 pF., 1/6; 600 pF., 750 pF., 1/9.

MAINS TRANSFORMERS

Post 2/- each

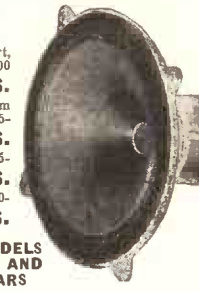
250-0-250, 80 mA. 6.3 v. .35 a., or 4 v. 4 a. Rectifier 6.3 v. 1 a. or 5 v. or 4 v. 2 a. 22/6; Ditto 350-0-350, 29/6; 300-0-300 v. 120 mA., 6.3 v. CT 4 a., 0, 5, 6.3 v. 2 a. 33/6

MINIATURE 200 v. 20 mA., 6.3 v. 1 a.	10/6
MIDGET 220 v. 45 mA., 6.3 v. 2 a.	15/6
SMALL, 300-0-300 v., 70 mA., 6.3 v., 4 a.	19/6
HEATER TRANS., 6.3 v. 1½ a., 7/6; 6.3 v. 4 a.	10/6
Ditto tapped sec. 1.4 v. 2, 3, 4, 5, 6.3 v. 1½ amp.	8/6
GENERAL PURPOSE LOW VOLTAGE, Outputs 3, 4. 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30 v. at 2 a.	22/6
Ditto, 1 amp., 5, 10, 15, 20, 25, 30, 35. 40, 45, 50, 55, 60	29/6
Sub-Min. Mains to 9v. 80 mA. 1×1¼×1¼in.	7/6
AUTO TRANS. 150 w., 0, 115 v., 230 v., 22/6; 500 w.	82/6

SUB-MINIATURE COMPONENT KIT

6-Transistor Coil Component Kit, 3 shielded high-Q 455 k/c I.F.'s, oscillator coil, slug tuned. Proper impedances for optimum circuit performance. Variable tuning condenser with trimmers. Flat ferrite aerial. Tuning dial. Circuit diagram listing parts for powerful 6-Transistor Radio. ONLY 24/6. Matched 6 Transistors, Diode, Thermistor 29/6

BAKER LOUDSPEAKERS



HIGH FIDELITY MODELS

12in., 15 w. Stalwart, 3 or 15 ohms, 45-13,000 c.p.s., 12,000 lines. **5 gns.**
12in. De Luxe. Foam suspension. 15 w. 25-17,000 c.p.s. 14,000 lines. **9 gns.**
12in. Bass. 25 w. 25-15,000 c.p.s. **12 gns.**
12in. Super. 20 w. 20-20,000 c.p.s. **16 gns.**

NEW GROUP MODELS FOR BASS, LEAD AND RHYTHM GUITARS

12in. dia., 25 watt. 20-10,000 c.p.s. Bass res. 80 c.p.s.	5 gns.
12in. dia. 35 watt. 20-10,000 c.p.s. Bass res. 80 c.p.s.	8½ gns.
15in. dia. 50 watt. 20-10,000 c.p.s. Bass res. 80 c.p.s.	18 gns.

LOUDSPEAKERS P.M. 3 OHMS, FAMOUS MAKES. 2½in., 3in., 4in., 5in., 7in. × 4in., 15/6 each; 8in. 17/6; 6½in. 16/6; 12in. 30/-; (15 ohms 35/-); 10in. × 6in. 22/6; 8in. × 5in. 21/-; 8in. × 3in. 21/-. E.M.I. Double Cone 13½ × 8in., 45/-; Stentorian 10in. HF1012, 87/6; 8in. HF812, 72/6. Crossover 3,000 c.p.s. 30/-. Horn Tweeter 104 dB 2 k/cs to 18 kc/s, 29/6.
WAVE-CHANGE SWITCHES WITH LONG SPINDLES.
2 p. 2-way or 2 p. 6-way or 3 p. 4-way or 1 p. 12-way ea. 3/6
4 p. 2-way or 4p 3-way. 3/6; 8 p. 4-way, 2 wafer 6/6
Wavechange "MAKITS" 1p. 12-way, 2 p. 6-way, 3 p. 4-way, 4 p. 3-way, 6 p. 2-way. Prices include click spindles, adjustable stops, spacers, etc. 1 wafer 8/6; 2 wafer 12/6; 3 wafer 16/-.
TOGGLE SWITCHES, s.p., 2/-; d.p., 3/6; d.p.d.t., 4/-.

★ RADIO BOOKS ★ (P & P 9d)

"W.W." Radio Valve Data	7/6
High Fidelity Speaker Enclosures	5/-
Transistor Commercial Superhet Receivers	7/6
TV Fault-Finding	6/-
Mullard Audio Amplifier Manual	8/6
Radio Valve Guide. Books 1, 2, 3, 4 or 5	5/-
Practical Radio Inside Out	3/6
Transistor Audio Amplifier Manual	6/-
Shortwave Transistor Receivers	5/-

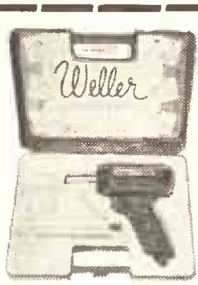
RETURN OF POST DESPATCH *Post 1/6, List 1/-, C.O.D. 2/6 extra: (Export—Send remittance and extra postage, no C.O.D.)* *CALLERS WELCOME*

RADIO COMPONENT SPECIALISTS

337 WHITEHORSE ROAD, WEST CROYDON Telephone THO 1665

the heat's on . . .

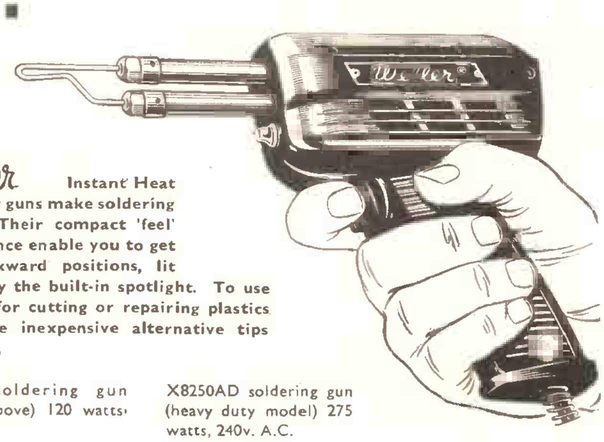
. . . as soon as you press the trigger of the Weller Instant Heat soldering gun — for professional and hobby use.



79/6

Soldering Kit 8100 D-PK

Comprises the 8100DP soldering gun, supply of resin cored solder, cleaning brush, soldering aid tool, spanner and two spare soldering bits set out in fully fitted polypropelene carrying case.



Weller Instant Heat soldering guns make soldering easier. Their compact 'feel' and balance enable you to get into awkward positions, lit clearly by the built-in spotlight. To use the gun for cutting or repairing plastics there are inexpensive alternative tips available.

8100D soldering gun (shown above) 120 watts, 240v. A.C. **65/-**

X8250AD soldering gun (heavy duty model) 275 watts, 240v. A.C. **91/6**

Guaranteed for 12 months by one of the world's largest makers of quality soldering tools.

UK SALES & SERVICE Weller ELECTRIC CORPORATION
HORSHAM · SUSSEX TEL 60807

WW—134 FOR FURTHER DETAILS.

BENTLEY ACOUSTIC CORPORATION LTD.

38 CHALCOT ROAD, CHALK FARM, LONDON, N.W.1
THE VALVE SPECIALISTS *Telephone PRIMROSE 9090*
ALL GOODS LISTED BELOW IN STOCK

OA2	4/6
OB2	6/-
OZ4GT	4/3
1A5	5/-
1A7GT	7/6
1C5	5/-
1D6	9/6
1H5GT	7/6
1L4	2/3
1LD5	4/-
1LN5	4/6
1N5GT	8/6
1R5	4/-
1S4	5/-
1S5	3/3
1T4	2/3
1U4	5/6
1U5	5/3
2D21	5/-
2X2	3/-
3A4	3/9
3A5	6/9
3B7	5/-
3D6	3/9
3Q4	5/3
3Q5GT	6/9
3S4	4/9
3V4	5/-
5R4GY	8/6
5U4G	4/6
5V4G	8/-
5Y3	4/9
5Z3	6/6
5Z4G	7/6
6A8	5/9
6AG5	2/6
6AG7	5/9
6AK5	4/9
6AQ5	5/9
6AT6	3/6
6AU6	5/9
6AV6	5/6
6B8G	2/6
6BA6	4/6
6BE6	4/3
6BH6	5/3
6BJ6	5/6
6BQ7A	7/6
6BR7	8/3
6BR8	8/-
6BS7	25/-
6BW6	7/6
6BW7	5/-
6C5	4/-
6CD6G	18/-
6CH6	6/6
6CW4	24/-
6D3	9/6
6E5	9/6
6F1	9/6
6F6G	3/9
6F13	3/9
6F23	9/3
6F24	10/6
6F33	3/6
6J5G	3/-
6J6	3/-
6J7G	4/6
6K7G	1/3
6K8G	3/3
6K8GTM	8/6
6K25	24/-
6L1	10/-
6L6GT	7/3
6L7GTM	5/6
6L18	10/-
6LD20	6/6
6N7GT	7/-
6P28	11/6
6Q7G	4/-
6R7G	5/3
6SG7GT	4/9
6SL7GT	5/3
6SN7GT	4/-
6U4GT	8/6
6U5G	5/-
6V6G	3/6
6V6GT	5/6
6X4	3/9
6X5GT	5/3
6/30L2	8/9
7B6	12/6
7B7	9/6
7C5	8/-
7C6	6/9
7D6	14/6
7H7	5/9

7R7	12/6
7Y4	5/-
9BW6	9/6
10C1	9/9
10C2	12/-
10D2	11/8
10F1	10/-
10F9	9/9
10F18	9/9
10P13	12/-
10P14	11/6
12A6	2/3
12AC6	8/6
12AD6	9/6
12AE6	8/-
12AH8	10/9
12AT6	4/6
12AU6	5/9
12AV6	5/9
12BA6	5/3
12BE6	4/9
12BH7	6/-
12E1	16/9
12J7GT	7/3
12K5	10/-
12K7GT	3/6
12K8GT	8/6
12Q7GT	3/6
12SA7	6/9
12SC7	4/-
12SK7	3/-
12SQ7	8/-
14H7	9/6
19AQ5	7/3
19H1	6/-
20D1	10/-
20D2	21/-
20F2	11/6
20L1	12/-
20P1	12/6
20P3	12/-
20P4	13/-
20P5	11/6
25A6G	7/6
25L6	4/9
25Z4G	6/6
27SU	23/3
28D7	6/9
30C1	6/6
30C15	10/-
30C17	11/9
30C18	9/3
30F5	7/3
30FL1	9/3
30L1	5/6
30L15	10/3
30L17	11/6
30P4	12/-
30P12	7/6
30P19	12/-
30PL1	9/6
30PL13	10/6
30PL14	11/3
30PL15	9/6
35A5	20/9
35L6GT	6/-
35W4	4/6
35Z3	16/2
35Z4GT	4/6
35Z5GT	5/9
50B5	6/6
50C5	6/6
50CD6G	40/9
50L6GT	6/-
72	6/6
80	5/3
85A2	6/6
90AG	67/6
90AV	67/6
90CG	42/-
90CV	42/-
90C1	16/-
150B2	16/6
5763	7/6
AZ1	8/6
AZ31	9/6
AZ41	6/6
B36	4/9
CCH35	14/6
CV85	14/6
CY31	5/9
D15	13/6
DAF96	6/-
DD4	12/6
DD41	10/6
DF66	15/-
DF96	6/-

DF97	10/-
DH76	3/6
DK40	15/6
DK92	8/-
DK96	6/6
DL68	15/-
DL96	6/-
DLS10	10/6
DM70	5/-
DY86	6/6
DY87	7/6
E80F	24/-
E83F	24/-
E88CC	10/-
E180F	19/6
EA50	1/6
EA76	6/9
EABC80	5/9
EAC91	3/3
EAF42	7/9
EB34	1/-
EB41	4/9
EB91	2/3
EBC33	6/-
EBC41	6/6
EBC81	5/9
EBF80	5/9
EBF83	7/3
EBF89	5/9
EBL21	10/3
EC92	6/6
ECC32	4/-
ECC33	29/1
ECC34	21/7
ECC35	5/3
ECC40	7/-
ECC81	3/6
ECC82	4/6
ECC83	4/6
ECC84	5/6
ECC85	5/9
ECC88	8/9
ECC189	11/6
ECC807	15/-
ECF80	7/3
ECF82	6/3
ECF86	11/6
ECF804	24/-
ECH21	9/-
ECH35	6/-
ECH42	8/-
ECH81	5/9
ECH83	6/6
ECH84	9/6
ECL80	5/9
ECL82	6/6
ECL83	8/9
ECK86	8/-
EF9	20/6
EF22	6/6
EF36	3/3
EF37A	7/-
EF40	8/9
EF41	6/6
EF42	3/9
EF50	2/6
EF54	3/-
EF73	5/-
EF80	6/-
EF83	9/9
EF85	4/6
EF86	6/6
EF89	4/-
EF91	3/-
EF92	2/6
EF97	10/-
EF98	9/9
EF183	7/3
EF184	6/6
EH90	9/6
EK32	5/9
EL32	3/6
EL33	6/6
EL34	9/9
EL36	8/9
EL41	7/-
EL42	7/9
EL81	8/3
EL83	6/9
EL84	4/6
EL85	7/6
EL86	7/3
EL91	2/6
EL95	5/-
ELL80	13/6
EM4	17/9
EM34	11/6
EM71	15/6

EM80	6/3
EM81	7/-
EM84	6/-
EM85	8/9
EM87	7/6
EN31	10/-
EY51	5/6
EY81	7/3
EY83	9/3
EY84	9/6
EY86	5/6
EY88	8/9
EZ40	5/3
EZ41	6/3
EZ80	3/9
EZ81	4/3
FC4	8/9
GZ33	17/6
GZ34	10/-
GZ37	14/6
HABC80	9/3
HL41DD	12/6
HL42DD	12/6
HN309	25/-
HVR2	8/3
HVR2A	8/9
KT33C	6/-
KT36	29/1
KT41	6/6
KT44	5/-
KT61	6/9
KT63	3/9
KT66	12/3
KT88	28/-
KTW61	4/9
KTW62	5/6
KTW63	5/6
MHLD6	12/6
MU14	4/6
N37	10/6
N78	26/-
N108	26/2
N339	25/-
PABC80	6/9
PC86	9/9
PC88	9/-
PC95	8/9
PC97	8/9
PCC84	5/6
PCC85	6/9
PCC88	10/6
PCC89	8/6
PCC189	10/-
PCF80	6/6
PCF82	6/-
PCF84	8/5
PCF86	8/6
PCF801	10/-
PCF802	10/-
PCL82	6/6
PCL83	9/6
PCL84	7/6
PCL85	8/6
PCL86	8/9
PEN45	7/-
PEN45DD	12/-
PEN3831	10/3
PEN453DD	10/6
PENDD 4020	17/6
PL33	9/-
PL36	9/-
PL38	16/-
PL81	6/9
PL82	5/-
PL83	6/-
PL84	6/3
PL500	15/9
PM84	9/3
PX4	9/-
PY31	6/9
PY32	8/9
PY33	8/9
PY80	4/9
PY81	5/-
PY82	4/9
PY83	5/6
PY88	7/3
PY800	5/9
PY801	7/6
QQV03/10	35/-

QV04/7	7/-
R10	15/-
R16	29/-
R18	9/6
R19	6/9
SP41	2/-
SP61	2/-
SU25	27/2
T41	9/-
TDD4	7/6
TH41	10/-
TH233	6/9
TP22	5/-
TP25	5/-
TP2620	7/6
TY86F	11/8
U12/14	7/6
U16	15/-
U18/20	6/6
U19	48/6
U22	5/9
U25	8/6
U26	7/6
U31	6/6
U33	13/6
U35	16/6
U37	29/-
U45	15/6
U76	4/6
U101	19/6
U191	9/6
U281	8/9
U282	12/3
U301	11/-
U329	9/-
U403	9/9
U404	6/-
U801	15/-
U4020	6/6
UABC80	5/-
UAF42	6/9
UB41	10/6
UBC41	6/3
UBC81	6/3
UBF80	5/6
UBF89	6/3
UBL21	10/9
UC92	6/3
UCC84	8/-
UCC85	6/6
UCF80	8/3
UCH21	8/-
UCH42	8/-
UCH81	6/3
UCL82	7/3
UCL83	9/3
UF41	6/9
UF42	4/9
UF80	6/3
UF85	6/9
UF86	9/-
UF89	5/6
UL41	7/-
UL44	23/3
UL46	8/6
UL84	5/6
UM4	17/6
UM34	17/6
UM80	8/3
UR1C	6/6
UU6	11/-
UU8	14/-
UYON	10/3
UY21	7/9
UY41	5/-
UY85	4/9
VMS4B	12/-
VP4	14/6
VP4B	12/-
VP13C	7/-
VP23	2/6
VP133	9/9
VR105	5/6
VR150	4/9
VT61A	7/-
W76	3/6
W81M	5/9
X41	10/-
X61	6/-
X61met	14/6
X65	5/6
X66	7/3
X76M	8/6
X78	26/2
X79	27/-
Y63	5/-
Z66	7/3

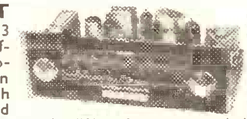
MIDGET SILICON RECTIFIERS
Mullard BY100
Output 250 v. at ½ amp.
No larger than a shirt button
7/- each.

TRANSISTORS AND DIODES

AA129	4/6
AC107	14/6
AC127	9/6
AD140	25/-
AF102	27/6
AF114	11/-
AF115	10/6
AF116	10/-
AF117	5/6
AF118	20/-
AF124	11/-
AF125	10/6
AF126	10/-
AF127	9/6
BYZ13	11/6
MAT100	7/9
MAT101	8/6
MAT120	7/9
MAT121	8/6
OA5	6/-
OA10	6/6
OA70	3/-
OA73	3/-
OA79	3/-
OA81	3/-
OA85	3/-
OA86	4/-
OA90	3/-
OA91	3/-
OA95	3/6
OA210	9/6
OA211	13/6
OC16W	35/-
OC19	25/-
OC22	23/-
OC23	57/-
OC25	12/-
OC26	8/-
OC28	23/-
OC29	16/6
OC35	9/6
OC36	21/6
OC41	8/-
OC42	5/-
OC43	12/6
OC44	4/9
OC44PM	8/3
OC45	3/6
OC45M	8/-
OC65	22/6
OC66	25/-
OC70	6/6
OC71	3/6
OC72	8/-
OC73	16/-
OC74	8/-
OC75	8/-
OC76	8/6
OC77	12/-
OC78	8/-
OC81	4/-
OC81D	4/-
OC81M	8/-
OC82	10/-
OC83	6/-
OC84	8/-
OC139	12/-
OC140	19/-
OC170	8/6
OC171	9/-
OC200	10/6
OC201	29/-
OC202	24/6
OC203	14/-
OCP71	27/6
ORP12	12/6
TS2	12/6
TS3	15/-
XA103	15/-

METAL RECTIFIERS. DRM1B 13/-; DRM2B and DRM3B 15/6; LW7 21/-; LW15 26/-; RMO 7/11; RM1 5/3; RM2 6/3; RM3 7/9; RM4 12/9; RM5 17/6; 14A86 17/6; 14A97 19/6; 14A100 23/-; 14A124 26/6; 14A163 35/6; 14B130 31/-; 14B261 11/6; FC101 16/9.
ELECTROLYTICS. Can types:—32 × 32/450 v. 6/-; 50—50/350 v. 6/-; 64 × 120/350 v. 9/-; 60 × 250/275 v. 9/6; 100 × 400/275 v. 12/6; 100/275 v. 3/-; 200/275 v. 4/-; 100 × 200/275 v. 8/5; Wire-ended types:—8/450 v. 1/9; 16/450 v. 2/9; 32/450 v. 3/9; 8 × 8/450 v. 3/-; 16 × 16/450 v. 4/-; 32 × 32/350 v. 4/-; 8 × 16/450 v. 3/9; 32/350 v. 3/-.
BRIDGE RECTIFIERS. 12 v./1 amp. 6/6; 12 v./2 amp 9/9; 12v. /4amp. 14/6; 12 v./6 amp. 21/9; 6 v./2 amp. 6/6; 6 v./4 amp. 9/9; 6 v./8 amp. 14/6; 6 v. 12 amp. 21/9; Post 1/6 each.
All goods are new. first quality brands only, and subject to maker's full guarantee. We do not handle manufacturers' seconds nor rejects. which are often described as "new and tested" but have a limited and unreliable life.
Terms of business:—Cash with order or C.O.D. only. Post/packing 6d. per item. Orders over £5 post/packing free, C.O.D. 3/6 extra. All orders cleared on day of receipt, and C.O.D. orders by telephone accepted for immediate despatch until 3.30 p.m. Any parcel insured against damage in transit for only 6d. extra. Callers welcome Mon-Fri. 9-5 p.m., Sats. 9 a.m.-1 p.m. Complete catalogue of valves and components, with conditions of sale. price 6d.

6 VALVE AM-FM TUNER UNIT



Med. and VHF 190 m.-550 m., 85 Mc/s-103 Mc/s., 6 valves and metal rectifier. Self-contained power unit, A.C. 200/250 v. operation. Magic-eye indicator, 3 push-button controls, on/off, Med., VHF. Diode and high output sockets with gain control. Illuminated 2-col. perspex dial 11½ x 4in. Chassis size 11⅝in. x 4 x 5¾in. A recommended Fidelity Unit for use with Mullard "3-3" or "5-10" Amplifiers. Available only at present as built-up units, aligned and tested ready for use. **Bargain Price £12/10/-. Carr. 5/-. This popular unit will be available in kit form within the next few weeks. Circuit and Construction details 2/6.**

We manufacture all types Radio Mains, Transf. chokes, Quality O/P. Trans., etc. Enquiries invited for specials, prototypes for small production runs. Quotation by return.

RECORDING TAPE

Famous American Columbia (CBS) Premier quality tape at NEW REDUCED PRICES. A genuine recommended Quality Tape—TRY IT. Brand new, boxed and fully guaranteed. Fitted with leader and stop foils.

	Standard		Double Play	
5in.	600ft.	13/-	1,200ft.	31/6
5¾in.	900ft.	16/-	1,800ft.	37/6
7in.	1,200ft.	21/-	2,400ft.	47/6
	Long Play		Post & Pack per reel 1/- plus 6d. ea. for additional reels.	
5in.	900ft.	17/6		
5¾in.	1,200ft.	19/6		
7in.	1,800ft.	28/6		

SPECIAL OFFER. 3in. Message tape 150ft. 3/9; 3in. L.P. 225ft. 4/9; 3in. D.P. 300ft. 6/6; P. & P. per reel 6d. **TAPE REELS.** Mnfrs.' surplus 7d. 2/3; 5¾in. 2/-; 5in. 2/-; 3in. 1/3; Plastic spool containers, 5in. 1/9; 5¾in. 2/-; 7in. 2/3.

ENAMELLED COPPER WIRE—¼lb. reels 14g-20g, 3/-; 22g-28g, 3/6; 30g-34g, 4/3; 30g-38g, 4/9; 39g-40g, 5/-, etc.

TINNED COPPER WIRE 16-22g, 3/- ¼lb.

VALVE HOLDERS—Int. Oct. 6d. Nylon or Ceramic, B7G, B9A unskirted, 9d. B7G, B9A skirted 1/- each; B7G with Can 1/6; B9A with Can, 1/9, etc.

KNOBS—Modern Continental types:—Brown or Ivory with Gold Ring. 1in. dia. 9d. ea. 1¼in. 1/- ea. Brown or Ivory with Gold Centre. 1in. dia. 10d. each; 1¾in. 1/3 each. LARGE SELECTION AVAILABLE.

JACK PLUGS—2½in. type 2/6; Screened ditto, 3/3; Stereo ditto, 3/6; 1¼in. Screened 2/3; Transistor type Min. and Sub-min. 1/3.

JACK SOCKETS—Moulded type. open 3/6, ditto, closed 4/-. Stereo ditto, 3/6; Pax. type, open 2/6; ditto, closed 3/-. Transistor type, closed, Min. and Sub.-min. 1/6.

ALUMIN. SHEET. 18g. 6in. × 6in., 1/-; 6in. × 9in., 1/6; 6in. × 12in., 2/-; 12in. × 12in., 4/6, etc.

SPEAKERS P.M. 3 ohms. 2½in. EMT, 15/6. 3in. Goodmans 16/6. 5in. Rola 15/6. 6in. Elac 16/6. 7 × 4in. Goodmans 15/6. 8in. Rola 19/6. 10in. Elac 25/-. 10 × 6in. Goodmans 22/6. 2½in. E.M.I. Tweeter 22/6. 13½in. × 8in. E.M.I. (Ceramic Magnet), 37/6.

BONDACOUST Speaker Cabinet Acoustic Wadding, approx. 1in. thick; 18in. wide, any length cut 2/3 ft. 6/- yd. **EXPANDED ANODIZED METAL.** Attractive gilt finish, ⅛ × ¼in. diamond mesh 4/6 sq. ft. Multiples of 6in. cut. Max. size 4ft. × 3ft. 47/6 plus carr.

[redacted] JASON F.M. TUNER UNITS
Designer-approved kits available.
FMT1. 5 gns. 4 valves 20/-.
FMT2. £7. 5 valves 35/-.
JTV Mercury, 10 gns. 3 valves 22/6.
JTV2. £13/19/6. 4 valves 28/6.
NEW JASON F.M. HANDBOOK 2/6.
48 hr. Alignment Services. 7/6 plus 2/6.

CONDENSERS—Silver Mica. All values. 2 pf. to 1,000 pf., 6d. each. Ditto ceramics 9d. Tub. 450 v. T.C.C., etc. .001 mfd., .01 and .1/350 v. 9d. .02-1/500 v., 1/-. .25 Hunts 1/6. .5 T.C.C. 1/9 etc., etc.

CLOSE TOL. S/MICAS. 10% 5 pf.-500 pf. 8d. 600-5,000 pf. 1/-. 1% 2 pf.-100 pf. 9d. 100 pf.-500 pf. 11d. 575 pf.-5,000 pf. 1/6.

RESISTORS—Modern ratings full range 10 ohms to 10 megohms. 20% ¼-½ w. 3d. ea., ditto 1 w. 6d. ea., 2 w. 9d. ea., 10% ¼-½ w. 4d. ea., 5% Hi-stab, ¼-½ w. 6d. ea. (below 100 ohms and over 1 meg. 9d. ea.) 1% Hi-stab., ½ w. 1/6 ea. (below 100 ohms 2/- ea.).
WIREWOUND. 25 ohms to 10K. 5 w. 1/3. 10 w. 1/6. 15 w. 2/-.

PRE-SET T/V POTS. W/W 25 ohms-50K. 3/-. 50 K. 2 Meg. (Carbon), 3/-.

Electrolytics All Types New Stock

TUBULAR		CAN TYPES	
25/25v. 50/12v.	1/9	8+8/450v.	4/6
50/50v. 100/25v.	2/-	32+32/275v.	4/6
8/450v. 4/350v.	2/3	50+50/350v.	6/6
16/60/450v.	5/6	60+250/275v.	17/6
32/32/450v.	6/6	100+300/275v.	12/6

Transistor Midget types—all values 1 mfd. to 50 mfd. 1/9 ea. 100 mfd. 2/-, 12 v.

VOLUME CONTROLS—5K—2 Meg. ohms, 3in. SPINDLES, MORGANITE MIDGET TYPE, 1⅛in. dia. Guar. 1 year. LOG or LIN. ratios, less Sw. 3/-. D.P. Sw. 4/6. Twin Stereo less Sw. 6/6. Some values with DP Sw. 8/6.

SOLDERING IRONS. Mains 200/220 v. or 230/250 v. Solon 25 watt Inst., 22/6. Spare Elements 5/6. Bits, 1/3. 65 watt, 27/6, etc.
ALUMIN. CHASSIS. 18g. Plain Undrilled, folded 4 sides, 2in. deep. 6in. × 4in., 4/6; 8in. × 6in., 5/9; 10in. × 7in., 6/9; 12in. × 6in., 7/6; 12in. × 8in., 8/-, etc.
TYGAN FRET (Contem. pat.) 12 × 12in. 2/-; 12 × 18in. 3/-; 12 × 24in. 4/-, etc.
PHONO PLUGS 9d. Phono Sockets (open), 9d. Ditto (closed), 1/-. Twin Phono Sockets (open), 1/3.

DE-LUXE RECORD PLAYER KIT

Incorporating 4 Sp. Garrard Auto-Slim unit and Mullard latest 3 watt printed circuit amplifier (ECL86 and EZ80), vol., bass and treble controls, with 8 x 5in. 10,000 line speaker. Contemporary styled two-tone cabinet, charcoal grey and off-white with matching blue relief. Size 17¼in. x 16in. x 8in.

A stylish unit capable of quality reproduction. Circuit and const. details 2/6 (free with kit).

COMPLETE KIT **£13.19.6**
Carr. and ins. 10/-.

Illuminated Perspex control panel escutcheon 7/6 extra. Ready wired 30/- extra. 4 contemporary mounting legs (6, 9 or 12in.), 12/6 per set.

Only a few items are listed from our comprehensive stock. Write now for full bargain lists, 3d.

Terms: C.W.O. or C.O.D. post and packing ½lb. 9d., 1lb. 1/3, 3lb. 2/3, 5lb. 2/9, 10lb. 3/9 etc.

TRS RADIO COMPONENT SPECIALISTS Established 1946

70 BRIGSTOCK RD., THORNTON HEATH, SURREY
Tel.: THO 2188: Hours 9 a.m.—6 p.m. 1 p.m. Wednesday.

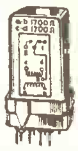
SERVICE TRADING CO

Postage and Carriage shown below are inland only. For overseas please ask for quotation. We do not issue a catalogue or list.

ULTRA VIOLET BULBS

Easy to use source of U.V. for dozens of practical and experimental uses.
12 volt 36 watt A.C./D.C. SBC **6/6**. P. & P. 1/-.
12 volt 60 watt A.C./D.C. SBC **8/6**. P. & P. 1/-.
Transformer to suit the above. Input 200-240 v. A.C., 12 volt 36 watts, **16/6**; P. & P. 2/6. Input 200-240 v. A.C. 12 volt 60 watt. **22/6**. P. & P. 3/6.
Set of 4 Colours FLUORESCENT PAINT. Red, yellow, green and cerise. In ½ oz. tins. Ideal for use with the above Ultra Violet Bulbs, **9/6**, plus 1/6 P. & P.

SIEMENS SEALED HIGH SPEED RELAYS



H96A, 2.2 ohm + 2.2 ohm, new.
H96G, 50 ohm + 50 ohm, new.
H96C, 145 ohm + 145 ohm, new.
H96D, 500 ohm + 500 ohm, new.
H96E, 1,700 ohm + 1,700 ohm, ex. equip., all at **12/6** each. P. & P. 1/- on each Relay.

P.O. RELAYS, Type 3000

100 ohm, 3 c/o, 2 make, 2 break.
200 ohm, 6 c/o.
500 ohm, 1 Heavy duty c/o.
500 ohm, 4 Heavy duty make.
2,000 ohm, 4 make, 4 break.
16,000 ohm, 2 make, 2 break.
20,000 ohm, 2 Heavy duty make.
All at **12/6** each, plus 1/-. P. & P.

G.E.C. SEALED RELAYS

M1069 5,000 ohm, 2 c/o. M1084 180 ohm, 4 c/o. M1092 670 ohm, 4 c/o. M1095 670 ohm, 2 m. 2 b. M1100 670 ohm, 2 c/o. Ex new equipment.
All at **12/6** each plus 1/- P. & P.

14,000 OHM SEALED RELAY. High Speed single c/o, Platinum contacts. Super-sensitive, ideal for Transistor circuitry. Will operate on 1 milliamp **25/-**. P. & P. 1/-.

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.

SPECIAL REVERSING 24 VOLT D.C. MOTOR 2-AMPERE
Quadrant moves 90 degrees with limit switches. Ideal for opening doors, etc. Price **32/6** P. & P. 3/-.

SOLENOID. Overall length 3⅛in., stroke ⅛in. to ½in. Maximum push 8 oz. 12-24 v. D.C. operation. D.C. resistance 35 ohm. Price **8/6**. P. & P. 1/6.
SOLENOID Heavy Duty 230 v. A.C. Approx. 3lb. pull. **15/-**. P. & P. 1/6.
SOLENOID OPERATED MAGNETIC RELAY. Type Sc/3944, 4 Pole c/o., 10 amp. Contacts, 24 volt D.C. operation. **12/6** each. P. & P. 1/6.

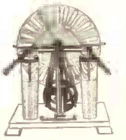
LATEST HIGH SPEED MAGNETIC COUNTERS

4 figure 10 impulses per second. Type 100D, 4.1 ohm coil. 3.6v. D.C. operation. Type 100A, 500 ohm coil, 18-24 v. D.C. operation. Type 100B, 2,300 ohm coil, 36-48 v. D.C. operation. Any type **15/-** each, plus 1/6 P. & P.

RESETTABLE HIGH SPEED COUNTER

4 figure 1,000 ohm coil, 36-48 v. D.C. operation, **£3/10/-**, 1/6 P. & P.

WIMSHURST ELECTROSTATIC GENERATORS



Really well constructed machine. Ideal for School and Laboratory to demonstrate the various effects associated with static energy. Will work well in any atmospheric conditions giving a spark over 3in. long in dry weather. 11in. dia. twin plates. 2 Leyden jars. Discharge electrodes. Heavily plated fittings, mounted on solid wooden base. Outstanding value at **£13/17/6**. Carriage U.K. (B.R.S.) 10/-.

ELECTRIC CHECK METER (Sangamo Weston) 200/240 volt, A.C., 40 amp. As new **35/-** plus 3/6 P. & P.

0-4 MINUTE MECHANICAL TIME SWITCH. 16 amp. D.P. switch, complete with knob. Will switch off any setting between 0-4 min. As new, fraction of maker's price, **10/-**. P. & P. 2/6.

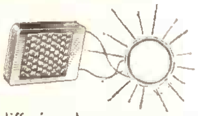
CRATOR. 4 way 16 amp, 250 v A.C. switch. 3 on, 1 off, position. Complete with knobs. **7/6**. P. & P. 1/6.

CROMPTON PARKINSON BRAND NEW ¼ h.p. MOTORS. 230/250 VOLT A.C. 1,400 R.P.M. Fitted with 2¼ × ½in. SPINDLE. **Price £3/5/-**. Carriage 8/6.

HIGH SPEED BLOWER UNIT

200/250 volt A.C. Powerful 2-speed motor, 11,000 and 13,000 R.P.M. **17/6**, plus P. & P. 2/6.
AUTO TRANSFORMERS. Step up, step down. 110-200-220-240 v. Fully shrouded. New. 300 watt type **£2/6/6** each. P. & P. 2/6. 500 watt type **£3/7/6** each. P. & P. 3/9. 1,000 watt type **£4/10/-** each. P. & P. 6/6.

FIRST AGAIN! TYPE 34R SILICON SOLAR CELL



Four .5 volt units series connected in high impact polystyrene case, flying lead connections. Specially designed diffusing lens system to ensure maximum light pick-up. Output—up to 2 v. at 16—20 mA. in bright sunlight. Wider spectral response, and thirty times the efficiency of selenium cells. As used to power earth satellites! **37/6**, and 1/- P. & P.
JUST PUBLISHED "SOLAR CELL & PHOTO-CELL EXPERIMENTERS GUIDE." Teaches the principles of light sensitive devices and their application. **26/-** post paid.

230 v. A.C. RELAY. Type 1, 2 c/o, 2 amp. contacts, **9/6**. Type 2.2×15 amp. break, 2×2 amp. make, 1×2 amp. break. **11/6**. Both types ex new equip. P. & P. 1/6 each.

230 VOLT A.C. GEARED MOTORS

Type D16G 5 r.p.m. 1.7lb. inch £2/9/6. P. & P. 2/6
Type D16G 13 r.p.m. 1.45lb. inch £2/12/6. P.&P.2/6

UNISELECTOR 8 bank, 25 way, all non-bridging, full wipers, twin coil, 950 ohm. Each unused **£3/2/6**. P. & P. 4/6.
MINIATURE UNISELECTOR SWITCH. 3 banks of 11 positions, plus homing bank. 40 ohm coil. 24-36 v. operation. Ex equip. Individually tested. **22/6**, plus 2/6. P. & P.

LIGHT SENSITIVE SWITCH

Kit and parts including ORP.12 Cadmium Sulphide Photocell, Relay, Transistor and Circuit. Now supplied with new Siemens High Speed Relay for 6 or 12 volt operation. **Price 25/-**, plus 2/6. P. & P.
ORP.12 and Circuit 8/6, post paid.

A.C. MAINS MODEL

Incorporates main transformer, rectifier and special relay with 3, 5 amp. mains c/o contacts. Price inc. circuit **47/6**. Plus 2/6 P. & P.

AVO METER CALIBRATION TEST UNIT, TYPE CT155. A modern precision instrument giving 7 standard voltages, 1 v. A.C., 2.5 v. A.C., 10 v. A.C., 25 v. A.C., 100 v. A.C. and 250 mV. A.C. Also 250 mV. D.C. from internal standard cell. Internal power supply 110-250 v. A.C. contained in portable carrying case. Size: 11×8×7in. As new **£6/10/-**. P. & P. 10/6.

SEMI-AUTOMATIC "BUG" SUPER SPEED, MORSE KEY. 7 adjustments, precision tooled, speed adjustable 10 w.p.m. to as high as desired. Weight 2½lb. **£4/12/6**, post paid.
TRANSISTORISED FULLY AUTOMATIC ELECTRONIC KEYER. 230v. A.C. or Battery operated. Incorporates built-in monitor Oscillator, Speaker, and Keying Lever. Adjustable speeds. Keying either auto., semi-auto. or hold. 4 diodes. 7 transistors. Price **£16/10/-**, plus 4/6 P. & P.

TRANSISTORISED MORSE OSCILLATOR Fitted 2½in. Moving Coil Speaker. Uses type PP3 or equiv. 9 v. battery. Complete with latest design Morse Key, **22/6**, plus 1/6, P. & P.
KEYING LEVER. Especially designed for use with all types of electronic keyers. Fully adjustable micro-switch action, no contact bounce, precision made, finely polished parts, screw down base. Price **£4/4/-**, post paid.

MINIATURE IMMERSION HEATER. 6in. x ½in., 240 volt, 120 watt, **6/6** plus 2/- P. & P.

TRANSISTOR

1st grade		Brand new			
OC28	17/-	OC83*	6/-	2N458	20/-
OC29*	18/-	OC139	12/-	2S019	30/-
OC41	7/-	OC140	19/-	SB345	7/6
OC44	6/6	OC171	9/-	TK20B	4/-
OC45	5/-	OC200	10/6	AC107	14/6
OC71	5/-	OC203	14/-	AF114	11/-
OC72*	7/-	Get 104	6/-	AF115	10/-
OC73	6/-	Get 105	10/-	AF116	10/-
OC75	7/-	Get 573	12/6	AF117	9/6
OC76	6/-	2N706A	17/6	BCZ11	10/-
OC81*	8/-				

*Available in Matched Pairs.

DIODES

OA91	3/-	IS111	4/-
SX781	4/-	ZS10B	3/-

ZENERS 5%

All ¼ watt 5% at **10/-** each, 4.3 v., 4.7 v., 5.1 v., 5.6 v., 6.2 v., 6.8 v., 7.5 v., 8.2 v., 9.1 v., 10 v., 12 v., 15 v., 16 v., 22 v.

HEAVY DUTY L.T. TRANSFORMER

Very conservatively rated for continuous duty. Input 110-260 volts, multi-tapped, 50 cycles, single phase. Output 28, 29, 30, 31 volts at 21 amp. Price **£6/15/-**. Carr. 10/-.

L.T. TRANSFORMERS

All primaries 220-240 volts.

Type No.	Sec Taps	Price	Carr.
1	30, 32, 34, 36 v. at 5 amps.	£2.17.6	4/-
2	30, 40, 50 v. at 5 amps	£4.15.0	4/-
3	10, 17, 18 v. at 10 amps	£2.17.6	4/-
4	6, 12 v. at 20 amps	£3.12.6	5/-
5	17, 18, 20 v. at 20 amps	£5. 2.6	5/-
6	6, 12, 20 v. at 20 amps	£4.15.0	7/6
7	24 v. at 10 amps	£3. 5.0	4/-

A.C. AMMETERS

0-1, 0-5, 0-10, 0-15, 0-20 amp. F.R. 2½in. dia. All at **21/-** each.

A.C. VOLTMETERS

0-25 v., 0-50 v., 0-150 v. M.I., 2½in. Flush round all at **21/-** each P. & P. extra.
0-300 v. A.C. Rect. M-Coil 2½in. **29/-**
0-300 v. A.C. Rect. M-Coil 3½in. Type W23.. **55/-**

D.C. AMMETERS

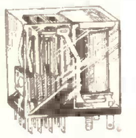
0-5 amp. D.C. M.I. 2½in. Rnd. **11/6**
0-500 Microamp. sub-min. 1¼in. dia. Scaled 0-1 milliamp **21/-**
Postage extra.

CONDENSER

8,000 mfd., 50 v., 2½in. x 4½in. **12/6**

DELCO 12-27 VOLT D.C. SHUNT WOUND MOTOR. 5,400 r.p.m. Torque 4in. oz. double spindle, smooth running ex-new equip. **12/6** P. & P. 2/6.

VAN DE GRAAF ELECTROSTATIC GENERATOR, fitted with motor drive for 230 v. A.C. giving a potential of approx. 50,000 volts. Supplied absolutely complete, including accessories for carrying out a number of interesting experiments, and full instructions. This instrument is completely safe, and ideally-suited for School demonstrations. Price **£6/6/-** plus 4/- P. & P. *Leaflet on request.*



Latest type SIEMENS MINIATURE RELAYS in Transparent Case. Gold-plated spring sets. 4 c/o 700 ohm coil. 25 v. D.C operation. Size 1⅜ x ¾ x 1⅛in. New in maker's packing. Price **12/6**. As above 2 c/o 700 ohm coil size ⅞ x ¾ x 1⅛in. **15/-** including base.

BUILD AN EFFICIENT STROBE UNIT FOR ONLY "37/6"
The ideal instrument for workshop, lab. or factory. This wonderful device enables you to "freeze" motion and examine moving parts as if stationary. We supply a simple circuit diagram and all electrical parts, including the NSP2 Strobe tube which will enable you to easily and quickly construct a unit for infinite variety of speeds, from 1 flash in several seconds to several thousands per minute. New, modified circuits bring price down to **37/6**, plus 3/- P. & P.
NSP2 CV2296 STROBOTRON FLASH TUBE made by Ferranti, brand new, I.O. base. Price **15/-**. P. & P. 1/-.

SX 631 SILICON RECTIFIER. 100 v. PIV. 750 mA in air or 2 amp. on 2x2 ali, heat sink, 3/6 each. P. & P. 6d., or 4 to make bridge **12/-**. P. & P. 1/-.

DIALS FOR AUTOMATIC TELEPHONES, used but good condition, **12/6** ea., plus 2/6 P. & P.

ALL MAIL ORDERS. ALSO CALLERS AT:
47-49 HIGH STREET, KINGSTON-ON-THAMES
Telephone: KINgston 9450
Closed Saturdays.

PERSONAL CALLERS ONLY: **9 LITTLE NEWPORT STREET, LONDON, W.C.2.** *Tel.: GER 0576*
(OFF LEICESTER SQUARE)
Open till 1 p.m. Thursday and all day Saturday.

NEW LIST OF BARGAINS

Transistor ferrite rod aerial with medium and long wave coils with circuit, **7/6.**

Oscillator Coil and set of 3 I.F. transformers for transistor set with circuit, **12/6.** Tuning Condenser to suit, air-spaced, with trimmers, 9/-.

Ditto, but min. 10 mm. **12/6** the set, two-gang condensers to suit **8/6** (request sub. min. circuit).

Midget 3in. P.M. Loudspeaker, 3 ohm, **12/6,** 80 ohm' **13/6.**

Midget 208 pF + 176 pF two-gang Tuning Condenser with trimmers for transistor set. Price 9/-.

Push-Pull Transformer. Sub-miniature. **8/6.** .0005 mfd. Single Tuning Condenser. Solid dielectric ¼in. spindle for transistor of Crystal set, with spindle tapped 6 BA. **2/6.**

46 Sets (Receiver/Transmitter pack set). Unused sets complete except for crystals, **19/6.** Post 3/-.

Battery Charger Kit, Comprises 4 amp. transformer, 5 amp. rectifier, metal case and meter to charge 6 or 12 volt batteries up to 5 amps. With variable charge rate, **19/6** each. 4/6 post & insurance.

Waterproof Heater Wire

16 yds. length. 70 watts, self regulating temperature control. **10/-,** post free.

Mains Transformer. 250-0-250 at 80 mA. 6.3 volts 5 a. (normal mains input). **12/6** each. Carr. 2/6.

Output Transformer. Standard pentode matching type, **3/6** each; **36/-** per doz.

Slide Switch. Sub-miniature but dpdt., **2/-**; **18/-** doz.

T.C.C. or Dubilier Tubular Condensers.

.5 mf. 500 v.	**10/-** doz.
.25 mf. 500 v.	**7/6** doz.
.25 mf. 350 v.	**6/-** doz.
.05 mf. 500 v.	**5/-** doz.
.0001 mf. 1000 v.	**5/-** doz.
.001 1000 v.	**6/-** doz.
.002 1000 v.	**7/6** doz.
.005 1000 v.	**9/-** doz.
.02 750 v.	**8/6** doz.
.01 1000 v.	**10/-** doz.

Battery Charger Rectifier. Selenium 12-15 v. 5 amp. **9/6.**

Metal Chassis. Punched for Mullard 510 Amplifier complete with inner screening sections and stove enamelled. **8/6.** P. & P. 2/9.

Unbreakable Mains Lead. Type of lead fitted to electric razors makes fine lead for test meters and any other devices where subject to continuous bending. Twin figure eight construction, soft cream P.V.C. covered. Normally costs **2/-** per yard. Three 6ft. leads for **2/-.**

Filament Transformers, 6.3 v., 1½ amp., **4/6.**

Neon Lamp—midget wire ended, ideal mains tester, etc. **2/-.** Ex-Govt. **1/6.**

Philips Trimmers. 0-30 pF. **1/-** each; **9/-** doz.

Low Resistance Headphones. Ideal crystal sets, etc. **7/6,** plus 2/6.

Cold Cathode Valve CV 413. Voltage regulator or trigger switch—unused but ex-equipment **2/-** each.

Tag Panels. Ideal for construction, experimental circuits, etc. 3 of each of 12 different types, **5/-.** Post 1/6.

Slydlock Panel Mounting Fuses, with carrier, 5 amps. **2/-** each; 15 amp. **2/6** each.

Potentiometers. Sealed type by Morganite among the best ever made, standard ¼ spindle, 1in. long. ½ meg. **6/-** doz., 2 meg **6/-** doz. 100K ditto **5/6** doz., 50 K **5/-** doz.

MU Metal Screen for American 5 CP1, etc. **10/6** pair for VCR97 and other 6in. tubes, **7/-** complete. Ditto for 2-3in. tube **5/-** complete.

Electric Lock. 24 v. coil but rewindable to alter voltages **4/6, 48/-** doz.

.1 mfd. 350 v. Small tubular metal-cased condenser made by Dubilier, **2/6** doz.

24 Volt Motor with blower attached. 12/6. plus 2/9.

115 Volt American magslips (selsyns) **50/-** each transmitter or receiver. Post 2/9. Pair Post Free.

Morse Practice Outfit—Comprises valve oscillator with controls in wooden box, battery operated, **12/6.** Plus 2/9.

Mains from Car Battery rotary generators 12v. input 240v., output 110 mA, **40/-**; 600 m.a. **£5.** Plus 5/- post.

H.R.O. Power Pack. Suitable for 240 or 115 volt mains give 250v. H.T. and 6.3v. l.t., new and unused, but less rectifier valve, **19/6,** plus 5/- post.

A.C./D.C. Ammeter 2½in. flush mounting 0-9 amps but external shunt easily removed offered at silly price, **8/6, £5** doz.

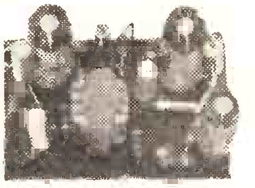
DLRS Headphones, 9/6 pair, Post 2/-.

SOULU Powered Inserts. Make excellent microphones or speaker, **5/6** each. **£3** doz.

Where postage is not definitely stated add 2/- to all orders under £3. Also add 2/6 if you would like our new 100 page list of bargains.

See in the Dark
INFRA-RED BINOCULARS

These if, ed from a high voltage source will enable objects to be seen in the dark, providing the objects are in the rays of an infra-red beam. Each eye tube contains a complete optical lens system as well as the infra-red cell. These optical systems can be used as lens for T.V. cameras—light cell, etc. (details supplied). The binoculars form part of the Army night driving (Tabby) equipment. They are unused and believed to be in good working order, but sold without a guarantee. Price **£2/17/6** plus 10/- carriage and insurance. Handbook 2/6.



750 mW TRANSISTOR AMPLIFIER

4 transistors including two in push-pull-input for crystal or magnetic microphone or pick-up—feed back loops—sensitivity 5 m/v. Price **19/6.**

Post and ins: 2/6. 35 ohms speaker **12/6** extra.

OUR BARGAIN OF THE YEAR

A complete kit of parts to build this 6-transistor 2 wave superhet receiver at only **39/6,** plus 3/6 post and ins.

"CORONET" Mk. IV

It fully covers the medium-wave band and that part of the long-wave band to bring in B.B.C Light. The circuit includes a highly efficient slab aerial 2½in. P.M. speaker. Overall size approximately 4½ × 2½ × 1½in. Supplied complete with carrying case and instructions.

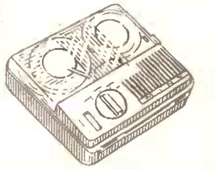
AUTO CHANGER BARGAIN

GARRARD AUTO-SLIM RECORD CHANGER

One of the nicest record changes that this famous company make—Automatic selection of records which may be mixed—may also be played manually. Finger-tip adjustment of Stylus pressure. Fitted with mono head—but pickup wired for stereo—suitable 200/250 A.C. mains—cabinet space required 14¼ x 12¼ with 4⅜in. above and 2⅞in. below. DON'T MISS THIS SPECIAL SNIP, ONLY **£5/15/-.** (Post and ins. 6/6.)

Just arrived! GARRARD AT5 £6/15/- plus 6/6 post and ins.

THIS MONTH'S SNIP



THE "MINY" TAPE RECORDER

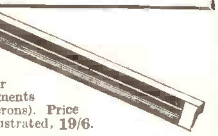
of the many tape recorders to offer at **£12** or less we have at last found one we can recommend. Equally suitable for music or speech this instrument uses two motors, is completely portable and is beautifully styled and looks like a good tape recorder.

Among its many good features is a switch on the microphone to stop and start the tapes. A very useful feature for you when recording, and for your typist for note-taking, stock-taking, etc. Other points are twin track recording—40 mins with normal tapes, standard batteries.

Although originally sold at £16/16/0, we are able this month to offer for only **£7/19/6,** plus 5/- Post and Insurance. Brand New and complete with microphone, batteries, tape and spools, nothing else to buy.

Don't miss this AMAZING Offer.

INFRA-RED HEATERS

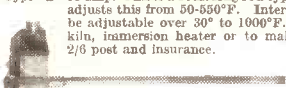


Make up one of these latest type heaters. Ideal for bathroom, etc. They are simple to make from our easy-to-follow instructions—uses silica enclosed elements designed for the correct infra-red wavelength (3 microns). Price for 750 watts element, all parts, metal casing as illustrated, **19/6,** plus 2/6 post and insurance. Pull switch 3/- extra.

THERMOSTATS

Type "A" 15 amp. for controlling room heaters, greenhouse, airing cupboard. Has spindle for pointer knob, quickly adjustable from 30-80°F., **9/6** plus 1/- post. Suitable box for wall mounting, **5/-.** P. & P. 1/-.

Type "B" 15 amp. This is a 17in. long rod type made by the famous Sunvic Co. Spindle adjusts this from 50-550°F. Internal Screw alters the setting so this could be adjustable over 30° to 1000°F. Suitable for controlling furnace, oven kiln, immersion heater or to make flame-start or fire alarm. **8/6** plus 2/6 post and insurance.



Type "C" is a small porcelain thermostat as fitted to electric blankets, etc. 1½ amp. setting adjustable by screw through side, **3/6.** P. & P. 6d.

Type "D" We call this the Ice-stat as it cuts in and out at around freezing point, 2/3 amps. Has many uses, one of which would be to keep the loft pipes from freezing. If a length of our blanket wire (16 yds. **10/-**) is wound around the pipes, **7/6.** P. & P. 1/1

Type "E" This is a standard refrigerator thermostat. Spindle adjustments cover normal refrigerator temperature, **7/6,** plus 1/- post.

MAKING AN F.M TUNER.

Available, at present, is a very nice cadmium - plated F.M. Tuner chassis with holes punched for coils and other components Also a nicely printed Perspex front, calibrated usual F.M. frequencies. Real bargain **6/6** plus 2/- or with two-gang tuning condenser **10/-** plus 2/- postage.

SPEAKER BARGAIN

12in. High fidelity loudspeaker. High flux permanent magnet type with either 3 or 15 ohm speech coil. Will handle up to 10 watts. Brand new, by famous maker.

Price **29/6** plus 3/6 post and insurance.

Simmerstat Heater Regulator

Suitable to control elements, heater, soldering irons and boiling rings up to 2,500 watt. Complete, adjustable, normal price 55/- each, special snip price **12/6** plus 2/- postage and insurance.

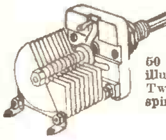
TRANSISTOR SET CASE

Very modern cream cabinet, size 5¼ × 3 × 1⅜in. with chrome handle, tuning knob and scale. Price **4/6** plus 2/- postage.

Fluorescent Light Kits

For pelmet lighting, etc. Kit consists of: Super silent choke; 2 chrome clips to hold tube; 2 bi-pin holders for tube and starter with a starter holder. Kit A for 80 watt tube at **27/6.** Kit B for 40 watt tube at **19/6.** Kit C for 2×2ft. 20 w. lamp **25/-.** Kit D for 1×2ft. 20 w. lamp **18/6.** Post and insurance 2/9 per Kit. Absolutely silent in operation.

FINE TUNERS



50 pf with long spindle as illustrated, **1/6,** or **12/-** doz. Twin 50 pf not quite such ong spindle, **2/6,** or **24/-** doz.

FIVE CORE CABLE

Ideal for switching circuits, intercoms, P.A. runs, etc., each core flex copper with rubber insulation cores covered overall in tough rubber or P.V.C. 9d. per yd. or 30 yds. length **15/-** plus 5/- post.

THREE UNUSUAL ITEMS

OZONE OUTFIT—for removing smells and generally improving any oppressive atmosphere. Kit consists of Philips ozone lamp and mains unit, only needs box. **19/6,** plus 3/6 postage and insurance.

BLACK LIGHT UNIT. 40 watt intensity, comprises lamp, lamp holder and 40-watt choke. Only **29/6,** Plus 6/6 carr. and ins.

TIMER KIT. Special offer of all components except metal box to make mains operated interval timer for photography etc., **12/6,** Plus 2/6 post

MAINS POWER PACK

MAINS POWER PACK designed to operate transistor sets and amplifiers. Adjustable output 6 v.-9 to 12 volts for up to 500 mA (class B working). Takes the place of any of the following batteries: PR1, PP3, PP4, PP6, PP7, and others. Kit comprises: mains transformer-rectifier, smoothing and load resistor, 5,000 and 500 mfd. condensers, zener diode and instructions. Real snip at only **14/6,** plus 3/- post.

ELECTRONICS (CROYDON) LIMITED

266 LONDON ROAD, WEST CROYDON, SURREY

Post orders to: **Dept. WW, 43 SILVERDALE ROAD, EASTBOURNE, SUSSEX**

OHM-METER

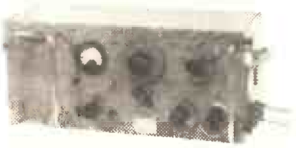
Nashton Type V 16. A.C. mains operation 200 to 250 v. 50 c/s. 10 ohms to 1 Megohm (4 ranges) and 1 Meg. to 10,000 Megs. (4 ranges). Weston 4in. mirror scale meter. Uses 4 cathode-follower valves fed from stabilised H.T. line. With circuit, etc. A quality instrument at a fraction of original price. **BRAND NEW £8/19/6.** P. & P. 5/6. Details on request.

PORTABLE RECEIVER TESTER MARCONI INSTRUMENTS TF-888/3
This instrument combines the functions of a wide range signal generator and output meter. Continuous frequency coverage of 70 Kc/s to 70 Mc/s in 8 wavebands by means of a rotating coil turret. Output impedance 80 or 52 ohms or high level (500 mV) 40Ω Int. Mod. at 1,000 c/s. Two crystal checks at 500 Kc/s and 5 Mc/s. Panel meter monitors carrier and also functions as output meter full scale 10 mV., 100mV. and 1w. Input impedances 3, 33, 150 and 600Ω. Handsome grey case, size 15¼×7½×11½ high. Wt. 17½ lbs. Operates from A.C. mains 100 to 250 volts. As new, tested and guaranteed. **£39/10/-.** Carr. 10/-.

TRANSISTORISED D.C. SUPPLY UNIT
Type **VP II.** Famous make. Bench type in handsome case 15×10×10in. Weight 18 lbs. Mains operation 200 to 250 volts 40-60 c/s. Output voltage continuously variable from 3 to 15 volts at 1 amp. (max.). Output impedance 0.01 ohms. A 10% supply variation produces less than 0.1% variation in output. Both voltage and current are independently metered. Electronic cut-out with front panel reset. ABSOLUTELY BRAND NEW with handbook. **£21.** Carr. 7/6. **VQ 161.** "Brick" type. Output voltage adjustable from 3 to 25 volts (1 amp. max.), by changing transformer taps and preset pots. Similar spec. to above. Not metered. Electronic cut-out. Auto reset. 3×4½×10in. Weight 8 lbs. BRAND NEW with handbook. **£12/10/-.** P. & P. 7/6.

LM-14 HETERODYNE FREQUENCY METER
Naval version of the BC-221. 125 Kc/s to 20 Mc/s. Undoubtedly superior to the BC-221 in construction and performance. Requires 12 or 24 v. LT and between 200 and 475 v. HT (self-stabilised). A particularly useful feature is variable RF coupling and modulation is also available. With correct individual calibration books. Unused and guaranteed. **£25.** P. & P. 7/6. Separate power unit for A.C. (if required). **£4/10/-.** P. & P. 5/-.

GENERAL RADIO LRS HETERODYNE FREQUENCY & CALIBRATOR EQUIPMENT.
BRAND NEW. **£75**



MARCONI TF-390-G SIGNAL GENERATOR. £7/10/-. Carr. £1. Four ranges: 16-32, 32-60, 50-100 and 75-150 Mc/s. A.C. mains operation. AS NEW in original transit cases with correct individual calibration and instruction books.

G.E.C. RECEIVER BRT402E
14 valve superhet 150-385 Kc/s, 510 Kc/s to 30 Mc/s in six wavebands. Sensitivity, sig./noise ratio, freq. stability, etc. of the highest order. Six step variable selectivity, Xtal filter (Xtal phasing control), RF, IF and AF gain, 500 Kc/s Xtal cal., Audio Filter, "S" meter, Ae trimmer, Variable BFO, A.C. mains operation. EVERYTHING. Reconditioned. **£60.** Carr. 30/-. S.A.E. for details.

WIRELESS SET No. 76
A compact CW only crystal controlled transmitter. Consists of a Pierce crystal oscillator (807) and a Power Amplifier (807). Both are cathode keyed by means of a relay. Six switched crystal channels are available in the frequency range of 2 to 12 Mc/s. (Crystals not included.) Aerial current is indicated on a panel meter and two spare valves are supplied. Operates from 12 v. car battery via internal rotary transformer. RF output 9 watts. Contained in steel case 12×12×8in. Weight 30 lbs. Ideal for 80 or 40 metres or cheap enough for breakdown. Good condition and working order. Circuit included. **£3/10/-.** Carr. 10/-.

SIGNAL GENERATOR CT-218 (FM/AM)
MARCONI TF 937. Covers 85 Kc/s to 30 Mc/s in 8 switched ranges. Effective length of film scale is 50 ft. Output level variable in 1 dB steps from 1μV to 100 mV (75Ω). Also IV Outputs down to 0.1μV from an outlet at 7.5Ω. Int. mod. at 400 c/s, 1 Kc/s, 1.6 Kc/s and 3 Kc/s. FM at frequencies above 394 Kc/s. Variable mod. depth and deviation. Crystal calibrator 200 Kc/s and 2 Mc/s. Monitor speaker for beat detection. Fully metered, blower cooled, Panclimatic. A.C. mains 100 to 150 and 200 to 250 volts, 45 to 100 c/s. 17×20½×17½in. Weight 117 lbs. Fully tested and guaranteed. Under 10% of original price. **£65.** Carr. 50/-.

TELEVISION SWEEP GENERATOR

MARCONI TF 1104/1. V.H.F. alignment oscilloscope for TV, V.H.F., IF and VF response. Crystal controlled or variable oscillator markers. Sweep width up to 10 Mc/s. Can be used as normal oscilloscope. With handbook. Details on request. **ABSOLUTELY BRAND NEW. £75.**

MAGNETIC COUNTERS (Ex-G.P.O.). 4 figures to 9,999. Coils 500Ω for 24 v. operation. Tested (no reset). 5/- each. P. & P. 1/6. SPECIAL OFFER. 10 for **30/-.** P. & P. 5/-.

ABSORPTION WAVEMETERS
MARCONI TF-643-B. Covers from 20 to 300 Mc/s in four plug-in coil ranges. Complete with individual calibration charts. Accuracy 1%. Indication is on a 50μA 2½in. panel meter. In original transit cases. Condition as new **£5/19/6.** Carr. 7/6.

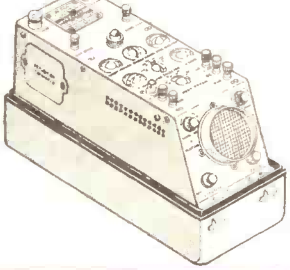
RELAYS G.E.C. MINIATURE SEALED

M-1099. 670Ω 2M H/D Wire Ends	7/6
M-1052. 5,000Ω 2/CO. Plat. Wire Ends	10/-
M-1092. 670Ω 4/CO. Plat. Wire Ends	12/6

ALL BRAND NEW AND BOXED. Please add postage.

MINIATURE RELAYS. 240 v. A.C. coils. Contact assembly 2 "makes" and 1 C.O. 5 amps. Size 2×1½×1in. Unused and removed from brand new equipment. **8/6** post paid.

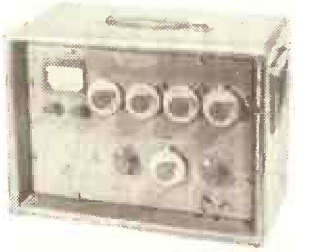
HICKOCK OSCILLOSCOPE OS-8B/U



A high grade general purpose instrument made to exacting U.S.A. Navy specification. Detachable cover with carrying handle. Compact (13½ × 6 × 8¾in.), weight 17 lbs. Green trace 3in. tube. Bandwidth "Y" amplifier D.C. to 2 Mc/s (D.C. coupled). Sensitivity 40 mV/cm. "X" amp. can be used separately, similar spec. to "Y" amp. Leads are housed in case. For A.C. mains 105 to 125 v., 50 to 1,000 c/s. BRAND NEW, tested and guaranteed. **£25.** Carr. 10/-. *Auto transformer 15/6 extra.*

CHARLES BRITAIN (Radio) LTD.

11 UPPER SAINT MARTIN'S LANE
LONDON, W.C.2. *TEMPLE Bar 0545*
Near Leicester Sq. Station. (Opposite Thorn House)
Shop hours: 9-6 p.m. (9-1 p.m. Thursdays). Open all day Saturday.



LOW CAPACITANCE BRIDGE
MARCONI TF 1342. Range 0.002 pF to 1,111 pF. Accuracy 0.2%. Three terminal transformer ratio arm bridge allows "in situ" measurements. Internal oscillator frequency 1,000 c/s. 12×17×8½in. Weight 15¾ lbs. A.C. mains 200 to 250 and 100 to 150 v. 40-100 c/s. With leads and handbook. **ABSOLUTELY BRAND NEW. £45.**

PHASE MONITOR ME-63/U (AN/URM-67)
Designed to measure directly the phase angle between two applied audio frequency signals of from 20 to 20,000 c.p.s. ±1°. Direct indication on a panel meter. Input can be sinusoidal or non-sinusoidal from 2 to 30 volts peak. Of recent manufacture (1957) by Control Electronics Inc. and ex-U.S.A. Air Force. In first class condition with handbook. A complex instrument with 19 valves. **£40.** Carr. 30/-.

MOVING COIL PHONES. Finest quality Canadian with chamois ear-muffs and leather-covered headband. With lead and jack plug. Noise excluding and supremely comfortable. **22/6.** Post 1/6. As above but complete with moving coil microphones. **25/-.** Post 2/6. DLR-5 Low impedance headphones with attached throat microphone. **12/6.** Post 1/6. All these items BRAND NEW.

T.C.C. VISCONAL CONDENSERS. 8 mfd. 800 v. D.C. wkg. at 71°C. CP 152 v. Size 3×1¾×5in. high. BRAND NEW (boxed), **8/6** each. **DUBILIER NITROGOL.** 8 mfd. 350 v. D.C. wkg. at 71°C. Size 1¾×1¾×4¾in. high. With fixing clips. BRAND NEW. (boxed) **5/-** each. **T.C.C. or DUBILIER.** 4 mfd. 600 v. wkg. CP 130T or similar. 1¾×1¾×4¾in. high. BRAND NEW (boxed), **4/6** each. All post paid.

ASSORTED CAPACITORS. Mixed parcel of 100 all brand new, marked value quality types. Silver mica, ceramicon and feed through from 1 pF to 3,000 pF. **10/-.**

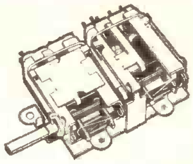
STANDARD TRANSFORMERS
Vacuum impregnated, interleaved, E.S. screen, universal mounting. Size 4×3½×2½in. ALL BRAND NEW. **18/6** each. Post 2/6.
Type 1. 250-0-250 v. 80 m/a. 6.3 v. 3 a. tapped at 4 v. 4 a. 6.3 v. 1 a. tapped at 4 v. and 5 v. 2 a.
Type 2. As above but 350-0-350 v. 80 m/a.
Type 3. 30 v. 2 a., tapped at 12, 15, 20 and 24 v. to give 3-4-5-6-8-9-10 v., etc.
Type 5. 0-6-9-15 v. 4 a. Ideal for chargers.

ADVANCE CONSTANT VOLTAGE TRANSFORMERS. Input 190-260 v. 50 c/s. A.C. mains. Output 230 v. 150 watts. **£7/10/-.** Carr. 5/-.

OSCILLOSCOPE TRANSFORMER
These are replacements for the Cossor 339A 'scope. BRAND NEW in original packing. **79/6.** P. & P. 5/6.

SANGAMO WESTON VOLTMETERS

561. 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 **32/6.** Post 2/6.



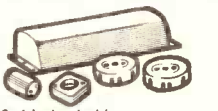
CYLDON A.M./F.M. PERMEABILITY TUNER FOR ALL TRANSISTOR OPERATION

Size 2¼in. × 2¼in. approx. By famous manufacturer. A.M.-I.F. 470 Kc/s. F.M.-I.F. 10.7 Mc/s. A.M. coverage from 1,620 kc/s.-525Kc/s. F.M. coverage 108 Mc/s.-88 Mc/s. Circuit diagram 2/6. FREE with Tuner. 1st, 2nd, 3rd A.M.-I.F.'s 1st, 2nd, 3rd and 4th F.M.-I.F.'s V.H.F. Osc. choke A.M.-F.trap. All the above are the R.F. end of an AM/FM receiver car radio etc. The above items. **£2.10.0**

BSR MONARCH UA14 With FUL-FI HEAD

4-speed, plays 10 records, 12in., 10in. or 7in. at 16, 33, 45, or 78 r.p.m. Intermixes 7in., 10in. and 12in. records of the same speed. Has manul play position: colour, brown. Dimensions: 12½ × 10¾in. Space required above baseboard 4⅝in., below baseboard 2⅜in. Fitted with Ful-Fi-turn-over crystal head, £5/19/6. P. & P. 7/6.
B.S.R. UA16, similar to the above, £6/12/6. P. & P. 7/6.
B.S.R. GU7, 4-speed, single player, complete with pick-up on uni-plate with automatic switch £3/19/6. P. & P. 6/6.

40W. FLUORESCENT LIGHT KIT

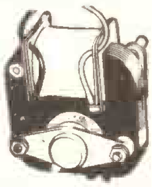


Incorporating **GEC** Choke size 8¼in. × 1¾in. × 1¾in., 2 bi-pin holders, starter and starter holder. **11/6** P. & P. 4/6.
Similar to above: 80W. Fluorescent Light Kit incorporating **GEC** choke size 11¾in. × 1¾in. × 1¾in. 2 bi-pin holders, starter and starter holder. **17/6** P. & P. 5/6.

TRANSISTOR INVERTOR

50 v. D.C. Input. Output 240 v. A.C. 40 Watts incorporating transformers, choke, condensers and 2 GET 573. In solid 16 gauge Aluminium Case size 15in. × 6in. × 2½in. by famous manufacturer. **19/6** plus 7/- P. & P.

AC MAINS MOTOR



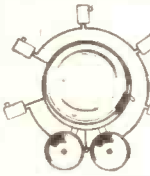
Can be used for a variety of purposes, silent running, satisfactory in every way, 230/250 v. A.C. **9/6** P.&P. 3/-.

FLUORESCENT LIGHT FITTING

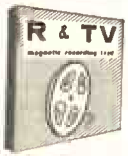
Twin 40 watt 200/250 v. less tubes. **39/6** P.&P. 7/-.

RINGO BURGLAR ALARM

A.C. Mains 200/240 volt. Fire salvage slightly tarnished. List price 7 gns. Our price complete with double gong bell, five micro switches and full instructions. **49/6** P. & P. 5/-.



SILICON RECTIFIERS 250 v. P.I.V. 750 milli-amps. Six for **7/6d.** post paid.

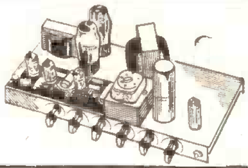


FIRST QUALITY PVC TAPE

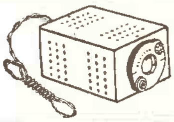
5¾in. Std. 850ft. ...	9/-	5in. L.P. 850ft. ...	10/6
7in. Std. 1200ft....	11/6	3in. T.P. 600ft. ...	8/-
3in. L.P. 240ft. ...	4/-	5in. T.P. 1800ft....	20/6
5¾in. L.P. 1200ft....	11/6	5¾in. T.P. 2400ft....	27/6
7in. L.P. 1800ft....	18/6	7in. T.P. 3600ft....	37/6

P. & P. on each 1/6, 4 or more post free.

6 VALVE 15 WATT PUSH-PULL AMPLIFIER



15 × 7 × 1½in. A.C. mains 200-250 volts. 4 inputs with controls for same and bass and treble lift controls. Tapped for 3 and 15 ohm speakers. Extra H.T. and L.T. for F.M. Tuner supplies, etc., built and tested, **7 gns.** plus **13/6** P. & P.



POWER SUPPLY KIT

In metal case, size 3¾in. × 2½in. × 2in. incorporating mains transformer, rectifier and condensers. 230/250 A.C. Mains. Output: 9 v. 100 mA. Price **10/6** plus 3/-. P. & P.

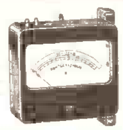
OSCILLOSCOPE for D.C. & A.C. Applications

Push-pull X amplifier; Fly-back suppression; Internal Time-base Scan Wave form available for external use; pulse output available for checking TV line O/P Transformers etc. Provision for external—I/P and C.R.T. Brightness Modulation. A.C. mains 200/250 v., £18/18/-, P. & P. 10/-. FULL 12 MONTHS' GUARANTEE INCLUDING VALVES and TUBE.

3 to 4 WATT AMPLIFIER KIT comprising chassis 8¾in. × 2½in. × 1in. Double wound mains transformer, output transformer. Volume and tone controls, resistors, condensers, etc. 6V6 ECC81 and metal rectifier circuit 1/6 free with kit. **29/6** plus 4/6 P. & P.

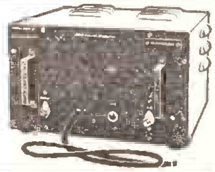
POCKET MULTI-METER. Sizes 3⅞ × 2⅛ × 1⅛in. Meter size 2⅛ × 1⅝in. Sensitivity 1,000 OPV on both A.C. and D.C. A.C. and D.C. volts 0-15, 0-150, 0-1,000. D.C. current 0-150 mA. Resistance 0-100KΩ. Complete with test prods, battery and full instructions. **42/6**, plus 3/6 P. & P.

50 MICRO-AMP. METER Movement by world - famous manufacturer. Size 3in. × 2¾in. 25/- plus 2/-. P. & P.



FIXED FREQUENCY SIGNAL GENERATOR

Crystal control in metal case, size 10in. × 6in. × 6in. Incorporating 2 FC13 valves, mains transformer, metal rectifier, choke, indicator lamp, crystal and numerous components. Modulated and unmodulated output sockets. Originally used for I.T.V. frequencies. Brand new. **39/6.** plus 7/- P. & P. A.C. Mains 200/250 volts.



SPECIAL OFFER!

"Elegant Seven" Mk. II

POWER SUPPLY KIT to purchasers of Elegant Seven parts, incorporating mains-transformer, etc. A.C. mains 200-250v. Output 9v. 100mA. 7/6.

COMBINED PORTABLE & CAR RADIO. The Radio with the STAR features 4in. SPEAKER.

- ★ 7-transistor superhet. Output 350mW.
- ★ Grey wooden cabinet, fitted handle with silver coloured fittings. Size 12¼in. × 8¼in. × 3½in.
- ★ Horizontal tuning scale, size 11½in. × 2⅜in. in silver and black lettering.
- ★ All stations clearly marked.
- ★ Ferrite-rod internal aerial.
- ★ I.F. Neutralisation on each stage. 460 Kc/s.
- ★ D.C. coupled output stage with separate A.C. negative feed back.
- ★ All components, ferrite rod and tuning assembly mounted on printed board.
- ★ Operated from PP9 battery.
- ★ Full comprehensive instructions and point-to-point. wiring diagrams.
- ★ Printed circuit board, back printed with all component values.
- ★ Fully tunable over medium and long waveband.
- ★ Car aerial socket.
- ★ Full after-sale service.

ONLY **£4.4.0**

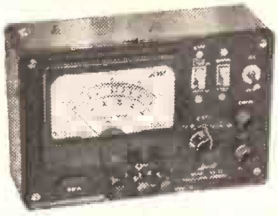
Plus 6/6 P. & P. Parts list and circuit diagram 2/6. Free with parts.

RADIO AND T.V. COMPONENTS (ACTON) LTD.

21A, HIGH ST., ACTON, LONDON, W.3.

Goods not despatched outside U.K. All enquiries S.A.E. Terms C.W.O.
SHOP HOURS 9 a.m.- 6 p.m. EARLY CLOSING WEDNESDAY

TRANSISTOR TESTER Model AT-1



Measures characteristics of PNP and MPN. Transistor and power diodes. Precision transistor portable instrument. 50μA meter with fitted moving coil. **£10.10.0** P. & P. 7/6

VARIABLE VOLTAGE TRANSFORMERS

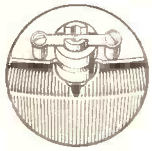
WORLD FAMOUS "SLIDE-TRANS" AVAILABLE ONLY FROM I.M.O.

★ *RATED CURRENT CONSISTENT AT ALL POINTS ALONG THE WINDING.*

Output: 0-260 v. Input: 230 v. A.C. 50/60~.

Shrouded fully variable transformers for bench or panel mounting.

Inset shows latest type brush gear providing 1 volt variation.



1 Amp.	£4.10.0
2.5 Amp.	£5.17.6
5 Amp.	£9. 0.0
10 Amp.	£18. 5.0
20 Amp.	£32.10.0

Carr. & Pkg. extra

CONSTANT VOLTAGE TRANSFORMER

AUTOMATIC MAINS STABILIZER

★ **CORRECTED WAVE**

Modern design in 2-tone grey hammer steel case with handle. Complete with lead and plug.

Provides perfectly stabilized constant voltage for all laboratory equipment.

★ **No Moving Parts** ★ **No Maintenance.** ★ **No Attention.**

Specification:

★ **Input:** 240 v. A.C. ±20%—50 cycles.
★ **Output:** 240 v. A.C.
★ **Accuracy:** ±1%.
★ **Capacity:** 250 watts.
★ **Size:** 11×6½×6in. high.
★ **Weight: 21 lbs. Fitted signal lamp and switch.**

£11.10.0 Carr. & Pkg. 20/-

1,000 WATT MODEL
Input 240 v. A.C. ± 20%.
Output accuracy ±1%.
Fitted signal lamp & switch, complete with plugs **£29.10.0.** Carr. and pkg. 25/-.

PORTABLE VARIABLE A.C. POWER SUPPLY UNIT

DESIGNED FOR ENGINEERS WHOSE REQUIREMENTS CALL FOR A VISUAL INDICATION OF VOLTS APPLIED.

OUTPUT: 0-260 v. 1½ amps.

INPUT: 230 v. A.C. 50/60~. Unit fitted with fuse, voltmeter, safety indicator, on-off switch and lead. Size: 8 × 5 × 5in. high.

PRICE £8.10.0 Carr. & Pkg. 10/-

IMMEDIATE DESPATCH

FULL SPARES AND SERVICE AVAILABLE

AC/DC VALVE VOLTMETER

Price ONLY **£35.0.0**

C/W probes and leads—
no extras.

Latest circuitry provides perfect stability and sensitivity. Professionally acknowledged.

JUST LOOK AT THIS SPECIFICATION!

★ **11 megohms per volt.**
★ **5mV-1,500 V. A.C.**
★ **100 mV-1,500 V. D.C.**
★ **0.1 ohm—1,000 Megohms.**
PLUS
★ **1 Kc Oscillator Test Source.**
★ **Complete with Test Probe with BUILT-IN A.C./D.C. switch, no fumbling or fiddling with out-of-reach knobs.**

This superbly finished instrument is invaluable in Production depts. and Labs. and is presented in an attractive light grey crackle steel case with satin alloy front. Mains operated: Size and weight: 5½×3×8in. high, 5½lb.

LATEST Miniature

WALKIE TALKIE

'88' Set

Produced to exacting specifications by leading manufacturers E. K. Cole & Co.

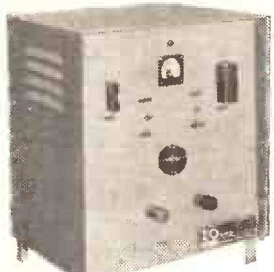
This Transmitter/Receiver weighs only 5½lb. (approx.) and measures 3½×5½×9½in. A crystal controlled 4 frequency set operates from standard dry battery—H.T./L.T. (i.e. Vidor L5537), 14 current series B7G valves used.

As supplied by us to Overseas Govt. Depts.

SUPPLIED COMPLETE WITH VALVES & CRYSTALS
Details & Prices of all Accessories supplied on request.

Only £10.0.0 EACH

20 AMP. SUPPLY UNIT



LATEST DESIGN!

HEAVY DUTY 12/24 VOLT D C.

Spec.: Output: Adjustable up to 20 amps **CONTINUOUS** at 12/24 volts plus trickle. Input: 220/230/240 VAC 50 cycles. Input and Output fully fused. Neon indicator, 0-20 amp.meter. Size: 16 × 12 × 20in. high, in heavy gauge steel cabinet. Grey Hammer finish. Weight: 50 lbs. ONLY **£29.10.0** Plus 40/- Carr. & Pkg. G.B. (Inland)

BUY DIRECT FROM MANUFACTURER

TRANSISTORISED MEGOHMMETER

★ **NO WINDING!**
★ **PUSH BUTTON TO READ**
500V.-1,000 MEGOHMS

Portable supplied c/w batteries, probes and carrying case. Superb instrument.

ONLY £23.10.0 Carr. & Pkg. 7/6.

Also: 500 v.-500 Megohms mains operated insulation tester. DESIGNED FOR CONTINUOUS USE. £26-5-0

30 AMP. SUPPLY UNIT

0 to 18 V.D.C. WITH SMOOTH STEPLESS VARIATION.

Designed for CONTINUOUS use at max. loading.

★ Fitted voltmeter and ammeter.
★ Input and output fully fused.
Input Mains A.C.
Robust Construction.
2 tone grey hammer finish. **Steel case.**

£49.10.0 Carr. & Pkg. 40/-. G.B. (Inland)

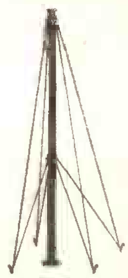
Entirely suitable for plating plants, laboratory supplies, etc.

36ft. AERIAL MASTS

NEW LATEST PATTERN TUBULAR MASTS

Check these vital points:

★ Made from 6 × 1¾in. dia. Sherardized steel sections, for durability and strength.
★ Extra strong locating base.
★ Top cap with fitted pulley and halyard.
★ 2 sets (8) Rotproof Guys.
★ Rustproofed Steel Picketing Stakes.



ONLY £13.2.6 ex works

Carr. 17/6. Returnable wooden case 20/-.

I·M·O (ELECTRONICS) LTD.

WRITE FOR ILLUSTRATED BROCHURE

(Dept. WW7), 313 Edgware Road, London, W.2. PADdington 2233/4

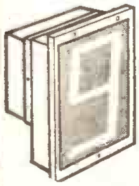
PROOPS Walk-around Store
and MAIL ORDER SERVICE

52 Tottenham Court Road, London, W.1. • Open 9-6, including Sats., Thurs. 9-1 • LANgham 0141

DEKATRON TYPE GS10E

by Ericsson, supplied brand-new, boxed and complete with performance and connection data. Max. operating speed: 10 kc/s. Anode voltage: 440/475 v. Current: 0.8 mA. Cathode voltage: 35 v. max. Pulse Amplitude: —120 v min. Size overall: 1.3in. dia. × 2.64in. Fitted with standard duodecal base. **15/-** post free

DECADE COUNTER WITH PHOSPHOTRON READOUT



A complete decade counter that simply requires 250 v. A.C. and 12 v. D.C. supplies to operate. Each stage is self-contained with readout display of 4in. high figures, presented on a electro-luminescent plate size 4in. × 5¾in. high. Stages can be simply connected together as add-on units with automatic carry-over up to any count required. Display colour is green; luminescence can be intensified by increase of frequency up to 1,000 c/s. but is nominally 8ft. Lamberts at 400 c/s. Maximum counting speed 20 pulses per second. Counter is stepped each time input pulse line is shorted; instant reset is provided. Complete with data. **£7/10/0** post free.

SEMI-CONDUCTOR MODULES
Ice cube size encapsulated circuits

Solid state semi-conductor modules—fully transistorized and completely wired and tested circuits that only require a 6-volt battery and connection to input and output to provide a compact ready-made unit. Encapsulated types are shockproof and almost indestructible. Supplied with instructions.

METRONOME—requires only 2 megohm potentiometer and any P.M. speaker to produce accurate repetitive beats at adjustable rates from 40 to more than 208 beats per minute. Low battery drain: simple connections. 22/6. *P. & P.* 1/-.

2-WATT GRAM. AMPLIFIER—just connect to any crystal pick-up and an 8 ohm speaker for above average output with excellent tonal quality. 1-megohm potentiometer recommended for volume control. Extremely compact, high quality unit. 35/-. *P. & P.* 1/-.

CODE PRACTICE OSCILLATOR. Simply connect with morse key and P.M. speaker and any 1½-6 v. battery. Fully transistorized and assembled on rigid board, size 2 × 1⅜in. 12/6. *P. & P* 1/-.

FIRE ALARM—Module contains temperature sensor and operates in conjunction with 8 ohm loudspeaker and 2 megohm potentiometer. Increase of room temperature above preset level immediately triggers screaming siren alarm. 50/-. *P. & P.* 1/-.

BURGLAR ALARM—Needs only 8 ohm loudspeaker, switch and microswitch (or reed switch and magnet) to complete. Operation of sensing switch triggers upwards, screaming siren to give instant alarm. For home or motor car protection. 30/-. *P. & P.* 1/-.

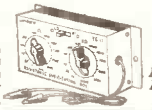
MICROPHONE TRANSMITTER MODULE— 30/- *P. & P.* 1/-. Contains complete solid state circuitry ready for use as a means of transmitting speech from any high impedance microphone into an ordinary A.M. radio without connecting wires. Requires only 9 volts battery and crystal microphone.

PHOTO MULTIPLIER POWER TRANSISTOR— 25/-. *P. & P.* 1/-. Complete photo-electric system in one unit of power transistor amplifier. Photo-electric cell and electronic relay. Make your own photocontrol system—door opener, burglar alarm, automatic door chimes, counters, etc. Complete with instruction literature of unusual applications.

WIRELESS TELEPHONE AMPLIFIER MODULE— 30/-. *P. & P.* 1/-. Complete electronic, solid state circuitry ready to amplify and transmit both sides of a telephone conversation into any A.M. broadcast band radio, without interconnecting cables. Operates from 9 volts "transistor" battery and requires only telephone pick up coil go operate.

PUBLIC ADDRESS AMPLIFIER—needs only carbon microphone and any speaker. Frequency response designed to provide maximum intelligibility. With 15in. speaker, sound covers hundreds of yards. Fully encapsulated. Size only 1½ × 1½ × ⅝in. 35/-. *P. & P.* 1/-.

RESISTANCE SUBSTITUTION BOX



Two switched ranges providing instant selection of any of 24 accurately chosen resistors. Low range 15 ohms to 10 kilohms (1 watt rating). High 15 kilohms to 10 megohms (½-watt rating) 36in. red and black test leads with alligator clips. In totally enclosed attractively finished case size 4⅝in. × 2⅝in. × 1⅝in. **32/6** Post & Pkg. 2/6

DRY REED SWITCHES

Basically a pair of gold diffused reed contacts hermetically sealed in a glass tube filled with inert gas. Contacts can be actuated by permanent, or electromagnets and so form ideal devices for a wonderful range of inexpensive devices such as burglar alarms, limit switches, position indicators, r.p.m. counters, night light controls, door bell switching, level controls, etc., etc. Reed switches have tremendous reliability factors and a working life of about 100 times that of micro-switches, and the use to which they can be put is limited only by imagination. Each switch is supplied complete with specification, instructions and ideas information. *Suitable magnets 1/- extra.* **7/-** *each, post free.*

MINIATURE TYPE 8/6 *post free.*

Only 0.82 inches long by 0.15 inches thick. Maximum current for long life. 100 milliamps.

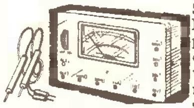
REED SWITCH COILS 4/- *post free*

Specially manufactured to provide electro-magnetic operation of Dry Reed Switches. Coil is simply pushed over glass tube envelope of switch and located round switch contacts. Size overall: ⅝in. dia. × ⅞in. long. Two types are available: Type 1 operates from any D.C. voltage from 1½ to 6 volts; Type 2 —operates from any D.C. voltage from 6 to 12 volts. Please state type required when ordering.

CHANGEOVER REED SWITCH TYPE UD593 12/6 *post free.*

Similar in construction to types listed above except that the reed is spring-loaded against one contact until actuated by a field from a permanent or electro-magnet to transfer connection to a second contact. Glass size: 1.375in. long × 0.201in. dia. Breakdown voltage 350 volts D.C. minimum. Contact rating for long life 250 m/A at 250 volts A.C. Ampere turns to Just Operate 70-120. Release 30-70.

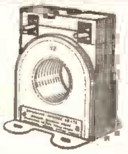
PROOPS MULTI-TESTER



39/6 *P. & P.* 2/-.

Specially designed for Proops! This truly low-priced, all-purpose tester combines the mose useful voltage, current, and resistance measuring ranges for home and motor car wiring and servicing, amateur radio and T.V. fixing, and electronics hobby construction checking. Extremely robust construction employs rugged, large scale meter movement, hard-wearing switch contacts, and impact resisting tough plastic case. Ranges: 0-10-50-250-500-1000 volts AC or DC. 0-1-500 mA. DC 0-100,000 ohms, and −20 to +36 decibels. Size overall: 5 × 3¼ × 1⅜in. deep. Supplied complete with red and black insulated connector leads, battery, and full instructions.

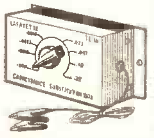
CURRENT TRANSFORMER



17/6 *P. & P.* 2/6.

Fully encapsulated with integral pedestal mounting and shrouded screw terminals. Rates 125/1 amp. 6 VA, 400 cycles but can be used for measurement in the same ratio of 125/1 amp. at 1 VA on a 50 cycles A.C. supply. Size 2⅞ × 1 × 3⅜in. high with 1½in. diam. centre hole. Made by English Electric Company Limited.

CAPACITANCE SUBSTITUTION BOX



25/- *P. & P.* 2/6.

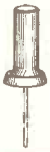
Compact unit providing a directly switched accurate selection of 9 capacitors: 0.0001, 0.0002, 0.0047, 0.01 0.022, 0.047, 0.1 and 0.22. Capacitance rating 600 v.w. case size 4⅝in. × 2⅝in. × 1 × ⅝in. Fitted with 36in. red and black test leads with shrouded alligator clips.

PRECISION VERNIER DIALS
Universal Mounting. For Standard ¼in. Drives.

Complete range of three progressively sized precision planetary drive Vernier Dials, each with approximately 8 to 1 ratio. Can be mounted on any panel surface, and requires only drilling for fixing screws and centring hole for metal insert to receive ¼in. drive shaft. Attractive, all-metal dials having brushed silver finish with deeply etched enamel filled engraving that provides maximum legibility, even in poor lighting conditions. Each dial is graduated 0 to 100 over 180 and fitted with large sure-grip knob and housing. Mechanical construction is phosphor-bronze and brass throughout. Range available:—

TYPE 1—1⅜in. diam. × 1⅜in. deep 8/6 TYPE 2—2in. diam. × 1in. deep 10/-
TYPE 3—2⅞in. diam. × 1⅛in. deep 12/6 *Post* 1/-.

MINIATURE MERCURY SWITCH
ALMOST INDESTRUCTIBLE, FEATHERLIGHT OPERATION



2 for 7/6 *Post free.*

Encapsulated in copper-plated steel tube only ³⁄₁₆in. dia. × ⅝in. long (inc flange). Tube provides one contact and other contact is ½in. long wire fused into glass centre of tube base. 20 deg. movement makes or breaks contact; vacuum sealing ensures unchanged contact resistance throughout life. Construction permits switch to be simply clipped into position. Rating 240 v. A.C. mains operation at 1 amp., may also be used with D.C. current from small torch battery. Can be installed almost anywhere to operate lights automatically or to provide simple warning or safety devices.

GUARANTEED TRANSISTORS. O.C.44 and O.C.45 2/6; O.C.71 3/6; O.C.26 6/6. Matched pairs of G.E.T. 8 (max. volts 32, output 50 w. in push-pull) 14/6 per pair. Add packing and postage.
SILICON RECTIFIERS. XU612 50 p.i.v. 500 mA. 2/6. R.T.C.D. 1,000 p.i.v. 500 mA. 7/6. Silicon bridge 24 v. D.C. 6 A. full wave £2.
ADJUSTABLE POT CORE. Mullard Vinkor Type LA45 18 mm. adjustable core, suitable for frequency range 120 kc/s.-1.2 Mc/s. Effective permeability 25. Turns for 1 mH. 133. Complete and brand new, 4/6. P. & P. 1/-.

CONSTRUCT ELECTRONICS with NEW VEROBOARD
● Quickly ● Cheaply ● Professionally ●

VEROBOARDS supplied by Proops Brothers Limited have been specially designed to meet the needs of the amateur constructor; hole matrices have been pitched to provide the greatest utility in a wide variety of circuit layouts; purchase price has been kept low by the deliberate selection of one standard board width (22 way) which may be used with almost any circuit but permits large quantity purchase with attendant saving; specially prepared design sheets are provided with each purchase to simplify circuit layout; accessories have been kept to an essential minimum to further reduce cost.

VEROBOARD SHEETS 12/6 each. *Post free*

Board size overall, 17in. long × 3⅝in. wide, 0.0312in. thick. Each is clad with 22 × 0.0015in. thick copper conductors which are fully pierced in line at 0.156in. intervals across width and 0.2in. along length. Boards are treated with flux preservative to give protection and ensure satisfactory soldering. A design sheet is supplied with each board.

SPOT FACE CUTTER 8/6 *Post free*

Specially designed hand cutting tool with hole locating spigot. Light turning and pressure removes copper conducting strip locally to make a neat break.

TERMINAL PINS 50 for 3/6 *Post free*

Made specially for Veroboard of pre-tinned brass with a flat head to give maximum contact, and self-cutting serrations near the head to ensure a tight fit when pushed into the hole.

INTRODUCTORY VEROBOARD KIT 24/- *Post free*

Includes one sheet of Veroboard, Design Sheet, Spot Face Cutter, 50 Terminal Pins, and instruction on design method and layout procedure.

RELAY UNIT. G.P.O. 600 types 5 relays 150 ohm 1 set C/O., and 5 relays 400 ohm 2 M., 1 set C/O., in metal box 8×6×5in., £2, post 5/-.

BC-221 or LM 13. Freq. meter complete with original charts in good working order. Range 125 kc/s.–20 Mc/s., £16/10/-, carr. 15/-.

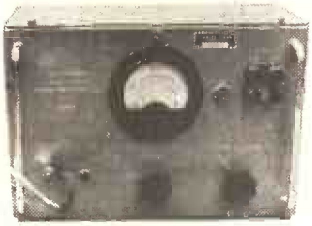
SIGNAL GENERATORS
TF.144G. 230 v. A.C. 85 kc/s.–25 mc/s. In excellent condition, £16/10/- each, 25/- carr.
TS.12AP. Standing Wave Indicator Equipment. Complete with Amplifier and waveguide plumbing equipment, £12/10/- each, 15/- carr.
TS.36AP Power Meter, with accessories, used for checking radar outputs, £5 each, 10/- carr.

DE-ICER, Controller Mk. 3. Contains 10 relays D.P. changeover heavy duty contacts, 1 relay 4P, C/O. (235 ohms coil). Stud switch 30-way relay operated, one five-way ditto, D.C. timing motor with Chronometric governor 20–30 volts 12 R.P.M., geared to two 30-way stud switches and two Ledex solenoids, 1 delay relay, etc., sealed in steel case, size 4×5×7in., £3 each, post 5/-.

BC640 MODULATOR UNIT. 2×811's, mod. transformer and fil., trans. complete mod. unit fits 19in. rack 50 watts, £5/10/-, carr. £1.

GEARED MOTORS (Reversible).
20-30 v. D.C. 72 r.p.m., 17/6, post 2/6.
28 v. 150 r.p.m., 25/-, post 2/6.
24 v. Open gears with governor, approx. 10 r.p.m., 25/-, post 2/6.
24 v. D.C., 1.4 r.p.m., reversible with two micro switches inside gear box, silent operation, £2 each, post 5/-.
A.C. Motor 115v. 50 c/s 1/300 H.P., 3000 r.p.m. Capacitor 1 mfd. 25/-, post 3/-.
Dalmotor SC5, 28 v. D.C. at 45 amps.; 12,000 r.p.m., output 750 w. (approx. 1 h.p.), brand new, £2/10/- each, post 7/6.

AZIMUTH INDICATOR UNIT ID-260/GRD 115 v. 50 c/s., complete with Azimuth Bearing Indicator and suitable for aerial direction control, 2" tube with shield suitable for modulation percentage indicator or oscilloscope and 3" speaker that can be utilised as a sidetone monitor. With all valves, in excellent condition, price £8/15/-, carriage 15/-.
CRD6 DIRECTIONAL ANTENNA for use with the above Instrument, £5 each, carriage £1.
CM23 COMPARATOR SIGNAL UNIT, £4/10/-, carriage 15/-.



MARCONI V. LVE VOLTMETERS TF428-B/1. Ranges: 0 to 1.5, 5, 15, 50 and 150 volts. Fitted with probe unit for RF measurements. 230 v. mains input. Brand new, £12/10/- each, carr. 10/-.

TCS MODULATION TRANSFORMER 20 w. Pri., 6,000 ohm C.T. Sec., 6,000 ohm. 25/- each, post 3/6.

MICROPHONE TRANSFORMER. Pri., 75 ohm. Sec., 125,000 ohm. 10/- each, post 2/6.

OUTPUT TRANSFORMER. Pri., 7,500 ohm. Sec., 500 ohm. C.T., 2.5 w. 12/6 each, post 3/-.

POWER SUPPLY unit for SENDER No. 36, 110-240 v. A.C. input, contains Speech amplifier. Modulator and External power supplies, 3×FW4/500 rectifiers provide H.T. for F.R. unit Speech amplifier 6C5G, Modulator 2×6C5G and 2×807 output. Size 24×16×14 inches. Housed in a fine oak case with circuit. Weight 110 lbs. As new, £6/12/6, carr. 30/-.

CONDENSERS. 1 mfd., 20 kv., £6/12/6 each, post 12/6 each. 0.25 mfd., 32,500 volts Wkg. £5 each, post 12/6 each. 150 mfd., 290 volts A.C. £5 each, post 12/6. 50 mfd., 330 volts A.C. 40/-, post 4/-. 10 mfd., 1,000 v. 12/6, post 2/6. 8 mfd., 1,500 volts, 17/6, post 2/-. 8 mfd., 1,200 volts, 12/6, post 3/-. 8 mfd., 600 volts, 8/6, post 2/6. 0.25 mfd., 2 kv. 4/-, post 1/6. 4 mfd., 12,500 v. D.C. working, £7/10/- each, carr. 15/-.
Vacuum condenser 50 pf. 32 kv. 30/-, post 1/6. 6 pf. 20 kv. 22/6, post 1/6. All the above are new in cartons.

BLOWER MOTORS. 24 v. D.C. (small U.S.A.), 12/6, post 2/-.

OSCILLOSCOPES, Cossor 1035 and 1049, used condition, £30 each. Hartley type 13A, £25 each.

INVERTERS. Type AN3499, 28 v. D.C., 9.2 amps. input, 115 v. 400 c/s 3 phase, £5 each, post 5/-.

TX DRIVER UNIT. 100-156 Mc/s. Ideal for two meters, Valves 3C24, in excellent condition, fits 19in. rack, £5 each, carr. 20/-.

CONTROL UNIT. 230 v. A.C., output 24 v. 2 amps., 230 v. A.C. solenoid switch, 15 amps., plus relays and switches, etc., £2/10/-, carr. 12/6.

RECEIVERS. HRO. Used condition, less coils £10 each, carr. £1. C.52, used, freq. 1.75-16 Mc/s., £5, carr. £1.

UNISELECTORS. 6 bank, 25 way, 20 ohm. coil, £2 each, post 2/6; 5 bank, 25 way, 20 ohm. coil, 35/- each, post 2/6. (Ex-new equipment.)

BOMB SELECTOR UNIT, complete with uniselector 3B., 25 watt, 22 ohms, magnetic counter 0-40, and 1 relay 500 ohm. 2 make, 50/- each, post 3/6.

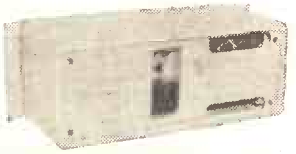
HEADPHONES. DLR5, 10/- pair, 2/6 post. No. 10 headset and microphone, 15/-, post 2/6. M/C phones with chamois ear muffs and jack plug, 17/6 pair, post 2/6.

APX6 TRANSPONDER. Complete with UHF valves 2C42, 2C46 and 1B40, complete with special holders and condensers. 30 Valves, Blower Motor, Mechanical Counters, etc. 115 v. 400 c/s. (Suitable conversion for 1,200 Mc/s.). Price £10 each, carriage 15/-.

AUTOMATIC PILOT UNIT Mk. 2. This complex unit of dioes and valves, relays, magnetic clutches, motors and plug-in amplifiers, with many other items, price £7/10/-, £1 carriage.

C.52 POWER SUPPLY 110/230 v. A.C. or 12 v. D.C. input, £2/5/- each, Carr. 12/6.

U.S.A. DESK MICROPHONE CRV/51018/A. Complete with 7 yards of screened cable and universal jack (adjustable), 10/- each, post 3/-.



POWER AND SMOOTHING UNITS. 100-250 v., A.C. input 24 v., D.C. at 3 amps. or 12 v. twice at 3 amps., continuous rating, switched fused, etc. In metal case 19 × 7 × 7in. Smoothing two large chokes and 0-1 ma., meter scaled 0-50 volts. £7/10/- (pr.), 15/- carr.

RESISTORS. Variable. 3 ohm. 10 amps., 25/-, post 4/-.

ROTARY TRANSFORMERS. 24 v. input, 175 v. at 40 ma. output, 25/-, plus 2/- post. EICOR type, 12 v. input, 400 v. at 180 ma. output, 30/-, plus 4/- post. 12 v. input, 225 v. at 100 ma. output, 25/-, plus 3/- post. (All the above are D.C. only.)

MICROPHONE Type T50. Fits the palm of hand with on/off switch and lead (electro dynamic), 35/- each, plus 2/6.

CIRCUIT BREAKER. 150 amps. 600 v. A.C., £3 each, carr. 7/6.

PLUGS. Standard two-way jack plug PL55 with 6ft. lead and transformer, low to high impedance, 7/6 each, plus 1/6 post. PL68 plug and switch lead assembly, 5/- each, plus 1/6 post.

DIPOLE AERIAL. Complete set suitable for 60-100 Mc/s., 27/6, carr. 4/-.

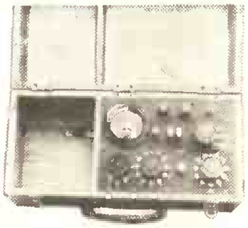
COMPRESSOR UNIT. Aircraft cabin pressurisation unit, 28 v. D.C., with automatic switches, etc., £3/10/-, post 6/-.

AR88 SPARES. Set of 14 valves and headphones and 3 pilot lamps, new, original cartons, £3/10/- each, post 2/6. Set of 14 valves only, £2/10/-, post 2/-. Vibrator unit, 6 v., 15/-, post 4/-. Headset only, 12/6, post 2/-. Speaker unit, R.C.A., £3/10/-, plus 5/- post. Block condenser unit, 3×4 mfd. at 600 v., 25/- each, post 3/-. 0.01 mfd. 400 v. D.C., 4 for 12/6. Capacitor air trimmer, 2-20 pf., box of 3, 10/-.

1154 TRANSMITTER UNIT less power supplies (used), £4 each, plus 15/-.

TRANSFORMERS. 230 to 115 v., isolation 300 va., £3 each, plus 5/-. 230 v. pri., 1,850-0-1,850 at 500 ma., £5 each, plus 15/- carr. 230/115 auto 300 watts, £2, post 6/-. 230 v. pri., 24 v. at 2 amp., 22/6, post 5/-. 230/115 v. pri., 275-0-275 v. at 120 ma., 6.3 v. at 4 amp., 6.3 v. at 1 amp., 25/-, post 5/-.

RADAR RECEIVER APG501. Complete Unit with Blower Motor, 40 valves, Relays, Transformers, etc. Condition as new. Price £5 each, carriage 15/-.



WHEATSTONE BRIDGE in a beautiful oak case, centre zero galvanometer 2.5 mA., 4 stud switches, 0-10, 0-100 ohms, 0-inf., size 16×7½×6in., 45/- each, 5/- post.

RADAR TRANSMITTER APG501. Complete Unit in pressurised case with Magnetron CBPV6765 and Klystron 6378 and associated crystals and waveguides, Blower Motor and 12 valves. Power inputs 115 v. 400 c/s. Condition as new, price £10 each, carriage 15/-.

CONVERTERS. Type 8a, 24 v. D.C., 115 v. A.C. at 1.8 amps 400 cycles, 3-phase, £6/10/- each, post 8/-.

SCANNER UNIT. AS. 596/APQ.43. This modern piece of equipment made by a well-known American firm, normally for aircraft use, has a 30in. diameter parabolic reflector adjustable 180 deg. vertical and horizontal and is complete with standard waveguide couplings and rotary joints. Three powerful D.C. motors by Dalmoter. Company, i.e. Types SC.5, SR.2 and PM.4. Three geared motors 0-6 r.p.m. and 0-150 r.p.m., also Kollsman Magslip motor type TY.971C-0460. Two solenoid contactors, small compressor unit with pressure gauge 0-30 and dehydrator unit. All the above is mounted in an aluminium casting, approx. weight 120-125 lbs. 4 Relays d.p. c/o. 24 v. 235 ohms., 4 Relays 4 p., c/o, 24 v. 235 ohms., Mechanical Counter 0-9999, 2 20K ± 0.15% Linear Potentiometer, 1,400 ohms. ± 3% Suppressors, Switches, Plugs, Sockets and assorted gears. Price £17/10/-, £2 carr. and £5 deposit for returnable container.

MODULATOR UNIT APQ.43 mounted in a pressurised container with pulse transformer network units, 7 various relays, high voltage condensers 0.001 mfd. 10,000 v. D.C., 0.5 7,500 v. working. Valves: KU25, 3B24W, 705A(3), blower motor 27 v. .17 h.p., 7,600 r.p.m. 4.6 amps, 90 c.f.m. Omite switch 150 v. 10 amps, 8 pcs. Approx. weight 80 lbs. Price £10, carr. £1.

APQ.43 RT UNIT complete with Magnetron 4J50, Klystrons 2K25, WL.5846 and 18 other valves, 0-1 ma. meter, relays, etc. Weight 65 lbs. Price £15 each, carr. 17/6.

ARN.21 or TR.9171 (Tacan Equipment), complete with valves, £25 each, carr. £1.

TRANS./REC. WIRELESS SET No. 31, complete sets with aerials, headphones and mikes in working order. Freq. 30/40 Mc/s. 4 channel xtal-controlled, £8/10/- each. **WIRELESS SET No. 88.** 4 channel, xtal-controlled, complete with all valves and xtals and attachments, £10 each.

HIGH SPEED RELAYS H96D, 500 + 500 ohm, 12/6 each, post 2/-.

AERIAL CHANGEOVER RELAY, Londex 24 v., 17/6 each, post 2/-.

POWER UNIT P94A. 24 v. D.C. input, 13 amps, 300 v. D.C. @ 300 ma., 150 v. D.C. @ 100 ma., 12 v. @ 5 amps., complete with relay, voltage regulator and radio suppressors, £3 each, carr. 12/6d., or 12 v. input, £3/10/- each.

Complete installations can be quoted for. Please write further details. List available 6d. S.A.E. for all enquiries.

W. MILLS

3-B TRULOCK ROAD, TOTTENHAM, N.17
Phone: Tottenham 9213 & 9330

R.S.C. (MANCHESTER) LTD.

MAIL ORDERS TO: Dept. W., 54 WELLINGTON ST LEEDS 1. Terms: C.W.O. or C.O.D. No C.O.D. under £1. Postage 2/9 extra under £2. 4/6 extra under £5. Trade supplied. S.A.E. with all enquiries please. Personal shoppers welcomed at any of the branches below. Open all day Saturday.

BRADFORD 10 North Parade. Tel.: 25349. (Half-day, Wed).

BRISTOL 14 Lower Castle Street. (Half-day Wed.) Tel: 22904

BIRMINGHAM 30/31 Gt. Western Arcade. Opp. Snow Hill station. Tel: CENtral 1279. (No half-day.) Larger premises now open.

DERBY 26 Osmaston Rd. The Spot. (Half-day Wed.) Tel: 41361.

DARLINGTON 13 Post House Wynd. Tel: 68043. (Half-day Wednesday.)

EDINBURGH 133 Leith Street. (Half-day Wed.)

GLASGOW 326 Argyle Street. Tel: CITy 4158. (No half-day.)

HULL 51 Savile Street. (Half-day Thursday.) Tel: 20505.

LEICESTER 32 High Street. (Half-day Thurs.) Tel. 56420.

LEEDS 5-7 County (Mecca) Arcade. (No half-day.) Tel: 28252.

LIVERPOOL 73 Dale St. (No half-day) Tel: CENtral 3573

LONDON 238 Edgware Road, W.2. (Half-day Thursday.) Tel: PADdington 1629.

MANCHESTER 60A-60B Oldham St. Tel: CENtral 2778. (No half-day.)

MIDDLESBROUGH 106 Newport Road. (Half-day Wednesday.) Tel: 47096

SHEFFIELD 13 Exchange Street, Castle Market Bldgs. Tel: 20716. (Half-day Thursday.)

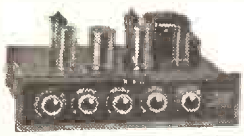
PRINTED CIRCUIT KITS

Etch your own circuits. 72 sq. in. Board. Fluids. Paint Brush and full instructions **16/9**

POWER PACK KITS

Fully smoothed output 250 v. 60 mA. H.T. and L.T. 6.3 v., 1.5 amps. Consists of chassis, mains trans. 200-250 v. Double wound, Rectifier, Choke, Electrolytics and circuit. **19/11**

R.S.C. STEREO/TEN HIGH QUALITY AMPLIFIER KIT



Valves EZ81, ECC83, ECC83, EL84, EL84. Separate bass and treble controls giving "cut" and "boost." Sensitivity 50 mV. 5 watts high quality output on each channel. Can be used as straight 10 watt amplifier. Controls: Stereo/Monaural switch, ganged volume, ganged treble, ganged bass and balance. Output for 3 ohms speaker. Point-to-Point wiring diagrams and instructions. Illustration full wiring details and priced parts list 1/9. **8 GNS.** Carr. 10/-. Or supplied assembled and tested 59/6 extra. Deposit 2 gns. and 9 monthly payments of 24/2. (Total £12-19-6.).

Full range of Hi-Fi equipment. Cash or Terms. **ARMSTRONG, LINEAR, LEAK, QUAD, JASON, ROGERS, TRUVOX, TANDBERG, FERROGRAPH, GARRARD, GOLDRING, CONNOISSEUR, WB., GOODMANS, FANE, WHARFEDALE, RESLO, GRAMPIAN.**

FANE 122/10 20 WATT HEAVY DUTY LOUDSPEAKERS

12in. 15 ohm. With exceptionally robust 2in. diameter voice coil assembly. **5 GNS.** Post free

TANNOY 8 WATT RE-ENTRANT LOUDSPEAKERS.

8 ohms. For workshop, factory or outdoor use 27/6 ea. Post 4/6.

HEAVY DUTY SELENIUM RECTIFIERS

12 V. 15 AMPS. F.W. (BRIDGE.) **19/9**

EX. GOVT. SMOOTHING CHOKES

60 mA. 10 h. 400 ohms 3/11. 100 mA. 10 h. 100 ohms 6/9. 150 mA. 10 h. 100 ohms 10/11. 120 mA. 12 h. 100 ohms 9/9. 200 mA. 5-10 h. 100 ohms 11/9. 250 mA. 5 h. 50 ohms 10/9.

R.S.C. A10 30 WATT AMPLIFIER

HIGH FIDELITY ULTRA LINEAR PUSH-PULL OUTPUT

SIX VALVES EF86, EF86, ECC83, 807, 807, GZ34. Tone Control Pre-Amp. stages are incorporated. Sensitivity is extremely high. Only 12 millivolt minimum input is required for full output. **THIS ENSURES THE SUITABILITY OF ANY TYPE 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 associate vol. control is provided so that two separate inputs such as "mike" and gram, etc., can be simultaneously applied for mixing purposes. **AN OUTPUT SOCKET WITH PLUG IS INCLUDED FOR SUPPLY OF 300 v. 20mA. and 6.3 v. 1.5 A. FOR A RADIO FEEDER UNIT.** Price in kit form with easy to follow wiring diagram ONLY **11 Gns.** Carr. 10/-. Or factory built using latest EL34 output valves and with 12 months' guarantee. **14 GNS. TERMS ON ASSEMBLED UNITS, DEPOSIT £2/5/0** and 9 monthly payments of **32/4 (Total 16 GNS.)** Protective cover with handles available for **19/9.**

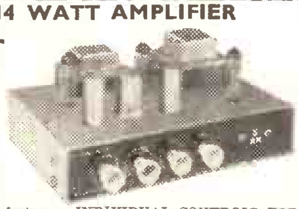
Type 807 output valves are used with High Quality Sectionally Wound output transformer specially designed for Ultra Linear operation. Negative feedback of 20 D.B. in main loop. **CERTIFIED PERFORMANCE FIGURES ARE EQUAL TO MOST EXPENSIVE UNITS AVAILABLE.** Frequency response ±3 D.B. 30-20,000 c/s. Tone Controls +12 D.B. at 50 c/s. +12 D.B. to −6 D.B. at 12,000 c/s., hum and noise 70 D.B. down. Good quality reliable components used. Chassis finish gold hammer. Overall size 12×9×9in. approx. Power consumption 150 watts. For A.C. mains 200-250 v. 50 c/s. Output for 3 and 15 ohms 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 Microphone, Speakers, etc., etc., at keen cash prices or on terms with amplifiers.**

EXPORT ENQUIRIES INVITED.

R.S.C. A11 12-14 WATT AMPLIFIER

HIGH FIDELITY PUSH-PULL ULTRA LINEAR OUTPUT

"BUILT-IN" TONE CONTROL PRE-AMP STAGES

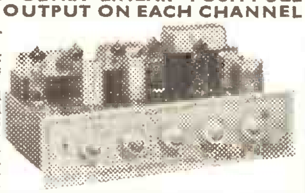


Two input sockets with associated controls allow mixing of "mike" and gram. as in A.10 High sensitivity. Includes 5 valves ECC83, ECC83, EL84, EL84, EZ81. High quality sectionally wound output transformer specially designed for Ultra Linear operation. Reliable small condensers of current manufacture. **INDIVIDUAL CONTROLS FOR BASS AND TREBLE** "Lift" and "Cut." Frequency response ±3 D.B. 30-20,000 c/s. Six negative feedback loops. Hum-level 60 D.B. down. **ONLY** 23 millivolt **INPUT** required for **FULL OUTPUT.** Suitable for use with all makes and types of pick-ups and mikes. 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. 50 c/s. 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 51/6 extra). ONLY **8 Gns.** Carr. 10/-. If required louvred metal covers with 2 carrying handles can be supplied for **18/9.** **TERMS ON ASSEMBLED UNITS, DEPOSIT 33/3 and 9 monthly payments of 24/1. (Total £12/10/-),** S.A.E. for illustrated leaflet of Cabinets, Speakers, "Mikes" etc.

R.S.C. STEREO/20 HIGH FIDELITY AMPLIFIER

Providing 10/14 WATTS ULTRA LINEAR PUSH-PULL OUTPUT ON EACH CHANNEL



Features include:

- ★ Four-position tone and compensating Input Selector switch.
- ★ Stereo/Mono switch so that peak monaural output of 28 watts can be obtained.
- ★ Separate Bass "lift" and cut" and treble "lift" and "cut" controls.
- ★ Neon panel indicator.
- ★ Handsome Perspex Frontplate

Send SAE for illustrated leaflet.

Complete set of parts with point-to-point wiring diagrams and instructions. Carr. 10/-. **13 Gns.** or Factory assembled. tested and supplied with our usual 12 months' guarantee for 18 gns., or DEPOSIT £2/17/0 and nine monthly payments of 39/10. (Total £20/15/6.) SUITABLE for "MIKE," GRAM, RADIO OR TAPE. INTENDED FOR HOME OR STUDIO BUT SUITABLE FOR LARGE HALLS AND CLUBS. Based on a current Mullard design, and employing valves ECC83, ECC83, ECL86, ECL86, ECL86, ECL86, EZ81. Output transformers are high quality sectionally wound to required specification. Output matchings for 3 and 15 ohm speakers on each channel. FREQUENCY RESPONSE ± 2 D.B. 30-20,000 c.p.s. HUM LEVEL 65 D.B. down. SENSITIVITY: 15 millivolts maximum. HARMONIC DISTORTION (each channel) 0.2 per cent. For operation on 200/250 v. A.C. Mains.

AUDIOTRINE HI-FI TAPE RECORDER KIT

Only 3 pairs of soldered joints plus mains.

Build a high quality recorder in the £70 class for only **25½ GNS.** Carr. 17/6. Can be assembled in one hour. S.A.E. for leaflet.

OR DEPOSIT 4 gns. and 12 monthly payments of 42/-. (Total 28 Gns.). Cash price if settled in 3 months. **INCORPORATING THE LATEST MAGNAVOX STUDIO TAPE TRANSCRIPTOR THE AUDIOTRINE HIGH QUALITY TAPE AMPLIFIER. A HIGH FLUX 7×4in. LOUDSPEAKER.** Reel of Best Quality TAPE. Spare Tape Spool, a Portable Cabinet, size approx. 14½ × 15 × 8½in. finished in complementary shades of Rexine and Vynair, Connection diagram for wiring amplifier to transcriptor provided. **FEATURES INCLUDE: ★ 3-SPEEDS ★ FREQUENCY RESPONSE 50-11,000 c.p.s. ★ SWITCHED TONE COMPENSATION FOR EACH SPEED ★ OUTPUT 4 WATTS ★ MAGIC EYE RECORDING LEVEL INDICATOR ★ 3 MOTORS ★ Fast rewind ★ TAPE MEASURING & CALIBRATING DEVICE ★ TAKES FULL 7in. DIAMETER REELS OF TAPE ★ NEGLIGIBLE HUM ★ ENTIRELY EFFECTIVE AUTOMATIC ERASURE.**

R.S.C. TRANSFORMERS

Fully Guaranteed. Interleaved and Impregnated.

MAINS TRANSFORMERS. Primaries 200-250 v. 50 c/s.

MIDGET CLAMPED TYPE 2⅝ x 2⅝ x 2¼ ins.

250 v., 60 mA., 6.3 v., 2a.	13/9
250-0-250 v. 60 mA., 6.3 v. 2a.	14/9

FULLY SHROUDED, UPRIGHT MOUNTING

250-0-250 v. 60 mA., 6.3 v. 2 a. 0-5-6.3 v. 2a. 2½-3-3in.	18/9
250-0-250 v. 100mA., 6.3 v. 4 a., 0-5-6.3 v. 3 a.	29/9
300-0-300 v. 100mA., 6.3 v. 4 a., 0-5-6.3 v. 3 a.	29/9
300-0-300 v. 130 mA., 6.3 v. 4 a. c.t., 6.3 v. 1 a. For Mullard 510 Amplifier	36/9
350-0-350 v. 100 mA., 6.3 v. 4 a., 0-5-6.3 v. 3 a.	29/9
350-0-350 v. 150 mA., 6.3 v., 4 a., 0-5-6.3 v., 3 a.	38/9
425-0-425 v. 200 mA., 6.3 v. 4 a., c.t., 5 v. 3 a.	59/9
425-0-425 v. 200 mA., 6.3 v. 4 a., 6.3 v. 4a., 5 v. 3 a.	63/9
450-0-450 v. 250 mA., 6.3 v. 4 a c.t. 5 v. 3 a.	69/9

TOP SHROUDED DROP-THROUGH TYPE

250-0-250 v. 70 mA., 6.3 v. 2 a., 0-5-6.3 v. 2 a.	17/9
250-0-250 v. 100 mA., 6.3 v. 3.5 a.	19/9
250-0-250 v. 100 mA., 6.3 v. 2 a., 6.3 v. 1 a.	21/9
350-0-350 v. 80 mA., 6.3 v. 2 a. 0-5-6.3 v. 2 a.	21/9
250-0-250 v. 100 mA., 6.3 v. 4 a., 0-5-6.3 v., 3 a.	28/9
300-0-300 v. 100 mA., 6.3 v. 4 a., 0-5-6.3 v. 3 a.	28/9
300-0-300 v. 130 mA., 6.3 v. 4 a., 0-5-6.3 v. 1 a. suitable for Mullard 510 Amplifier	35/9
350-0-350 v. 100 mA., 6.3 v. 4 a., 0-5-6.3 v. 3 a.	28/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 0-5-6.3 v. 3 a.	37/9

Midget clamped type. Primaries 200-250 v.

250-0-250 v. 60 mA., 6.3 v. 2 a., 2×2×2¼in.	13/9
250 v. 60 mA., 6.3 v. 2 a. Size 2×2×2¼in.	12/9

FILAMENT TRANSFORMERS 12 v. 1 a. 7/9

6.3 v. 1.5 a.	5/9	6.3 v. 3 a.	9/9
6.3 v. 2 a.	7/6	6.3 v. 6 a.	17/9
		12 v. 3 a. or 24 v. 1.5 a.	17/9

AUTO (Step UP/Step DOWN) TRANSFORMERS

0-110/120 v-200-230-250 v.

50-80 watts	14/9	250 watts	49/9
150 watts	29/9	500 watts	89/9

CHARGER TRANSFORMERS

0-9-15 v 1½ a.	12/9	0-9-15 v. 5 a.	19/9
0-9-15 v. 2½ a.	14/9	0-9-15 v. 6 a.	23/9
0-9-15 v. 3 a.	16/9	0-9-15 v. 8 a.	28/9

OUTPUT TRANSFORMERS

Standard Pentode 5,000Ω to 3Ω or 7,000Ω to 3Ω	5/9
Push pull 8 watts EL84 to 3Ω or 15Ω	8/9
Push pull 10-12 watts 6V6 to 3Ω or 15Ω	18/9
Push pull 10-12 watts to match 6V6 to 3, 5, 8 or 15	19/9
Push pull EL84 to 3 or 15Ω 10-12 watts	18/9
Push pull Ultra Linear for Mullard 510, etc.	29/6
Push pull 15-18 watts, sectionally wound 6L6, KT66, etc., for 3 or 15Ω	29/9
Push pull 20 watt high-quality sectionally wound, EL34, 6L6, KT66, etc., to 3 or 15Ω fully shrouded	49/9

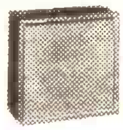
MICROPHONE TRANSFORMERS

120-1 High quality, clamped	8/9

SMOOTHING CHOKES

250 mA., 5 H., 100Ω	11/9	80 mA., 10 H., 350Ω	5/6
150 mA., 7-10H. 250Ω	11/9	60 mA., 10 H., 400Ω	4/11
100mA., 10 H., 200Ω	8/9	1 amp. 0.5Ω L.T. type	6/6

LOUDSPEAKERS IN CABINETS



12in. 10 WATT. Walnut Veneered Cabinet, size 15 × 15 × 8in. approx. High quality 12in. 10 watt 12,000 line speaker, 3 ohms or 15 ohms **£4/19/6.** Carr. 5/6. Or Deposit **11/3** and nine monthly payments **11/3.** (Total **£5/12/6**).

12in. 20 WATT. High Quality, 15,000 line l/speaker 15 ohms in Cabinet, finished as above. Size 18 × 18 × 8in. **£7/19/6.** Carr. 8/6. Or Deposit **17/9** and 9 monthly payments of **17/9.** (Total **£8/17/6.**)

AUDIOTRINE CORNER CONSOLE CABINETS. Strongly made. Beautiful polished walnut veneered finish. Pleasing design.

JUNIOR MODEL. To take up to 8in. speaker. Size approx. 20in. × 11in. × 8in. Only **49/9.**

STANDARD MODEL. To take up to 10in. speaker. Size 27in. × 18in. × 18in. **5** gns. Carr. 7/6.

SENIOR MODELS. To take up to 12in. speaker and with Tweeter cut-out. Size approx. 30in. × 15in. × 15 in. (Recommended for use with Audiotrine speaker system). **8 Gns.** Carr. 7/6., or terms.

W.B. "STENTORIAN" HIGH FIDELITY P.M. SPEAKERS. HF1012. 10 watts rating. Where a really good quality speaker at a low price is required, we highly recommend this unit with an amazing performance. **£4/12/0.** Please state whether 3 ohm or 15 ohm required.

R.S.C. JUNIOR BASS REFLEX CABINET. Designed for above speaker, but suitable for any good quality 8in. or 10in. speaker. Acoustically lined and ported. Polished walnut veneer finish. Size 18in. × 12in. × 10in. Strongly made. Handsome appearance. Ensures superb reproduction for only **£4/7/6.** Deposit **10/9** and 9 mthly pmts. of **10/9.** (Total **£5/7/6.**)

GL3A MINIATURE 3-WATT GRAM. AMPLIFIER. For 200-250 v. 50 c.p.s. A.C. mains. Overall size only 11¾in. × 2¼in. × 2¼in. Fitted Vol. and Tone Control with mains switch. Designed for use with any kind of single player or record changer unit. Output for 2-3 ohm speaker. Only **59/6.**

R.S.C. BATTERY TO MAINS CONVERSION UNITS. Type BM1. An all-dry battery eliminator. Size 5½in. × 4½in. × 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. Complete kit with diagram **39/9,** or ready for use **46/9.**

R.S.C. 4 WATT GRAM. AMPLIFIER KIT.

Complete set of parts to build a good quality compact unit suitable for use with any record playing unit. Mains isolated chassis. Separate Bass and Treble controls. Output for 2-3 ohms speaker. For 200-250 v. A.C. **59/9.**

FULLY DETAILED AND ILLUSTRATED

CATALOGUE

Now 96 big pages. The largest range available in the country. All types of components and equipment at competitive prices. PRICE 2/6 (post paid)

PROVED AND TESTED DESIGNS

FULL AFTER SALES SERVICE AND GUARANTEE

★ CALL IN FOR DEMONSTRATIONS ★

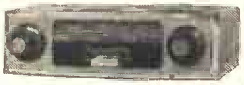
DETAILED LEAFLETS FOR ANY MODEL FREE ON REQUEST

FREE!

New 8 page book with details of over 80 semiconductor projects, Transistors, Scrs, Light Cells, etc., etc. All Items in stock. Get your Free Copy NOW!

★ TWO WAVEBAND ALL TRANSISTOR CAR RADIO TO ASSEMBLE

TOTAL COST TO BUILD **£8.19.6** P.P. 3/6



7 x 4 inch Hi-Flux speaker with car fixing kit and baffle 20/- extra.

- ★ 6-Transistor push-pull superhet design.
- ★ Uses factory assembled panels.
- ★ Permeability geared tuning.
- ★ Double tuned I.F.T.s.
- ★ Size 7 x 4 x 2in. Fits any car.
- ★ Attractive chromed front plate.
- ★ Prebuilt units available separately.
- ★ Full MW/LW tuning, push-button wavechange.
- ★ Highly sensitive selective superhet.

● HIGH PERFORMANCE SUPERHET ●

THREE WAVEBAND TRANSISTOR PORTABLE TO BUILD

TOTAL COST TO BUILD **£8.19.6** P.P 3/6

(All parts sold separately.)

- ★ Short waves (17-50 metres).
- ★ Medium and longwaves.

The ONLY fully tunable 3-waveband portable available to the home constructor.

- ★ Push-button coil pack.
- ★ 1 watt push-pull output.
- ★ Printed circuit geared tuning.
- ★ Car aerial and record sockets.
- ★ Full 3-waveband tuning.
- ★ Size 11 x $7\frac{1}{2}$ x $3\frac{1}{4}$ in.
- ★ Black fabric—chrome fittings.

SENSITIVE SUPERHET DESIGN

★ VHF FM ALL TRANSISTOR TUNER TO BUILD.

TOTAL COST TO BUILD (Complete with front plate). **£6.19.6** P.P 2/6

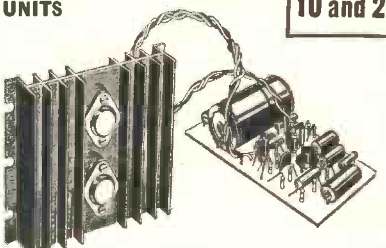
(Gold sprayed metal cabinet assembly 20/- extra.)

- ★ Printed circuit design.
- ★ 5-transistor, 4-diode superhet design.
- ★ Geared tuning 87 to 105 Mc/s, FM.
- ★ R.F. stage and double tuned I.F.T.s.
- ★ Peak audio output up to 1 volt.
- ★ 30mV output for 10μV input, S/N 50 dB.
- ★ Output for 30 to 100 k/ohm impedance.
- ★ 9 volt 9 mA supply.
- ★ Size in cabinet, 4 x $3\frac{1}{2}$ x $2\frac{1}{4}$in.

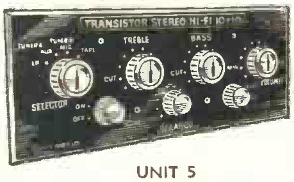
● HIGH FIDELITY SUPERHET TUNER ●

PREBUILT AND TESTED UNITS

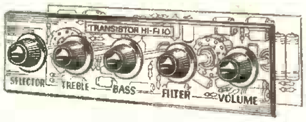
10 and 20 WATT HI-FI AMPLIFIERS



UNITS 1 and 2



UNIT 5



UNIT 3

● **Power Amplifiers**, 10 watts push-pull RMS music power—6 transistor design. Panel size 4 x $2\frac{1}{2}$ x $\frac{3}{4}$in. H/S, 4 x 4 x 1in. 100mV. to 33 k input. Response 40 c/s to 20 kc/s.

★ **Unit 1.** 12/15 ohm O/P. 40 volt supply. PRICE BUILT **£5.19.6** P.P. 2/6

★ **Unit 2.** 3 to 5 ohm output version. 24 volt supply. PRICE BUILT **£5.10.0** P.P. 2/6

★ **Mains Units.** 59/6 to power one amplifier or 69/6 to power two (state 3/5 or 12/15 ohm version.)

● **Preamplifiers.** Mono and stereo versions. 8 inputs, sensitivities $1\frac{1}{2}$ mV. to 300 mV. 1k to 500k. Response 30 c/s. to 20 kc/s. Complete range of controls, battery operated or from mains units.

★ **Mono Full Function** (Unit 3). Size $9\frac{1}{2}$x$2\frac{1}{2}$x2in. PRICE BUILT **£5.10.0** P.P. 2/6

Low noise Hi-Fi Units. (Brown and gold front panel plate 8/6.)

★ **Multi-input** (Unit 4). Simplified version of Unit 3. Size 5 x $2\frac{1}{2}$ x 2in. PRICE BUILT **65/-** P.P. 1/6 Front panel plate 6/6

★ **Stereo Preamplifier** (Unit 5) for use with two of units 1 or 2. Size 9 x $3\frac{1}{4}$ x $1\frac{5}{8}$in. PRICE BUILT **£10.19.6** P.P 3/6 Front panel plate 12/6

● THE FINEST QUALITY HI-FI AT UNBEATABLE PRICES ●

WE STOCK

TRANSISTORS
RECTIFIERS
VALVES
CRYSTALS
MICROPHONES
TEST GEAR
TAPE DECKS
SPEAKERS
MULTI-METERS
RADIO CONTROL
AMPLIFIERS
RECORDERS
TUNERS
RECORD DECKS
TWEETERS
RECEIVERS
GENERATORS
COMPONENTS AND ACCESSORIES

SEE LATEST CATALOGUE

★ MW/LW POCKET SUPERHET RADIO TO BUILD

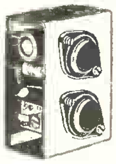
TOTAL COST **85/-** P.P. 2/-

(Battery 2/6. Phone 5/-).

- ★ 6-transistor design.
- ★ Printed circuit.
- ★ Push-pull output.
- ★ "Cleartone" $2\frac{1}{2}$in. speaker fitted.
- ★ Moulded high impact attractive cabinet.
- ★ Size 5 x 3 x $1\frac{1}{4}$in., slow motion tuning.

● AMAZING SENSITIVITY AND SELECTIVITY ●

● 5 WATT AND $1\frac{1}{2}$ WATT PACKAGED AMPLIFIERS



- ★ New design 5 watt unit
- ★ 6-transistor push-pull printed circuit designs.
- ★ For 3 to 5 ohm speakers.
- ★ Size only $2\frac{1}{2}$ x 2 x $1\frac{1}{4}$in.
- ★ 5 watt 12/18 volts, $1\frac{1}{2}$ watt 9/12 volts.
- ★ 7mV. into 1 k/ohm sensitivity.

PRICES BUILT. $1\frac{1}{2}$ watt **65/-** 5 watt **79/6** P.P. 1/6 either type

QUARTZ CRYSTALS

1000 kc/s (1 Mc/s) HC6U Miniature, 25/-
100 kc/s RCA, 3-pin type, 15/-
100 kc/s+1 Mc/s, 3 pin, 10X type, 22/6

TRANSISTORS/RECTIFIERS/SCRS.

Over 400 types from stock. LISTS 1/-.

TRANSISTOR PORTABLE TEST EQUIPMENT

All units size $6\frac{3}{8}$ x $4\frac{5}{8}$ x $2\frac{3}{4}$in.

★ RF generator, 150 kc/s to 350 mc/s in 8 ranges. RF, Mod. RF, AF outputs. **PRICE £9.10** P.P. 2/6

★Resistance / capacitance bridge. **£8.5.** P.P. 2/6.

★ Audio generator 10 c/s—100 kc/s. 4 ranges. **£16.15** P.P.2/6

★ VHF FM TUNER TO ASSEMBLE

- ★ Two pre-built and aligned units plus metal work and panel.
- ★ 88 to 108 Mc/s tuning range.
- ★ Output 100mV. to 100 k/ohm.
- ★ 6-transistor superhet, printed circuit design.
- ★ Size $9\frac{1}{2}$ x $3\frac{1}{2}$ x 4in. ★ S/N 50dB.

TOTAL COST TO BUILD **£12.17.6** P.P 2/6

(All units sold separately.)

★ 2 AND 4 TRACK RECORDERS TO ASSEMBLE

TOTAL COST TO BUILD

● 2-track **£26** P.P 8/6

● 4-track **£30** P.P. 8/6

● Complete range of decks. Amplifiers and pre amps. in stock.

- ★ Collaro Studio decks.
- ★ 6-valve record/play amplifiers.
- ★ Sturdy portable cabinets with speaker.
- ★ Printed circuit, prebuilt units.
- ★ Complete in every detail.

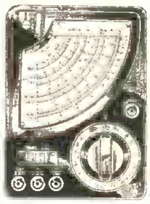
★RECORD AND PLAYBACK SYSTEM★

LET US QUOTE FOR PARTS FOR YOUR CIRCUIT. SEND LIST FOR QUICK REPLY.

TRADE AND EXPORT ENQUIRIES INVITED.

★ MULTI-TEST METERS (Full details in Catalogue).

★ PT34	1 k/ohm per volt	£1	19	6
★ M1	2 ,, ,, ,,	£2	9	6
★ THL33	2 ,, ,, ,,	£3	15	0
★ EP10K	10 ,, ,, ,,	£3	19	6
★ EP20K	20 ,, ,, ,,	£4	19	6
★ TP5S	20 ,, ,, ,,	£5	19	6
★ ITI-2	20 ,, ,, ,,	£4	9	6
★ EP30K	30 ,, ,, ,,	£6	10	0
★ Model 500	30 ,, ,, ,,	£8	17	6
★ EP50K	50 ,, ,, ,,	£8	15	0
★ EP100K	100 ,, ,, ,,	£10	10	0



★ **Model 700.** Professional meter, 20 k/ohm/volt with AC/DC volts, resistance DC and AC current. Size $7\frac{1}{2}$ x $5\frac{3}{4}$ x $3\frac{3}{4}$in.

PRICE **£17.10.0** P.P. 5/-

All types Brand New and guaranteed. (Post and packing 1/6 per meter).

SINCLAIR EQUIPMENT X10 Kit £5/19/6. X10 Built £6/19/6. X20 Kit £7/19/6. X20 Built £9/19/6.

(All Sinclair designs in stock.)

HENRY'S RADIO LTD.

303 EDGWARE ROAD LONDON W2

PADdington 1008/9

Open Mon. to Sat. 9-6. Thurs. 1 p.m.

Open all day Saturday.

HR LTD

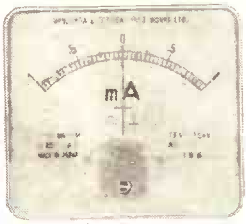
SEW PANEL METERS

MANUFACTURED BY SHINOHARA ELECTRICAL INSTRUMENTS LTD., JAPAN. FAMOUS ALL OVER THE WORLD FOR THE QUALITY, DEPENDABILITY AND ACCURACY OF THEIR INSTRUMENTS.

The comprehensive range below is available ex-stock. Other ranges to special order. Special quotations for quantities.

S.A.E. FOR ILLUSTRATED LEAFLET

CLEAR PLASTIC METERS



Type MR.38P. 1 21/32in. square fronts.

50µA	32/6	750mA	22/6
100µA	29/6	1A D.C.	22/6
200µA	27/6	2A D.C.	22/6
500µA	25/-	5A D.C.	22/6
50-05µA	29/6	3V D.C.	22/6
100-0-100µA	27/6	10V D.C.	22/6
500-0-500µA	22/6	20V D.C.	22/6
1-0-1mA	22/6	50V D.C.	22/6
1mA	22/6	100V D.C.	22/6
2mA	22/6	150V D.C.	22/6
5mA	22/6	300V D.C.	22/6
10mA	22/6	500V D.C.	22/6
20mA	22/6	750 VD.C.	22/6
50mA	22/6	15V A.C.	22/6
100mA	22/6	50V A.C.	22/6
150mA	22/6	150V D.C.	22/6
200mA	22/6	300V A.C.	22/6
300mA	22/6	500V A.C.	22/6
500mA	22/6	'S' Meter 1mA	29/6

Type MR.52P. 2½in. square fronts.

50µA	57/6	100-0-100µA	47/6
100µA	47/6	1mA	32/6
500µA	37/6	5mA	32/6
50-0-50µA	57/6	10mA	32/6

Type MR.52P. 2½in. square fronts (Cont.)

50mA	32/6	300V A.C.	32/6
100 mA	32/6	'S' Meter 1mA	39/6
500 mA	32/6	*1A A.C.	32/6
1A D.C.	32/6	*5A A.C.	32/6
5A D.C.	32/6	*10A A.C.	32/6
20V D.C.	32/6	*20A A.C.	32/6
300V D.C.	32/6	*30A A.C.	32/6

Type MR.85P. 4½in. × 4⅞in. fronts.

50µA	69/6	1 amp. D.C.	45/-
100µA	59/6	5 amp. D.C.	45/-
200µA	55/-	15A D.C.	45/-
500µA	49/6	30A D.C.	45/-
50-0-50µA	69/6	*1A A.C.	45/-
100-0-100µA	59/6	*5A A.C.	45/-
500-0-500µA	49/6	*10A A.C.	45/-
1-01mA	45/-	*20A A.C.	45/-
1mA	45/-	*30A A.C.	45/-
5mA	45 -	20V D.C.	45/-
10mA	45/-	50V D.C.	45/-
		150V A.C.	45/-
50mA	45/-	300V D.C	45/-
100mA	45/-	15V A.C.	45/-
500mA	45/-	300V A.C.	45/-

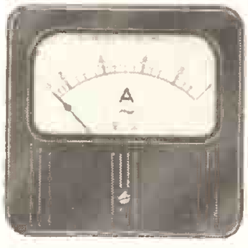
Type MR.65P. 3½in. × 3½in. fronts.

50µA	59/6	50A D.C.	42/6
100µA	49/6	*1A A.C.	35/-
500µA	39/6	*5A A.C.	35/-
50-0-50µA	59/6	*10A A.C.	35/-
100-0-100µA	49/6	*20A A.C.	35/-
VU meter	59/6	*30A A.C.	35/-
1mA	35/-	10V D.C.	35/-
5mA	36/-	20V D.C.	35/-
10mA	35/-	50V D.C.	35/-
50mA	35/-	150V D.C.	35/-
100mA	35/-	300V D.C.	35/-
500mA	35/-	15V A.C.	35/-
1A D.C.	35/-	50V A.C.	35/-
5A D.C.	35/-	150V A.C.	35/-
15A D.C.	35/-	300V A.C.	35/-
30A D.C.	35/-	500V A.C.	35/-

BAKELITE PANEL METERS

Type MR.65. 3½in. square fronts.

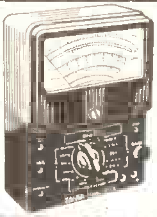
25µA	65/-	30A D.C.	29/6
50µA	42/6	50A D.C.	29/6
100µA	39/6	*1A A.C.	29/6
500µA	35/-	*5A A.C.	29/6
50-0-50µA	42/6	*10A A.C.	29/6
100-0-100µA	39/6	*30A A.C.	29/6
500-0-500µA	35/-	*50A A.C.	29/6
1-0-1mA	29/6	5V D.C.	29/6
50mV	39/6	10V D.C.	29/6
100mV	39/6	20V D.C.	29/6
1mA	29/6	50V D.C.	29/6
5mA	29/6	150V D.C.	29/6
10mA	29/6	300V D.C.	29/6
50mA	29/6	*30V A.C.	29/6
100mA	29/6	*50V A.C.	29/6
500mA	29/6	*150V A.C.	29/6
1A D.C.	29/6	*300V A.C.	29/6
5A D.C.	29/9	300V A.C.	35/-
15A D C.	29/6	VU Meter	49/6



*Moving iron, all others moving coil.

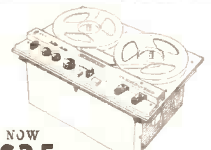
MAGNAVOX 363 TAPE DECKS

New 3 speed tape deck, supersedes old Collaro studio deck. 2 track, £10/10/-. 4 track, £13/10/-. Carr. Paid.



MODEL 370-E MULTIMETER

20,000 Ω/volt D.C.volts. 0/.5/2.5/ 10/50/250/1,000/5,000v. A.C. volts 0/2.5/10/ 50/250/1.000v. D.C. Current 0/50 µA/ 1/10/50/250mA /1/10 amp. A.C. Current 0/250mA/1/ 10 amp. Resistance: 0/5k 500k/5 meg/50 megohm. £12/10/0. P. & P. 3/6.



PROFESSIONAL 4-TRACK STEREO RECORD AND PLAYBACK TAPE DECK

Complete with 4 valve/4 transistor pre-amplifier. Will record and play back ¼ track stereo and ¼ track mono at 7½ or 3¾ I.P.S. Twin meter level indicators. digital counter. Mic gram/tuner inputs. Audio output 500 MW Bias and Erase 80 kc. Response 40-18,000 C.P.S. at 7½; 40-12,000 C.P.S. at 3¾ I.P.S. Motor 4 pole H.D. induction. Tape size up to 7in. 220/240 v. A.C. Size 15in. × 10½in × 6¼in. Line up: 4 × 2SB173. 2 × 12AT7, 1 × 12AU7, 1 × 12BH7. S.A.E. FOR FULL DETAILS. PRICE £35. CARR. 15/-.

NOW £35

G. W. SMITH & CO (RADIO) LTD
3-34 Lisle St., London, W.C.2 ALSO SEE OPPOSITE PAGE

AVOMETERS

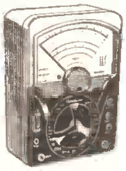
Supplied reconditioned, guaranteed perfect.

MODEL D £8/19/6

Post & Ins. 5/-.

TE-900. 20,000Ω/VOLT GIANT MULTIMETER. 6in. full view meter. 2 colour scale. 0/2.5/10/ 250/1,000/5,000 V. A.C. 0 / .25 / 1 / 2.5 / 10 / 50 / 250/1,000/5,000 V. D.C. 0/50µA/1/10/100/500MA/ 10 amp. D.C. 0/2K/ 200K/20 MEG OHM £13/10/-. P.P. 5/-.

MODEL 500. 30,000 O.P.V. 0 / .5 / 1 / 2.5 / 10 / 25 / 100 / 250/500/1,000 V. D.C. 0/2.5/ 10 / 25 / 100 / 250 / 500 / 1,000 V. A.C. 0/50µA/5/50/ 500mA. 12 amp D.C. 0/60/K6 Meg/60 Meg.Ω £8/17/6. Post Paid.



MODEL TE-12 20.000 O.P.V. 0/0.6/6/30/120/600/ 1,200/3,000/6,000 V D.C. 0/6/30/120/600/1,200 V. A.C. 0/60µA/6/60/600 MA. 0/6K/600K/6 Meg./60 Meg. Ω. 50 PF. ·2MFD. £5/19/6. P. & P. 3/6.

TE-58. DE LUXE 20,000Ω/ VOLT MULTIMETER 0/6/30/120/600/1,200 V, A.C. 0/.6/6/30/120/600/1,200V.D.C. 0/60µA/6/60/600 MA. D.C. 0 / 10K / 100K / 1M / 10 MEG. OHM. 200PF-0.2 MFD. £5/19/6. P.P. 3/6.

TS-76. 20,000 O.P.V. PUSH BUTTON MULTITESTER. Simple operation, D.C. volts up to 1,000 v. A.C. volts up to 1,000 v. Resistance up to 10 megohm. Current up to 250 mA. Decibels −20 to +36 db. £5/5/-. P. & P. 2/-.

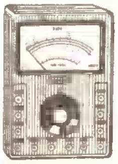
TE-51. NEW 20,000Ω/VOLT MULTIMETER. 0/6/60/120,1,200 V. A.C. 0/3/30/60/300/600/3,000 V. D.C. 0/60µA/12/300 MA. D.C. 0/60K/6 MEG. OHM 85/-. P.P. 2/6.

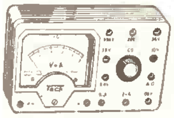
MODEL NH201 30,000 O.P.V. 0/.25/1/10/50/250/ 500/1,000 v. D.C. 0/10/50/ 250/500 v. A.C. 0/50µA/ 10/250 MA. 0/5/K500K/ 5 Meg. Ω 87/6. P. & P. 2/6.

MODEL AR-620 20,000 O.P.V. 0/10/50/250/500/ 1,000 v. A.C. and D.C. 0/500µA/10/250mA. 0/10K /100K/1 Meg.Ω. 250 PF— .02 MFD. 0-500 Henrys. 92/6. P. & P. 2/6.

MODEL ITI-2. 20.000 O.P.V. 0/5/25/250/500/ 2,500 v. D.C. 0/10/50/500/ 1,000 v. A.C. 0/50µA/25/ 250 mA. D.C. 0/60K/6 Meg. Ω. .02-3 MFD. 78/6. P. & P. 2/6.

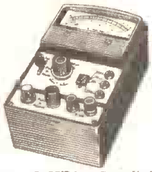
MODEL 250J. 2,000 O.P.V. 0/10/50/500/2,500 V. D.C. 0/10/50/500/2,500 V. A.C. 0/2 Meg. Ω. 0/250 mA. −20 to +36 db. 49/6. P. & P. 2/6.





MODEL PT-... 1,000 O.P.V. 0/10/50/250/ 500/1,000 v. A.C. and D.C. 0/1/100/500 MA. D.C. 0/100 kΩ 39/6. P. & P. 1/6.

MODEL ZQM TRANSISTOR CHECKER



It has the fullest capacity for checking on A, B and Ico. Equally adaptable for checking diodes, etc. Spec.: A: 0.7-0.9967. B: 5-200. Ico: 0-50 microamps, 0-5 mA. Resistance for diode 200Ω −1 MEG. Supplied complete with instructions, battery and leads. £6/19/6. P. & P. 2/6.

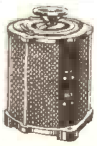
9-TRANSISTOR 2 WAY RADIOS

Super quality. Range up to 5 miles. Complete with all accessories. £25 per pair. Post extra. Also available, 3-TRANSISTOR MODEL. Range up to 1 mile. Complete with all accessories. £9/17/6 per pair. Post extra. (S.A.E. for full details).

MODEL PV-58 VALVE VOLTMETER

11 meg. input. 7 D.C. volt ranges. 1.5-1500 v. 7 A.C. volt ranges 1.5-1500 v. 4,000 Peak to Peak. Resistance .2 ohm to 1,000 megohm Decibels −10db to +65db Supplied brand new with instructions, leads and probe, £12/10/-. P. & P. 3/6.

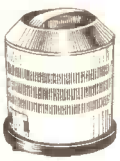
VARIABLE VOLTAGE TRANSFORMERS



Brand New Guaranteed — Fully Shrouded. Input 230 v. 50/60 c/s. Output 0-260 v.

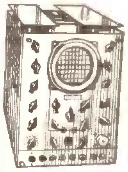
1 amp	£4/10/-	12 amp	£19/10/-
2.5 amp	£5/17/6	20 amp	£32/10/-
5 amp	£9/-/-	2.5 amp. portable, metal case with meter-fuses, etc.	£9/17/6
8 amp	£13/10/-		
10 amp	£17/-/-		

VOLTAGE STABILIZER TRANSFORMERS



Will stabilize your mains voltage. Ideal for TV Receivers and Industrial equipment. Input 80-120 v. and 160-240 v. Constant output 110 v. or 240 v. 250 watts. Brand new guaranteed £10/10/-. Carr. 7/6.

ERSKINE TYPE 13 DOUBLE BEAM OSCILLOSCOPES



Timebase 2 c/s-750 kc/s. Separate Y1 and Y2 amplifiers. Up to 5.5 Mc/s. calib. at 100 kc/s. and 1 Mc/s. 110/230 v. A.C. Guaranteed perfect £27/10/-, carr.20/-.

COSSOR 1035 DOUBLE BEAM OSCILLOSCOPES

4in. C.R.T. Calibrated Y1 Amplifier from 50 mV to 50 v., bandwidth 10 Mc/s. Calibrated Y2 Amplifier from 5 v. to 500 v., bandwidth up to 100 kc/s. Directly calibrated X shift providing time measurement from 15µsec. to 150 millisecs. Supplied in guaranteed perfect working order. £35. Carr. 20/-.

SILICON RECTIFIERS

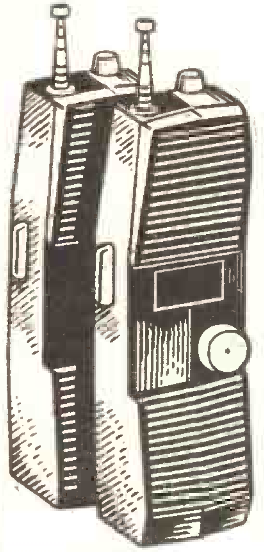
200 v. P.I.V. 200 MA	2/6
400 v. P.I.V. 3 amp	7/6
200 v. P.I.V. 6 amp	5/6
1,000 v. P.I.V. 650 mA	7/6
800 v. P.I.V. 500 mA	5/6
400 v. P.I.V. 500 mA	3/6
70 v. P.I.V. 1 amp	3/6
150 v. P.I.V. 165 mA	1/-

Discount for quantities. Post extra.

MINE DETECTOR No. 4A

Will detect all types of metals. Fully portable. Compact with instructions, 39/6 each. Carr. 10/-. Battery 8/6 extra.

SUPER WALKIE TALKIES



12 TRANSISTORS
1 DIODE
1 THERMISTER

25 gns PAIR

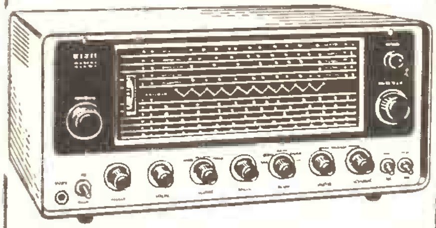
MODEL HE-100. Crystal control ed Transmit and Receive, A.V.C. Squelch, Push Pull Audio Output Range up to 7 miles under favourable conditions. Built-in separate speaker and mike for better modulation — gives increased range. Complete with carrying cases, batteries and telescopic aerials. Size 3in. wide, 9in. high, 2¾in. deep.

9 TRANSISTOR AND 1 DIODE **£22.10.0** Pair
MODEL HE-29C. Crystal control on both Transmit and Receive. Push to talk operation. Earphone for personal listening. Complete with carrying cases, batteries and telescopic aerials. Size 6⅞in. × 29/16in. × 1⅜in.

6 TRANSISTOR AND 2 DIODES **£17.10.0** Pair
MODEL HA-85. Crystal control on both Transmit and Receive. On-off Volume control and push to talk switch. Earphone for personal listening. Complete with carrying cases, batteries and telescopic aerials. Size 6⅞in. × 29/16in. × 1⅜in.

3 TRANSISTOR **£9.17.6** Pair
MODEL HA.70A. Crystal controlled transmit. Super sensitive regenerative circuit. Size 5¼in. × 2¼in. × 1⅜in. Complete with carrying cases, batteries and telescopic aerials.
S.A.E for descriptive leaflet.

LAFAYETTE DE-LUXE COMMUNICATION RECEIVERS



MODEL HA-225. 5 Bands 150-400 kc/s., 1.6-4.8 mc/s. 4.8-14.5 mc/s. 10.5-30 mc/s. 48-54 mc/s. 14 valve Superheterodyne Circuit, Extra RF Stage, Mixer/Osc. for Dual Conversion on 6 meters, 1 RF Plus 2 IF Stages for High Gain Reception on all other Bands, New Product Detector Circuit for Improved SSB Reception, Separate BFO and Q-Multiplier Circuits, Crystal Calibrator, Improved Automatic Noise Limiter. **PRICE 48 gns.**

MODEL HA-230, 4 Bands, 550-1600 kc/s., 1.6-4.8 mc/s., 4.8-14.5 mc/s., 10.5-30 mc/s., 8 valve Superhet Circuit, 1 RF plus 2 IF Stages for High Gain Reception, Easy to Read, Illuminated, Slide Rule Dial, Built in Q Multiplier, Aerial Trimmer for Optimum Performance on All Bands, Calibrated Electrical Bandspread on Amateur Bands. 80 through 10 Metres, 0-100 Logging Scale for SWL's. Effective Automatic Noise Limiter, AVC-MVC Selector on Front Panel, Stable Oscillator and BFO for clear AM CW and SSB Reception, Built-in Edgewise S-Meter. **PRICE 33 gns.**

S.A.E for descriptive leaflet.

GARRARD RECORD PLAYER BARGAINS

GARRARD AUTOSLIM Stereo/Mono EV26 cartridge. **5 GNS.** CARR. 5/-.

BRAND NEW WITH MAKER'S GUARANTEE. BUY NOW AT THESE UNREPEATABLE PRICES!

GARRARD A.T.6. Stereo/Mono HGP73/1 diamond stylus **9 GNS.** CARR. 5/-

SAVE £££'s AT GEES ! ! !

P.A. EQUIPMENT

NEW!

MOBILE 7 in. RE-ENTRANT HORN. 8 ohm, 10 watt. Brand new. Fully guar. 5 gns.

RE-ENTRANT LOUD HAILERS (ex Govt.) Heavy duty 20 watts, all metal, 15 ohms. Dia. 15in., length 15in. (approx.). Brand new and boxed **£10.** Carr. 10/-. Ditto reconditioned **£6/10/-.** Carr. 10/-.

TRANSISTORISED "BULL HORN"
Ideal for Sports meetings, building sites, etc. Range up to 200ft. Simply press trigger switch and talk. Length 11½in. Weight only 2½lb. Complete with batteries and instructions. **£4/15/-.** P. & P. 2/6.

10 inch P.M. HEAVY DUTY SPEAKERS. Complete with line trans., in all steel blue-grey double grilled cabinet, 39/6. Carr. 5/-.

SUPER POWER LOUD HAILER MODEL 2583. Hearing range 1,000ft. Lightweight self-contained portable, with detachable dynamic directional type microphone with cardiod polar diaphragm. Fully transistorised power amplifier. Long battery life. Ideal for all outdoor events. Brand new and guaranteed. **PRICE 22 GNS.**

Complete system comprising Control Unit, 4 Tannoy loud hailers, microphone and headphones, etc. 12 v. D.C. operation. Low battery drain. 8 watts power output. The ideal system for mobile use, outdoor meetings, sports days, factories, garden fetes, etc. Speakers can be spaced effectively over hundreds of yards. Guaranteed Brand New in sealed cartons. Price **£10/10/-.** Carriage 15/-. Speakers available separately **39/6.** P. & P. 5/-.

12V. D.C. TRANSISTOR AMPLIFIER MODEL T.615 15 watts max. output. Jack plug inputs for mike and gram. 15 ohms output. Complete in silver grey hammer finish case with carrying handle. Size 9in. × 6in. × 4½in. **PRICE £15.**
MATCHING MAINS POWER SUPPLY UNIT available. 200/250 v. input. 12 v. D.C. output. **PRICE 6 gns.**

ELPICO 50 WATT TRANSISTOR AMPLIFIER MODEL AC.99. Standard mains input or 24 v. D.C. battery. Two mike inputs. One gram/radio/tape input. 4-15 ohms output. Separate volume controls for each input channel. Separate Bass and Treble controls. Ideal for Guitars, P.A. systems, etc. **PRICE £42.**

BRAND NEW VARIABLE VOLTAGE TRANSFORMERS
230 v. A.C. input, 50/60 cycles, Continuously variable 0-260 v., current. Fully shrouded. 9 amp. **£15,** 5 amp. **£9,** 2½ amp. **£5/17/6.**

FIELD TELEPHONES. Tele "F" mint condition. Complete with batteries ready to use. **£2/10/-.** P. & P. 4/-.

GEE's TAPE!

5in.	Std.	600ft.	8/6
7in.	Std.	1,200ft.	12/6
8¼in.	Std.	1,750ft.	23/6
10in.	Std.	2,400ft.	32/6
5in.	L.P.	900ft.	10/-
5¾in.	L.P.	1,200ft.	12/6
7in.	L.P.	1,800ft.	15/-
4in.	D.P.	600ft.	9/-
5in.	D.P.	1,200ft.	15/-
5¾in.	D.P.	1,800ft.	22/6
7in.	D.P.	2,400ft.	25/-

P. & P. 2/6 per order.

TENSILISED TRIPLE PLAY

3in.	600ft.	15/-
4in.	900ft.	17/6
5in.	1,800ft.	35/-
5¾in.	2,400ft.	45/-
7in.	3,600ft.	58/6

SPARE SPOOLS
3in. 1/-; 3¼in. 1/6; 4in. 1/8; 5in. 2/-; 5¾in. 2/-; 7in. 2/6; 8¼in. 4/6; 10in. 11/-.

SPECIAL DISCOUNT FOR TAPE QUANTITIES. Send S.A.E. for Tape List.

B.S.R. 4 track TAPE DECKS 5¾in. spools, 3¾ i.p.s. Brand new. Guaranteed. **£7/10/-.**

MICROPHONES
BM3 Crystal Stick, 39/6. P. & P. 2/-.
PA.46 Dual Imp. Dynamic **84/-.** P. & P. 2/6.
PA.17 Studio Twin Crystal, **42/-.** P. & P. 2/6.
Telescopic Floor Stand, **55/-.** Carr. 5/-.
Send S.A.E. for Microphone list.

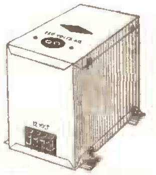
OUTSTANDING BUYS IN QUALITY MULTIMETERS
100,000 o.p.v. Model 370-N. **Price £14/14/-.**
30,000 o.p.v. NH.201. **Price £4/4/0.**
20,000 o.p.v. Model C.T.500. **Price £5/5/-.**
4,000 o.p.v. Model H20. **Price 79/6.**
All complete with test leads, battery, instructions and fully guaranteed.

EVERSHED & VIGNOLES. Wee Megger 100 v., with leather carrying case, good working order, **£6/6/-.**

EVERSHED & VIGNOLES. Series II, 500 v. Megger in good cond. **£18/18/-. EVERSHED & VIGNOLES MEGGER CIRCUIT TESTER** (low reading ohm meter). 2 ranges 0-500, 100-5,000 ohms. Complete with leather case and test leads. As new **£6/6/-.**

E. & V. BRIDGE MEGGER 500 v., with leather case. Perfect working order, **£40.**

NEW! DC/AC CONVERTOR. 12 v. D.C. in 230 v. 50 c/s. out. (45 watts max.) Ideal for Radio, Tape Recorders, Razors. Use in Car, Caravan or Boat. By well-known maker. Size 8in. × 4in. × 5in. Brand new. List price 10½ gns. GEE'S **PRICE 45/-.** P. & P. 5/-.



G.P.O. DESK TELEPHONES. Black, complete with bell, handset, standard auto dial. Guaranteed sound, ex-office equipment. Bargain price **35/-** P. & P. 5/-.

AUTO TRANSFORMERS
Step up, step down, 110/115, 220/230 v.
Fully shrouded terminal block connectors.

150 w.	32/6	500 w.	67/6	1,250 w.	117/6
200 w.	37/6	750 w.	77/6	1,500 w.	139/6
300 w.	47/6	1,000 w.	90/-	1,750 w.	175/-

Carriage 5/- on each type.

G.P.O. STANDARD 19in. HEAVY DUTY EQUIPMENT RACKS
5ft. 6in. Angle Uprights, **£5/10/-.** Carr. 20/-.
6ft. Channel Uprights, **£7/10/-.** Carr. 20/-.
7ft. Channel Uprights, **£8.** Carr. 25/-.
All with Heavy Duty Base.

6-IN. ALARM BELL, G.E.C. L.7502. 3-6 v. D.C. Heavy duty all metal. 29/6. Carr. 5/6.

GEE BROS. RADIO LTD.

15 LITTLE NEWPORT STREET, LONDON, W.C.2. GER. 6794/1453

Open 9-6 Mon. to Fri. 1 p.m. Sat. *Adjoining Leicester Square Tube.*

Samson's (ELECTRONICS LTD)

LONDON'S LARGEST SUPPLIERS OF ELECTRONIC EQUIPMENT
9 & 10 CHAPEL STREET, LONDON, N.W.1
Tel. PAD 7851 AMB 5125

HOURS 9.30-6 OPEN ALL DAY SAT.
SEND 6d. STAMP FOR LIST

HEAVY DUTY L.T. TRANSFORMERS ALWAYS IN STOCK

ALL PRIMARIES 220-240 volts. TERMINAL BLOCK CONNECTIONS
*Denotes Shrouded Types.

No.	Sec. Taps	Amps.	Price	Carr.
1.	25.30.35V.	40	£11 19 6	15/-
2.	25.30.35V.	20	£7 5 0	9/6
3.	25.30.35V.*	10	£4 19 6	6/6
4.	25.30.35V.*	2	£2 2 6	4/-
5.	10.17.18V.*	10	£3 2 6	4/6
6.	24V.	30	£8 10 0	9/6
6a.	24V.*	30	£9 10 0	9/6
7.	20V.	30	£6 15 0	8/6
8.	50V.	15	£7 5 0	8/6
9.	30.40.50V.*	5	£4 15 0	6/6
10.	24.36.48V.*	8	£5 5 0	6/6
11.	17.18.20V.*	20	£5 2 6	6/6
12.	6.12V.	20	£3 12 6	6/6
12a.	6.12V.*	20	£3 19 6	6/6
13.	20V.	20	£4 17 6	8/6
14.	30.32.34.36V.*	5	£2 19 6	6/-
15.	6.12V.	10	£2 5 0	5/-
15a.	6.12V.*	10	£2 12 6	6/-
16.	12V.	5	£1 12 6	4/6
16a.	12V.*	5	£1 17 6	4/6
17.	24V.*	10	£3 9 6	5/6
18.	24V.*	5	£2 5 0	4/6
19.	48.56.60V.*	1	£1 12 6	4/6
20.	12.24.36.48V.*	2	£2 5 0	4/6
21.	6.2V.*	15	£1 19 6	4/6
22.	6.3V. 5A. & 6.3V. 1A	—	15 0	4/6
23.	12.24V.*	1	17 6	3/6
24.	9.15V.	2	17 6	3/6
25.	6.9.15V.	4	£1 5 0	4/6
26.	12.18V.	10	£2 17 6	5/6
26a.	12.18V.*	10	£3 2 6	5/6
27.	12.18V.	20	£4 2 6	6/6
27a.	12.18V.*	20	£4 10 0	6/6
28.	48.56.60V.*	2	£2 9 6	5/-
29.	12V.	50	£6 10 0	8/6
30.	12.24.36.48V.	15	£7 5 0	9/6

MULTI TAPPED L.T. TRANSFORMERS

All Primaries 220-240 v.

Sec. Taps.	Amps.	Price	Carr.
6, 9, 10, 12, 15, 20, 24, 30 v.	2	25/-	4/-
Ditto	4	39/6	4/6
Ditto	5	45/-	5/-
Ditto	8	59/6	7/-

AUTO TRANSFORMERS

240 v.-110 v. Completely Shrouded fitted with 2 Two pin American Sockets or terminal blocks.
Please state which type required.

Wattage	Price	Carr.
1,000	£4 15 0	5/6
500	£3 10 0	5/-
300	£2 7 6	4/-
150	£1 17 6	3/6
80	£1 9 6	3/-

2000 WATTS. Completely enclosed in metal case. Size 10 x 8 x 6 in. Fitted with 2 two pin American sockets, or terminal blocks and carrying handle. £9/15/-. Carr. 7/6.

PARMEKO DOUBLE WOUND TRANSFORMERS

Pri. T 200, 220, 230, 240, 250 v. Sec. T. 90, 100, 110, 120 v. 1,750 watts. Totally enclosed table top connections. Size 8 x 8 x 7½in. Brand new. Fraction of maker's price £11/19/6, Carr. 10/-

ENGLISH ELECTRIC LT TRANSFORMERS

Pri. T. 110, 230, 240, 250 v. Sec. 25 volts, 5 amps. Totally enclosed in metal case. Size 9 x 6 x 6 ins. Designed as a low voltage safety transformer for outside use, 45/-. Carr. 7/6.

IBM DOUBLE WOUND TRANS.

Pri. Tapped 200, 220, 240 v. Sec. Tapped, 110-100 v., 200V.A. 47/6, Carr. 5/-.

LOW RESISTANCE CHOKES to Smooth 40 amps. ½ ohm. Size 7 x 7 x 5½in. 65/-, Carr. 7/6. Other types available. Let us know your requirements.

Send 6d. stamp for latest catalogue. Monthly account orders accepted from industrial companies, hospitals, colleges and schools, etc.

8 banks 50 positions. Arranged to give 4 banks 100 positions. Ex-equipment, in perfect condition.

These Selector Switches have been carefully removed from a modern PBAX (installed new in 1960). **£3/19/6** P.P. 4/6

ALSO MODERN G.P.O. UNISELECTOR SWITCHES. Alternate wiping type. 10 banks 25 positions. Two bridging, eight non-bridging wipers. 75Ω. £2/15/-. P.P. 4/-.

SIEMENS MINIATURE SELECTOR SWITCHES

Latest plug-in type. No. 2200C. 50Ω. 10-way, 3 bank, 3 wiper. Size 3½ x 2½ x 1¼in. Complete with base. Fraction of maker's price, 69/6. P.P. 2/6.

BRAND NEW G.P.O. 3000 TYPE RELAYS

2,000Ω 6 c/o; 1,000Ω 6 c/o; 500Ω 6 c/o; 300Ω 6 c/o. All at 12/6 each. P.P. 1/-. 500Ω 6 c/o., 8 lugged, 15/-. P.P. 1/-. 600 Type 500Ω 4 c/o., 7/6. P.P. 1/-.

MAGNETIC DEVICES MINIATURE RELAYS

Sealed type, 2,000Ω 2 c/o contacts. Size 1 x ¾ x ¼in. Brand new. 10/6. P.P. 1/-.

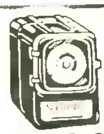
STC SILICON POWER RECTIFIERS RS300 SERIES All type 3 amps. Wire ended. Max. P.I.V. 100 v. 5/-, 200 v. 6/-, 300v. 7/-, 400 v. 8/-, 500 v. 9/-, 600 v. 10/-, 700 v. 11/-, 800 v. 12/-. Post free. Not seconds or surplus. New and guaranteed.

SELENIUM F.W. HIGH CURRENT BRIDGE RECTIFIERS. Supplied brand new and guaranteed. Not to be confused with Government Surplus. All materials used are the latest design and highest grade.

		Price	Carr.
PLATE SIZE 7¾in. SQUARE			
No. 1.	36V. D.C., 36 amps.	£11 15 0	7/6
No. 2.	36V. D.C., 18 ,,	£5 17 6	7/6
No. 3.	24V. D.C., 54 ,,	£11 15 0	7/6
No. 4.	24V. D.C., 36 ,,	£5 19 6	7/6
No. 5.	24V. D.C., 18 ,,	£3 19 6	7/6
No. 6.	12V. D.C., 54 ,,	£5 17 6	7/6
No. 7.	12V. D.C., 36 ,,	£3 19 6	7/6
No. 8.	12V. D.C., 18 ,,	£1 19 6	3/6
No. 9.	12V. D.C., 12 ,,	£1 12 6	3/6
PLATE SIZE 4¼in. SQUARE			
No. 10.	36V. D.C., 8 amps.	£2 19 6	3/6
No. 11.	24V. D.C., 8 ,,	£1 19 6	3/6
No. 12.	12V. D.C., 8 ,,	19 6	2/6

BRAND NEW 30 AMP VENNER TIME SWITCH Type MD 1 BP.

Size 5¼ x 8 x 4½in. deep. 24 hr. dial. One on, one off. Beautifully finished in black bakelite case with perspex window. Packed in original cartons at fraction of maker's price. £3/19/6. P.P. 5/-.
Arms for extra switch 6/- per pair



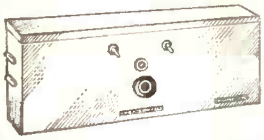
£3-19-6

HEAVY CURRENT TRANSFORMERS

LIMITED NUMBER ONLY

Pri. 230 v. Sec. T 4-6-11 v. 200 a. £10/19/6. Carr. 10/-. Pri. T 200-260 v. and 100-130 v. Sec. T 2, 28, 29, 30, 31 v. 25 a. conservatively rated £6/15/-, Carr. 10/-. Pri. T 210-250 v. and 105-115 v. Sec. 27 v. 60 a. Totally enclosed new in maker's cases, £12/10/-. Carr. 10/-. Pri. T 210-240 v. Sec. 17, 18, 30, 32 v. 8 a. £4/2/6. Carr. 7/6. Pri. 200, 225, 240 v. Sec. T 12, 18, 20, 24, 30, 36 v. 10 a. £5/5/-. Carr. 7/6. Pri. T 220-220, 240 v. Sec. T 50, 70, 73 v. 15 a. £6/19/6. Carr. 10/-. Pri. 200, 220, 240 v. Sec. T 100, 150, 155 v. 22 a. £9/19/6. Carr. 10/-. Pri. 240 v. Sec. T 53.5, 55.2 v. 6 a. C core £3/17/6. Carr. 6/-.

L.T. SUPPLY UNIT TYPE S.E.1



A.C. input 200-240 v. D.C. Output tapped to give 12 or 24 volts 8 amps. continuous rating. Fitted with panel fuse. Mains on/off switch and D.C. output socket. Built in strong metal case. Size 15 x 6 x 6in. An ideal general purpose L.T. supply unit for operating relays. Contactors, battery charging, etc. £9/19/6, carr. 7/6.

L.T. SUPPLY UNIT TYPE S.E.2

A.C. input 200-240 v. D.C. output 50 volts 5 amps. Built-in metal case size 15 x 6 x 6in. Fitted with on/off switch, panel fuse, and output socket, £9/19/6, Carr. 7/6.

BLOCK CAPACITORS

New and Guaranteed. Send for List, over 2,000 in stock.

LATEST ARRIVALS

Maker	Mfd.	D.C.V. wkg.	Temp.	Price	Carr.
TCC	10	750	60°C	10/6	2/6
TCC	10	350	60°C	6/6	2/-
TCC	8	1,500	60°C	17/6	3/-
TCC	8	1,000	60°C	10/6	2/6
TCC	8	750	60°C	8/6	2/-
TCC	8	600	60°C	7/6	2/-
TCC	8	400	71°C	6/6	2/-
TCC	2	2,000	60°C	12/6	2/-
Dubilier	8	600	60°C	7/6	2/-
Dubilier	4	800	71°C	5/6	2/-
Dubilier	1	3,000	100°C	17/6	2/-
Dubilier	0.5	5,000	60°C	17/6	2/-
Dubilier	0.1+0.1	6,000	71°C	8/6	2/-

TELE "F" FIELD TELEPHONES

Generator bell ringing. Operates over a distance of several miles. Perfect condition. £3/19/6 per pair. Batteries 3/- ex. Carr. 7/6.

SINGLE "D3" FIELD TELE CABLE

¼ mile drums. Unused. 45/-. Carr. 5/-.

T.C.C. ELECTROLYTICS

Type CF 3240E 100 mfd. 50 v. wkg. Brand new, 15/- per dozen. P.P. 2/-. Special price for larger quantities.

BRAND NEW D.C.M.C. INSTRUMENTS

2½in. round flush mounting, E. Turner. 0-50 microamps 50/-; 0-200 microamps 30/-; 0-50 milliamps 19/6; 0-10 v. 15/-; 0-20 v. 15/-; 0-200 v. 19/6. American Westinghouse 2¾in. 0-150 milliamps 19/6; 0-100 milliamps 19/6; rectangular 4¾ x 4¼in. 0-50 microamps 99/6. 2½in. square, 0-50 microamp 49/6; 0-100 microamp 39/6; 0-500 microamp 27/6; 0-1 MA 25/-. Please add 2/- P.P. on all meters.

HEAVY DUTY SLIDER RESISTORS

Zenith Double Tube Geared Drive Log Wound. 1.3Ω 15 amps. Continuing to 55Ω 2 amps. Overall size: 22 x 9½ x 7½in. £3/19/6. Carr. 7/6. 4Ω 8 amps. Single Tube. Enclosed, 32/6. P.P. 4/-. 33Ω 1.25 amps. S. Tube Gear Drive, 25/-, P.P. 3/-. 1Ω 12 amps. 12/6, P.P. 2/6. Ganged Twin Rheostats. 6in. dia. 200Ω 1.2 amps. each. Complete with Fixing Frame and Control Knob, 75/-. Carr. 5/-. Many other types available. Let us know your requirements.

G.P.O. HIGH SPEED COUNTERS

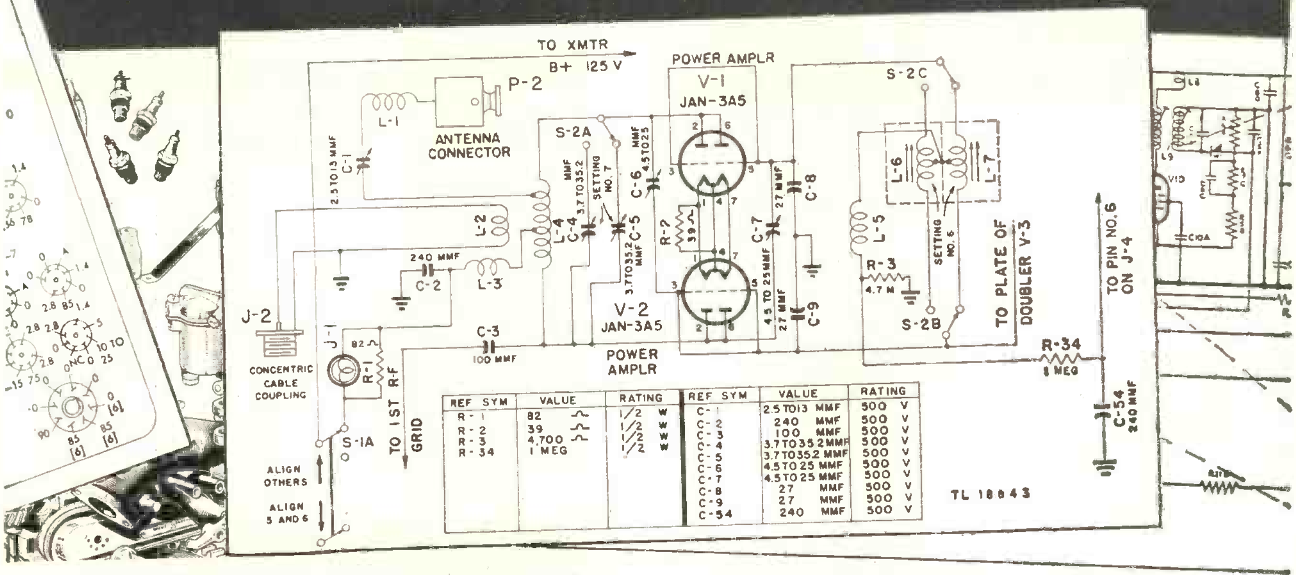
Latest Design Type 1000 4.1Ω 316 v. D.C. Type 100 a. 500Ω 18.24 v. D.C. either type 15/-, P.P. 1/6.

A.C. ELECTRIC CHECK METERS

220-240 v. 40 amps. by Sangamo Weston Ltd., in perfect condition, 35/-, P.P. 4/-. Chamberlain & Hookham Ltd. 25 amp. 27/6. P.P. 4/-.

WW—138 FOR FURTHER DETAILS.

FOR EXACT PERMANENT COPIES FROM ORIGINALS IN ANY COLOUR...



The PACER STAR is unequalled for performance or price. Technical Drawing Offices find the PACER STAR invaluable for producing top quality copies of Drawings, Plans, Circuits, Tables—everything in fact, including ball point, carbons and anything printed or drawn in colour. You get a standard of copying only associated until now with machines costing twice as much. Exact permanent copies of originals up to 9″ wide and any length can be made in seconds. Originals do not come into contact with the fluid and therefore cannot be spoilt. Superbly engineered to an outstanding design, the PACER STAR is compact and lightweight taking up a minimum of desk space. Controls are simple and no special skills are needed and it uses standard materials available at all large Stationers. Supplied complete with full instructions, plastic dust cover, initial supply of paper and fluid.

THE Pacer star PHOTOCOPIER at just

19 GNS

INCLUDING PAPER FOR 25 COPIES AND SACHET OF PROCESS FLUID

TERMS AVAILABLE: £5.12.6 deposit and 3 monthly payments of £5. (Total £20.12.6).

APPROVED ACCOUNTS NETT 30 DAYS
PERSONAL CALLERS WELCOME

SPECIAL TRIAL OFFER
Send deposit or full cash price for 10 days' trial. Your money refunded if not delighted (less £1.1.0. to cover cost of paper and fluid.)

P. & P. 10/6d. (Not refundable)

PLEASE SEND ME THE PACER STAR ON 10 DAYS' TRIAL.

I enclose £.. as Deposit/Cash plus 10/6d. P. & P.

NAME.. Tick here for free literature

ADDRESS..

.... W.W.I ☐

POST TO: C. & C. PHOTOCOPIERS, 2 AND 4 EARLHAM STREET CAMBRIDGE CIRCUS, LONDON, W.C.2. Tel: TEMple Bar 1189

LASKY'S RADIO

For The Finest Value a

THE HOME OF HI-FIDELITY

COMPLETE MONO/STEREO SYSTEMS TO YOUR SPECIFICATION AT LASKY'S SUPER PRIVILEGE PARCEL PRICES

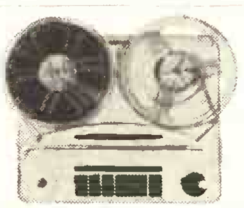
TAPE RECORDERS

ELIZABETHAN LZ 27 PORTABLE TAPE RECORDER

Special Bargain Offer—brand new, unused and fully guaranteed. Brief spec.: 2 speeds—7½ and 3¾ i.p.s.; 2 track; 3½ watt output; inputs for mic. and radio; outputs for ext. speaker and additional amp. or monitor; built in 7 × 4 speaker; tape position and record level indicators; fast forward and rewind. Volume and tone controls also superimpose facilities. Takes 7in. spools. For 200/250 v. A.C. mains. Attractively styled cabinet with carrying handle and detachable lid, size: 16 × 13 × 7in. Comp. with crystal mic. tape and empty spool. **MAKERS LIST PRICE 27 gns.**

LASKY'S PRICE 18 GNS. Carriage and Packing 10/-.

COLLARO STUDIO TAPE DECKS



3 speed model—1⅞, 3¾ and 7½ i.p.s., available with either ½ track or ¼ track heads. Fitted with 3 motors; pause control and tape position indicator. Fast forward and rewind. Deck size: 12¾in. × 10½in. × 4in. For use on 110-125 v., 50 or 60 c.p.s. mains but by the simple addition of a step-down auto transformer these decks can be operated direct from normal 200-250 v. A.C. mains. State whether 50 or 60 c.p.s. model required when ordering (note: U.K. mains is normally 50 c.p.s.) Brand new and used.

Suitable Mains auto transformer 15/6 if ordered with deck. (List 19/6). Carriage and Packing 7/6 extra.

LASKY'S PRICE ½ track model **£6.19.6**
LASKY'S PRICE ¼ track model **£10.10.0**

Standard model for 200/250 v. operation available from stock with ½ track heads **£10/10/-**; ¼ track **£13/19/6.** Carriage and Packing 7/6.

COMPLETE SYSTEMS

A **Lasky's "Privilege Parcel"** allows you to purchase the complete Audio System of your choice at a worth-while cash saving. We shall be pleased to quote our "Privilege Parcel" Prices for any selection of equipment of your own choice. Send us details of your requirements. **H.P. Terms can be arranged on Privilege Parcels.**

CUSTOM BUILT HI-FIDELITY FURNITURE

We will be happy to assemble your choice of Hi-Fi equipment in any cabinet or enclosure to suit your requirements from our wide range of designs by Record Housing, Fisher, Rowland-West etc. See and hear the wonderful "Group 4" system by Record Housing. Catalogues FREE on request.

RECORD PLAYERS

4-SPEED AUTO-CHANGERS

B.S.R. AUTOCHANGERS AT LOWEST EVER PRICES!

All brand new and fully guaranteed—complete with cartridge and stylus.

UA16 4-speed mains model	£4 19 6
UA16 9v. battery model	£5 19 6
UA20 4-speed mains model	£5 19 6

Add 5/- Post on each.

GARRARD

Auto-Slim Mono	£6 10 0	3000LM with stereo cartridge	£9 19 6
Auto-Slim Stereo	£7 10 0	SP25 less cartridge	£12 11 2
Auto-Slim Mono Plug-in Head	£7 7 0	AT60 with GP91	£13 14 1
Auto-Slim De Luxe Mono AT6	£9 19 6	A70 less cartridge	£22 11 1
Auto-Slim De Luxe Stereo AT6	£10 19 6	A50 less cartridge	£9 14 6
AT5P, Mono	£10 8 2	A1000 with GC8 cartridge	£8 10 0
AT5P, Stereo	£11 5 11	A2000 with GC8 cartridge	£9 8 8

Postage on all above 5/-.

TRANSCRIPTION MOTORS

GARRARD 4HF, ster. or mon.	£16 19 6
GARRARD 401	£32 10 0
GARRARD Lab. 80, Mono	£28 17 8
GARRARD Lab. 80, Stereo	£29 15 5
GARRARD 301 (Strobe)	£25 6 4
GARRARD Lab A Mono/Ster.	£14 19 6
GARRARD Lab A on plinth	£15 19 6
PHILIPS AG/1016	£12 12 0
BRAUN PC4L Stereo	£12 9 6
CONNOISSEUR	
Craftsman II	£17 2 11
Craftsman III	£22 19 6
Model B	£25 4 0
LENCO GL58	£17 1 9
LENCO G88	£18 18 5
LENCO GL70	£27 9 4
THORENS 135	£35 8 4
THORENS TD124	£38 7 4

SINGLE PLAYERS

Auto start and stop. With pick-up and crystal cartridge.

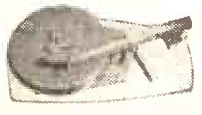
GARRARD SRP10 latest model single player with G.C.8. £5 9 11

COLLARO JUNIOR 4-speed motor and pick-up 69/6

6 volt battery version, 4-speed with pick-up 69/6

All other current models available. Postage on all above 5/- extra.

GREENCOAT RECORD PLAYER



45 r.p.m. 6 v. Batt. operated. Complete with pick-up fitted crystal cartridge. Size only 7½ × 6in. Fitted auto. stop and start. New and perfect. **49/6** Post 2/6.

NOW IN STOCK—2 speed model for 33⅓ and 45 r.p.m. (*As illustrated*) **59/6** Post 2/6.

DEMONSTRATION STUDIOS

VISIT OUR NEWEST BRANCH NOW OPEN AT:

42 TOTTENHAM COURT ROAD, LONDON, W.1.

Tel: LANgham 2573

This branch is devoted exclusively to quality High Fidelity equipment—Tape Recorders, Record Reproducers, Radios, Tuners, etc. Custom built installations provide balanced comparisons of the best in Hi-Fi in ideal surroundings. Open all day Thursday, early closing Saturday.

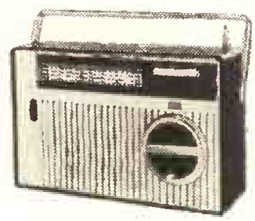
Visit our other spacious showrooms at 33 Tottenham Court Road, 207 Edgware Road or 152-3 Fleet Street, whichever is most convenient. In our Demonstration Studios you can see, examine, hear and compare the very latest products in the realm of high-fidelity reproduction by all the well-known makes including:

AKAI	G.E.C.	LOWTHER	SOUND
ARMSTRONG	GOLDRING	LUSTRAPHONE	STELLA
BRENELL	GOODMANS	ORTOFON	STUZZI
CHAPMAN	GRUNDIG	PAMPHONIC	TANDBERG
COLLARO	HARTING	PHILIPS	TANNOY
CONNOISSEUR	H.M.V.	QUAD	TELEFUNKEN
COSSOR	JASON	RADFORD	THORENS
DULCI	KORTING	RESLO	TRUVOX
E.A.R.	LEAK	REVOX	VORTEXION
ELIZABETHAN	LENCO	ROGERS	W.B.
FERROGRAPH	LINEAR	SIMON	WEARITE
FI-CHORD	LORENZ	S.M.E.	WHARFEDALE
GARRARD			

If you cannot pay us a visit please send us details of your choice of equipment and we shall be pleased to quote. See Complete Systems. "Purchase tax-free Plan" for overseas visitors. H.P. Terms available.

TRANSISTOR PORTABLES

THE SKYROVER AND SKYROVER DE LUXE



GENERAL SPECIFICATION

7 transistor plus 2 diode superhet. 6 waveband portable receiver.

The SKYROVER and SKYROVER DE LUXE cover the full Medium Waveband and Short Waveband 31-49M., and also 4 separate switched band-spread ranges, 13M., 16M., 19M., and 25M., with Band Spread Tuning for accurate Station Selection. The coil pack, and tuning heart is completely factory assembled, wired and tested. The remaining assembly can be completed in under three hours from our easy to follow, stage by stage instructions. Superhet. 470 Kc/s. All Mullard Transistors and Diode. Uses 4 U2 batteries. 5in. Ceramic Magnet P.M. Speaker. Easy to read Dial Scale. 500 MW Output. Telescopic Aerial and Ferrite Rod Aerial.

NEW! SKYROVER MK. III (Illustrated). **Now supplied with redesigned plastic cabinet, finished in black and grey with chrome trim, edgewise controls.** Controls: Waveband Selector, Volume Control with on/off switch, Tuning Control. In plastic cabinet, size 10 × 6½ × 3⅜in. with metal trim and carrying handle.

Can now be built for **£8.19.6**	Post 5/- extra.	**H.P. Terms: 27/- deposit and 11 monthly payments of 15/9.**	**Total H.P.P. £10/-/3.**

The SKYROVER De Luxe Tone Circuit is incorporated, with separate Tone Control in addition to Volume Control, Tuning Control and Waveband Selector. In a wood cabinet, size 11½ × 6½ × 3in., covered with a washable material, with plastic trim and carrying handle. **Also car aerial socket fitted.**

Can now be built for **£10.19.6**	Post 5/- extra.	**H.P. Terms: 33/- deposit and 11 monthly payments of 19/2.**	**Total H.P.P. £12/3/10.**

Data for each receiver: 2/6 extra. Refunded if you purchase the parcel. **Four U2 batteries** 3/4 extra. All components available separately.

★ LONG WAVEBAND COVERAGE IS NOW AVAILABLE FOR THE SKYROVER & SKYROVER DE LUXE A simple additional circuit provides coverage of the 1100/1950M band (including 1500M. Light programme). This is in addition to all existing Medium and Short wavebands. All necessary components with construction data. Only **10/-** extra. Post Free.

This conversion is suitable for Skyrover and Skyrover De Luxe receivers already constructed.

THE 'REALISTIC' SEVEN

Fully tunable over long and medium wavebands. Uses 7 Mullard Transistors, plus Diode OA70. STAR features: ★ 7 Transistor Superhet. ★ 350 Milliwatt output 4in. high flux speaker. ★ All components mounted on a single printed circuit board, size 5¼ × 5½in., in one complete assembly. ★ Plastic cabinet, with carrying handle, size 7 × 10 × 3¼in. in blue grey. ★ Easy to read dial. ★ External socket for car aerial. ★ I.F.-frequency 470 Kc/s. ★ Ferrite rod internal aerial. ★ Operates from PP9 or similar battery. ★ Full comprehensive data supplied with each receiver. ★ All coils and I.F.s, etc., fully wound ready for immediate assembly. An outstanding Receiver.

Can be built for **£5.19.6** Post 4/6.

REALISTIC SEVEN De Luxe Same specification as standard model—PLUS A SUPERIOR WOOD CABINET covered in washable material, with chrome trim and carrying handle. Also full vision circular dial. **ONLY £1 EXTRA.**

Both models: Battery 3/9 extra. (All components available separately). Data and instructions separately 2/6, refunded if you purchase parcel.

LASKY'S RADIO FOR FINEST VALUE and COURTEOUS SERVICE!

WW—140 FOR FURTHER DETAILS.

Service in Great Britain

CONSTRUCTORS BARGAINS

THE WIDEST RANGE AVAILABLE TODAY FOR HOME CONSTRUCTION OR READY BUILT TO HIGHEST STANDARDS

LASKY'S RADIO

READY BUILT BARGAINS

TRANSISTOR POCKET RADIOS

Ideal Gifts—all supplied complete with personal earpiece, battery and carrying case. Fully guaranteed—ready to use. POST FREE.

BOY'S 2 TRANSISTOR In attractive plastic case. Size ony 4in. × 2¼in. × 1in. Fitted 2¼in. speaker. Socket for personal earpiece. Uses PP3 battery. Tunable over full medium waveband. **LASKY'S PRICE 39/6**

BOY'S 4 TRANSISTOR MODEL LASKY'S PRICE 45/-

6 TRANSISTOR MODEL

Fully built in plastic case, 4in. × 2½in. × 1in. with 2½in. speaker. Uses single PP3 type battery Tunable over full medium waveband. **LASKY'S PRICE 59/6**

2 Waveband (Long and Medium) Model Size 5 × 3½ × 1½in. cream/black plastic case. Incl. earpiece & carrying case. **LASKY'S PRICE 89/6**

TEST METER ADAPTOR

Type PE 220—this is a fully transistorised device which enables any 50 microamp D.C. Multimeter to be used in place of a valve volt meter. On the 1 v. range an impedance of 1 megohm is offered which increases on the 1,000 v. range to 100 megohms. 7 ranges: 1 to 1,000 v. Designed for immediate connection to Avo 8 and similar size meters but quite suitable for use with any other 50 microamp meter. Size 6 × 6 × 5in. New and boxed. List price 7 Gns.

LASKY'S PRICE 39/6 Post and Packing 2/6. Set of batteries 7/5 extra.

CONSTRUCTORS BARGAINS

GORLER UT 340 FM/VHF TUNING HEART

Permeability tuned—covering 87 to 108 Mc/s. Designed for use with one ECC 85 valve. Built in cast metal case, size 3 × 2½ × 1½in. Circuit supplied.

LASKY'S PRICE 19/11 Post and Packing 2/-. ECC 85 valve 9/- extra.

HI-FI TAPE RECORDER HEADS

High Imp. Play. Low imp. Record/erase.

Upper or lower track. State track required	LASKY'S PRICE	29/6.
MARRIOTT "X" Type ½-track heads	LASKY'S PRICE	4 GNS. pair.
½-track heads Record/Play and Erase	LASKY'S PRICE	59/6 pair.
MICHIGAN ½-track heads	LASKY'S PRICE	5 GNS. pair.
BOGEN ½-track heads	LASKY'S PRICE	7 GNS. pair.

TRANSISTORS

ALL BRAND NEW AND GUARANTEED

GET 81, GET 85, GET 86 2/6; 837A, 874P 3/6; OC45, OC71, OC81D 4/6; OC44, OC70, OC76, OC81 (match pair 10/6) 5/6; AF117, OC75, OC200 6/6; OC42, OC43, OC73, OC82D 7/6; OC201, OC204 15/-; OC205, OC206 19/6; OC28 24/6.

TRANSFILTERS

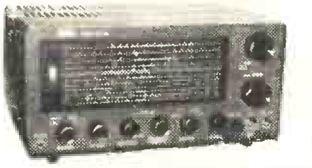
By BRUSH CRYSTAL CO. Available from stock.

TO—01B 465 kc/s. ± 2 kc/s.
TO—01D 470 kc/s. ± 2 kc/s.
TO—02B 465 kc/s. ± 1 kc/s.
TO—02D 470 kc/s. ± 1 kc/s.
TF—01B 465 kc/s. ± 2 kc/s.
TF—01D 470 kc/s. ± 2 kc/s.

7/6 EACH Post 6d.

SEND FOR OUR LATEST BARGAIN BULLETIN. 20 foolscap pages. Hundreds of Bargains for the "ham" and service man. PRICE 6d. POST FREE.

COMMUNICATION RECEIVERS



MODEL KT 320 KIT

Supplied in sub-assemblies for easy building. Covers range from 540 Kc/s to 30 Mc/s. Ham Band is provided with a scale for direct reading and can also be band spread. 9 valves. Facilities: A.N.L., A.V.C. and M.V.C. Q Multiplier also serves as B.F.O. H.F. stage and two I.F. stages ensure high sensitivity and selectivity (all coils and I.F.s are supplied pre-aligned). 2 Aerial Sockets. Stand-by position for use with a transmitter S meter fitted. 200-250 v. A.C. mains. Steel cabinet, grey crackle finish. Size 15 × 8 × 10in. Dial 12 × 4in. All parts new and fully guaranteed. Complete with full construction data and operating manual.

LASKY'S PRICE 25 GNS. POST FREE. Also available ready built and tested 33 gns. H.P. Terms Available.

MODEL HE40

Covers medium wave band and 1.6-4.4 Mc/s., 4.5-11.0 Mc/s 11.0-30.0 Mc/s. in switched band spread ranges. Controls B.F.O. Sensitivity, A.N.L. Receiver—Stand-by Switch, Tone Switch, S-Meter. For 200/250 v. A.C. 4 valves and metal rectifier. Size 13½ × 8¼ × 5½in. Full instruction manual. No Kits available.

LASKY'S PRICE 19 GNS. H.P. Terms £4 dep. and 11 months at £1/12/-. Total H.P.P. £21/12/-. Carr. & Pack. 10/-.

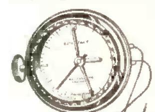
MODEL HE80

14-valves. Freq. range 540 Kc/s.—30 Mc/s. and 144-146 Mc/s. Dual conversion on 2 metres, with extra R.F. stage. B.F.O. and Q-multiplier circuits. Improved A.N.L. and voltage regulated powerpack. "S" meter. Steel case 17 × 7½ × 10in. For 200/250 v. A.C. mains. Brand new with full instruction manual. No kits available.

LASKY'S PRICE 59 GNS. H.P. Terms £12/19/- dep. and 11 mths. at £4/18/-. Total H.P.P. £66/17/-. Carr. & Pack. FREE

SPECIAL INTEREST ITEMS!

ROTOCONTACT MINIATURE CLOCK/TIME SWITCH



This is a Swiss made clock only 1¾" in diameter by ½" deep, incorporating a pair of contacts which will close at any time preselected by the user. Fully variable 12 hour delay. The clock has a normal 24 hour spring movement with standard dial. Used by famous British manufacturer in transistor radio-alarm. Dozens of uses with all transistorised low voltage equipment. New and perfect.

LASKY'S PRICE 21/- Post 1/6.

SINCLAIR SUPER MINIATURES IN STOCK

THE MICRO-6 Miniature radio, only 1 4/5 × 1 3/10 × ½in. CAN BE BUILT FOR 59/6.
THE SLIMLINE 2-transistor pocket radio only 2¾ × 1¾ × 1⅜in. CAN BE BUILT FOR 49/6
THE NEW X20 20 watts P.W.M. amplifier and pre-amplifier. KIT PRICE £7/19/6.
AVAILABLE READY BUILT & TESTED £9/19/6.
3 pots. for vol., bass and treble, 7/6 the 3 extra. Mains power pack, if required, £4 19 6.
THE X10 10 watt power amplifier with integrated pre-amp. KIT PRICE £5/19/6.
AVAILABLE READY BUILT & TESTED, £6/19/6.
3 pots for vol., bass and treble, 7/6 the 3 extra. Mains power pack, if required, 54/-.

INTERNATIONAL TAPE

Famous American Brand—Fully Guaranteed at record low prices. In sealed cartons.

3in.	Message tape, 150ft.	3/6
3in.	Message tape, 225ft.	4/11
3in.	Message Tape, 300ft.	7/6
3¼in.	Triple play, 600ft. Mylar base	15/-
4in.	Triple play, 900ft. Mylar base	17/6
5in.	Double play, 1,200ft. Mylar base	15/-
5in.	Long play, 900ft. Acetate base	10/-
5in.	Standard play, 600ft. P.V.C. base	8/6
5in.	Triple play, 1,800ft. Mylar base	35/-
5¾in.	Double play, 1,800ft. Mylar base	22/6
5¾in.	Long play, 1,200ft. Acetate base	12/6
5¾in.	Standard play, 850ft. P.V.C. base	11/6
5¾in.	Triple play, 2,400ft. Mylar base	45/-
7in.	Standard play, 1,200ft. Acetate base	10/-
7in.	Standard play, 1,200ft. Mylar base	12/6
7in.	Long play, 1,800ft. Mylar base	19/6
7in.	Double play, 2,400ft. Mylar base	25/-
7in.	Long play, 1,800ft. Acetate base	15/-
7in.	Triple play, 3,600ft. Mylar base	58/6

Post 1/- extra per reel; 4 reels and over Post Free.

TELEPHONE AMPLIFIER

Powerfully amplifies the incoming call. Fully transistorised. Pick-up suction fixed to phone. Battery-operated. Fitted with on/off switch and vol. control. Size 4½ × 3 × 1¼in. Complete with PP3 battery. **LASKY'S PRICE 69/6** Post 2/6.

U.H.F. TUNERS

Limited quantity only. Complete with P.C.88 and P.C.86 valves. Fully variable tuning capacitor etc. British manufacture. New and unused. Size 4½in. × 5½in. × 1¾in. We regret no circuit or data available. Knobs included.

LASKY'S PRICE 79/6 Post 2/6.

EXPORT MODEL—TV OFFER

625 line T.V. chassis (Export Model). For 200-250 v. A.C./D.C. mains. Fitted with Band I-III turret tuner. Fully loaded with 12 sets of coils for all CCIR channels in these band F/M sound. Made by famous British manufacturer. 15 Mullard valves. Electrostatic focus and deflection. Will take 17in., 19in., 21in. or 23in. CRT. All controls fitted. Supplied new and unused with all valves. 7in. × 4in. speaker and 17in. CRT (less cabinet).

LASKY'S PRICE £25 Carr. & packing FREE to any part of the World. (Tube sent at buyer's risk.) An allowance of £3 will be made if the CRT is not required. Circuit data included FREE.

CRYSTAL PICK-UP CARTRIDGES

LOWEST PRICES EVER!

All Complete with Styli L.P. and Standard, fully guaranteed. Standard Fitting will fit most P.U. Arms and Heads. Postage 1/- extra each.

Acos G.P.59	14/-
Acos G.P.65/3	15/-
Acos G.P.65/1	17/-
Acos G.P.67/1	14/-
STEREO Acostereo 73/1, with 2 sapphires	25/-
Acostereo 73/2, with diamond LP/Stereo and sapphire Std.	29/6
Ronette Stereo O.V. Turnover with 2 sapphires	25/-
Ronette Stereo type 105 and 106 with 2 sapphires	25/-
Ronette Stereo type 105 and 106 with diamond LP/Stereo and sapphire Std.	35/-

AND EVEN LOWER PRICES

Save money! Some of these cartridges are cheaper than styli

C.T.1 Mono, 2 sapphires	4/11
Collaro Type C, 2 sapphires, stereo	15/-
Collel SC1 Diamond LP, stereo	17/6
Sonotone 8T, stereo	19/10
Sonotone 2TA, mono	15/-

Postage 1/- extra each.

TAPE POSITION INDICATOR

Open type—as used by most makers. With re-set knob **3 DIGIT 7/6. 4 DIGIT 10/6.** Post 9d. on each

207 EDGWARE ROAD, W.2. Few yards from Praed Street. PADdington 3271/2 Open all day Saturday. Close 1 p.m. Thursday.

ELECTRONICS (FLEET ST.) LTD. **152/3 FLEET STREET, E.C.4.** Near "Daily Express" Building. FLEet St. 2833. Open all day Thursday. Close 1 p.m. Saturday.

33 TOTTENHAM COURT ROAD, W.1. 2 mins. Oxford Street. Nearest Station, Goodge Street. MUSeum 2605 Open all day Saturday. Close 1 p.m. Thursday.

PLEASE ADDRESS ALL MAIL ORDERS TO OUR HEAD OFFICE:—207 EDGWARE ROAD, W.2.

LASKY'S FOR ALL TEST GEAR & TECHNICAL ADVICE

Z. & I. AERO SERVICES LTD.

Head Office: 44a Westbourne Grove, London, W.2

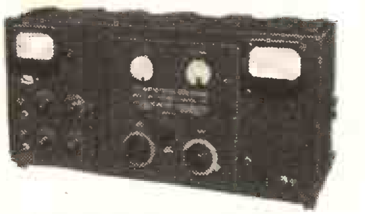
Tel.: PARK 5641/2/3 Cables: ZAERO, LONDON

A.R.B. Approved for inspection and release of electronic valves, tubes, klystrons, etc.

RETAIL BRANCH (personal callers only): 85 TOTTENHAM COURT ROAD, W.2. Tel: LANgham 8403

Please send all enquiries, correspondence and Mail orders to Head Office

"MEASUREMENTS CORPORATION" TYPE 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 10,000 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.

MARCONI FT934 DEVIATION TEST SET

Fundamental frequency range 2.5-100 Mc/s. basic; range can be extended to 500 Mc/s. by using harmonics. Deviation range, 0-5, 0-25 and 0-75 kc/s. in the modulation range of 50 c/s. to 15 kc/s. Sensitivity better than 55 mV. Power supplies 100-150 and 200-250 V. A.C. Price, fully overhauled and guaranteed £85 0 0

TRANSISTOR TESTER MODEL AT-1

For P-N-P and N-P-N Transistors.
Measures Ico and diode reverse current up to 50µA for low power transistors and up to 1 mA for power transistors. B from 2 to 500 at 1 mA. for low power and 5 mA. for power transistors. Powered by dry cells. £10/10/-, p.p. 5/6.

UHF CRYSTAL CONTROLLED HETERODYNE FREQUENCY METERS

TS174 (T-74) 20-280 mc/s. £140
TS175 (T-75) 80-1,000 mc/s. £150
Mains Power Supply Unit £10/10/-

AVOMETER MODEL 7

Fully tested in perfect condition and guaranteed. £11 10 0
Set of leads £1 0 0
Packing and carriage 15/-.

POCKET MULTIMETERS TYPE U-1

Sensitivity 1,000Ω/V. D.C. and A.C. voltage ranges 0-10-50-200-500-1,000V. D.C. current ranges: 0-100-500 mA. Resistance ranges 2,000Ω-200,000Ω. Brand new. £2/2/-. P.P. 7/6.

VARIABLE AUTOTRANSFORMERS

230 v. A.C. input. Output adjustable from 0 to 260 v. Type 01 (Philips) Skeleton Type.

i.e. without housing, 2 amps.	£3 15 0	P.P. 5/-
Type B2, 2.5 A. max.	£5 19 6	P.P. 7/6
Type SB5, 5 A. max.	£9 0 0	P.P. 10/-
Type SB10, 10 A. max.	£18 5 0	P.P. 12/6
Type SB20, 20 A. max.	£32 10 0	P.P. 15/-

POWER UNITS

TYPE 234. 19in. rack mounted fully smoothed and fused for 230 v. A.C. input. H.T. output adjustable from 180 v. to 270 v. at 80 mA. by means of primary taps and high-low switch in the secondary winding. L.T. output 6.3 v. A.C. at 4 amps. Fitted with M.I. meter to read A.C. input and D.C. output volts. Second-hand, tested, in good condition. £3 19 6
DITTO. model without meter £3 10 0
Packing and carriage 15/-.
TYPE E.H.T.45. Input 200-250 v. A.C. Output 1,200 v. D.C. at 200 mA., fully smoothed. Rectifies by means of metal rectifier. On-off relays. Floor mounted. Weight 112 lb. Fully tested and guaranteed £18 0 0
Packing & Carriage £1/10/-.

VARIABLE A.F. ATTENUATORS

Unbalanced "pi" type 600Ω. Attenuator switches consisting of 21-step stud switch and wire wound resistances. Switch provides 5 time impedance steps of 4dB and intermediate 1dB steps, giving the overall range of 0 to 20dB at 1dB steps. Panel mounting, fully screened, ¼in. spindle. Barrel dimensions 2½in. dia. × 3in. long. 10/-. P.P. 2/-.

R.P.M. INDICATOR KIT

Radio-Altimeter Indicators with moving coil movement on 5 mA. F.S.D., easily convertible to accurate engine R.P.M. indicators. Supplied complete with parts required for conversion and detailed instructions. Suitable for 4-cylinder engines with 12 v. electrical installation. 35/-. P. & P. 5/-.

METERS
PHILIPS FIRST-CLASS MIRROR SCALE 1 mA. D.C. M.C. METERS

Square flange 4.6in. × 4.6in. flush mounted. Scale length 4in. Body 3.8in. dia. × 1⅞in. deep. Calibrated 0 to 1 mA. Price 65/-

HEADPHONE EQUIPMENT

DLR5 BALANCED ARMATURE with sound powered inserts; D.C. resistance 40Ω per insert .... 10/- ea.
CHR MOVING IRON, D.C. resistance 4,000Ω .... 15/- ea.
MOVING COIL, with moving coil microphone fitted with press-to-talk switch. D.C. resistance 40Ω per insert. Large rubberised felt lined earpads. Very comfortable to wear. 15/- ea.
TANNOY MOVING COIL, similar to the above but fitted with heavy die-cast carbon microphone .... 12/9 ea.
Packing and postage 2/6 per headset.

Now available—3GP1 Cathode Ray Tubes as used in the P.E. oscilloscope £2/10/-. P.P. 5/-.

CATHODE RAY TUBES

VCR139A, 2½in., green trace, medium persistence, 500 V. E.H.T. (B12B) 30/-
3WP4, 3in., white trace, flat face, medium persistence 1,500 V. E.H.T. (B12A) 120/-
4EP1, 4in. green trace, flat face, medium persistence P.D.A.; Max. E.H.T. 4,000 V. (B12F) 100/-
4GP4, 4in. white trace, flat face, medium persistence, P.D.A., max. E.H.T. 4,000 V. (B14A) 100/-
5BP1 5in., green trace, medium persistence, max. E.H.T. 2,000 V. (USM11) 80/-
5BVP1 5in., green trace, flat face, medium persistence, P.D.A., max. E.H.T. 8,000 V. (B12F) 160/-
89J 4in. double beam, blue trace, flat face, short persistence, 2,000 V. E.H.T. (special) 60/-
90EG4P, 3in., green trace, medium persistence, P.D.A., max. E.H.T. 4,000 V. (B12D) 180/-
DG13-2, 5in., green trace, medium persistence, P.D.A., max. E.H.T. 4,000 V. (B14A) 120/-
DG16-22, 5½in. × 1½in., rectangular screen, green trace, medium persistence, E.H.T. 5,000 V. (B14A) 200/-
E4205/C/7, 2½in., green trace, long yellow after glow, E.H.T. 800 V. (B12B) 65/-
09D 4in., twin beam, green trace, medium persistence, E.H.T., 1,200 V. (B12B) 80/-
09J as 09D but blue trace, short persistence (B12B) 80/-
Bases: USM11 6/6; B12A 3/-; B12B 2/6; B12D 3/6; B12F 7/6; B14A 6/6

TEXAS SILICON FULL WAVE BRIDGE RECTIFIERS

1B20K10 100 piv, 2 amps., dimensions 1.4 × 1.4 × .6in. 25/-
1B40K10 100 piv, 4 amps., dimensions 1.4 × 1.4 × .6in. 30/-
1B100M10, 100 piv, 10 amps., dimensions 2¼ × 2¼ × 1in. 85/-
Postage 1/6 per rectifier.

GERMANIUM JUNCTION STUD MOUNTED POWER RECTIFIERS

GJ3M, 200 piv, 500 mA./1 amp 3/6
GJ5M, 300 piv, 500 mA./1 amp 3/6
GJ6M, 150 piv, 800 mA/1 amp 3/6
GJ7M, 80 piv, 500 mA./1 amp 3/6
Higher rating refer to cooling fin mounting.

NUVISTORS TRIODES

2CW4 (2V htrs.); 6CW4 (6.3V. htrs.)—for TV tuners and F.M. tuners 12/-
6DS4, similar to 6CW4, but with remote cut-off for weak signal areas 15/-
7586, general purpose industrial triode, low 'µ' 22/6
7895, general purpose, industrial triode, high 'µ' 22/6
Bases for the above 2/9 each.

PHOTOCELL GS16—CV248

Caessium-Antimony coated anode. Working voltage 140-160 v. Side-on anode. Sensitivity 160 µA/Lumen. 5/- each. Postage 1/6.

KLYSTRONS

2K48	£9	CV228	£10	CV2343	£1
2K41	£20	CV238	£5	CV2346	£15
2K45	£7	CV2116	£10	CV2422	£20
6BL6	£14	CV2161	£4	CV5364	£12
726A	£4	CV216A	£12	CV6002	£12
CV129	£4	CV2304	£10		

FERRITE ROD AERIALS

OSMOR PW/FR1 for pocket superhet, long and medium waves 8/6
WEYRAD RA2W for transistor radios using OC44 or similar transistor; long and medium wave. Car aerial coil. 12/6
Packing and postage 9d.

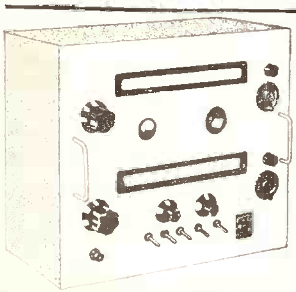
I.F. COILS FOR TRANSISTOR RADIOS

For use with OC44/DC45 Transistor. Adjustable Ferrite cores.
P50/1 A.C. MW/LW Oscillator 5/4
P50/2CC—1st and 2nd IF 5/7
P50/3CC—3rd IF 6/-
Postage 6d. per coil. Postage for set of 4 coils 1/6d.

TV BAND 1 SIGNAL EQUALIZER AND PATTERN REJECTOR

For balancing BBC/ITA signals or for rejecting BBC signal from ITA where it causes patterns. For channels 1, 2 and 3. P.P. 9d. 10/-

VHF HETERODYNE PRECISION FREQUENCY METER TYPE 183



Total Frequency Coverage 20-1,000 Mc/s.

The instrument consists of: Crystal Controlled Oscillator (Crystal 100 kc/s. ± 5 c/s.) providing spot frequencies at 25, 50 and 100 kc/s. intervals; Fine (L.F.) Oscillator continuously tuned from 5.0 to 6.25 Mc/s. in 9 bands; Coarse (H.F.) Oscillator continuously tuned from 20 to 300 Mc/s.; and associated mixer and A.F. stages. By using coarse oscillator alone quick frequency identification can be made from 20 to 1,000 Mc/s. with an accuracy of .3%. By using correct measuring procedure, i.e., by calibrating fine oscillator against crystal and beating input frequency with the former an accuracy of ±.02% is easily obtained. Long scales graduated in Mc/s. provide exceptional degree of discrimination. Beat detection by Magic Eye or headphones. Dimensions: 22in. × 19½in. × 14in. Weight 71lb. Power requirements 115/230 v. A.C.

PRICE, new and fully guaranteed £85 0 0
Packing and carriage £1/10/-.

To book panel advertisements in this section, apply to Wireless World, (Dept. P), Dorset House, Stamford St., London, S.E.1 or telephone WATerloo 3333, Ext. 210

BOOKS

"INTRODUCTION to Valves." By R. W. Hallows, M.A.Cantab., M.I.E.E., and H. K. Milward, B.Sc.Lond., A.M.I.E.E. Describes the principles, construction, characteristics and uses of most types of radio valves. The approach is simple and, as far as possible, non-mathematical, but the book provides the student with a thorough understanding of valves and how they work. 8/6 net from all booksellers. By post 9/4 from Iliffe Books Ltd., Dorset House, Stamford St., London, S.E.1.

"ABACS of Nomograms." By A. Giet. Translated from the French by H. D. Phippen and J. W. Head. Most engineers have made use of nomgrams at some time in their careers, and are fully alive to the fact that they are a very convenient tool when the same formula has to be solved repeatedly for several sets of variables. It is fair to say, however, that only a small proportion of even those who habitually employ nomograms know how to construct them for their own use. Most of the comparatively small literature on the subject is written for mathematicians and is extremely difficult for the practical engineer to comprehend. This book is essentially practical, and not only demonstrates the many and varied applications of the abac of nomogram, but shows how even those without highly specialized mathematical knowledge may construct their own charts. 35/- net from all booksellers. By post 36/- from Iliffe Books Ltd., Dorset House, Stamford St., London, S.E.1.

"ULTRASONIC Delay Lines." C. F. Brockelsby, B.Sc., A.R.C.S., A.M.I.E.E., J. R. Palfreeman, R. W. Gibson, B.Sc.(Eng.), Grad.I.Mech.E. The authors are members of a team which has been working on ultrasonic delay lines, since the early days, at the Mullard Research Laboratories. This is the first book to be written specifically on the subject, which has important applications in radar, radio and television, electronic computers, pulse-forming networks, correlation techniques and multi-channel communication systems. The early chapters discuss basic principles and the various types of delay lines are then covered. The chapter on electronics for delay lines deals fully with the design of broad-band amplifiers, oscillators, etc., either with transistors or valves. The last two chapters are devoted to the delay line measurements and the many applications of delay lines. Among the five appendices there is one containing nearly 60 curves which give the characteristics of many delay line materials. The final appendix discusses one of the latest developments, ceramic transducers. 65/- net, 66/3 by post.

"TELEVISION Engineering Principles and Practice, vol. III. Waveform Generation," by S. W. Ames, B.Sc.(Hons.), A.M.I.E.E., and D. C. Birkinshaw, M.B.E., M.A., M.I.E.E. The third volume of a comprehensive work on the fundamentals of television theory and practice, written primarily for the instruction of BBC engineering staff. This volume gives the application in television and sinusoidal, rectangular, sawtooth and parabolic waves and shows the mathematical relationship between them. The main body of the text is devoted to the fundamental principles of the circuits commonly used to generate such signals, the treatment being largely descriptive in nature and therefore less mathematical than that of the previous volume. The work is intended to provide a comprehensive survey of modern television principles and practice. 30/- net from all booksellers. By post 31/- from Iliffe Books Ltd., Dorset House, Stamford St., London, S.E.1.

"RADIO Interference Suppression as Applied to Radio and Television Reception." By G. L. Stephens, A.M.I.E.E. 2nd Ed. An up-to-date guide to the various methods of suppressing electrical interference with radio and television reception. Many practical applications are given, particular attenion being paid to the problem of interference at television frequencies. Other chapters deal with the design and choice of suppressor components, methods of locating the source of interference, and suppression of the receiver itself. 10/6 net from all booksellers. By post 11/2 from Iliffe Books Ltd., Dorset House, Stamford St., London, S.E.1.

"BASIC Mathematics for Radio and Electronics." By F. M. Colebrook, B.Sc., D.I.C.A.C.G.I. Revised and enlarged by J. M. Head, M.A. (Cantab.), presents in readable form a complete course in basic mathematics from engineering students of all kinds and leads on to the more advanced branches of mathematics of increased importance to radio engineers. In this edition the chapter covering the application of mathematics to radio has been revised and enlarged, while new subjects covered include Stability, Linar Differential Equations, Elementary Statistics, Short Cuts to Numerical Calculations and an Introduction to Matrices. Will be invaluable to those without previous knowledge of the subject. 17/6 net from all booksellers. By post 18/6 from Iliffe Books, Ltd., Dorset House, Stamford St., London, S.E.1.

"RADIO Designer's Handbook." Editor, F. Langford-Smith, B.Sc., B.E., Senior Member I.R.E. (U.S.A.), A.M.I.E. (Aust.), a comprehensive reference book, the work of 10 authors and 23 collaborating engineers, containing a vast amount of data in a readily accessible form; the book is intended especially for those interested in the design and application of radio receivers or audio amplifiers. Television, radio transmission and industrial electronics have been excluded in order to limit the work to a reasonable size. 65/- net from all booksellers. By post 67/9 from Iliffe Books Ltd., Dorset House, Stamford St., London, S.E.1.

CLASSIFIED ADVERTISEMENTS

DISPLAYED: £5 per single col. inch.
LINE advertisements (run-on): 5/6 per line (approx. 7 words), minimum two lines.
Where an advertisement includes a box number (count as 2 words) there is an additional charge of 1/-.
SERIES DISCOUNT: 15% is allowed on orders for twelve monthly insertions provided a contract is placed in advance.
BOX NUMBERS: Replies should be addressed to the Box number in the advertisement, c/o Wireless World, Dorset House, Stamford Street, London, S.E.1.
No responsibility accepted for errors.

Advertisements accepted up to SEPT. 10th for the OCTOBER issue, subject to space being available.

SITUATIONS VACANT

RADIO & Television Testers.
FOR City Factory; good rates up to 7/6 per hour; five-day week.
APPLY to Personnel Manager:—
ALBA (RADIO & TELEVISION), Ltd., Tabernacle St., London, E.C.2. [105

AN OVERSEAS CAREER WITH
INTERNATIONAL AERADIO, LIMITED
TO meet the requirements of constant growth and expansion we invite applications from technicians and engineers for an overseas career in North, West and East Africa, the Mediterranean area, the Caribbean, the Arabian Gulf and the Far Eeast. If you have recently completed service in a trade such as Ground Wireless Fitter in the R.A.F. or Radio Electrical Artificer in the Royal Navy or have other experience in the maintenance of HF and VHF communications, RTT and navigational aids, we should be interested to hear from you. Successful candidates would normally spend six weeks at our Radio Training School, Southall, Middlesex, before proceeding overseas, but in some cases staff with suitable qualifications and experience may be offered immediate posting. Overseas staff receive a tax-free salary with married and child allowances if appropriate and accommodation, bachelor or married, is provided free; other benefits include generous U.K. leave and membership of an excellent pension and life assurance scheme.
WRITTEN applications, please, to Personnel Officer, 40, Park St., W.1. [115

STATES OF GUERNSEY AIRPORT.
APPOINTMENT of a Radio Technician.
APPLICATIONS are invited for the above appointment on the Established Staff of the States of Guernsey. Applicants must hold the City and Guilds Telecommunications Intermediate Certificate or equivalent technical qualifications and should have had previous experience in Radar and V.H.F. systems.
SALARY £735/£1,125 (£40, 4×£35, £40, £30, £40, £30, 2×£35). Commencing salary according to age and experience.
THE post is pensionable (non-contributory) and arrangements can be made for back years of service to count for pension purposes in accordance with the pensions rules.
CONTRIBUTORY Widows and Orphans Pensions Scheme (at present 3% of annual salary).
TEMPORARY housing accommodation can be provided at an economic rental and removal expenses paid.
FURTHER details of the duties and responsibilities attaching to the post may be obtained from the Airport Commandant, States Airport, Forest, Guernsey.
APPLICATIONS (stating age, qualifications, present and previous appointments, experience and the names of two referees) should be addressed to the President, Civil Service Board (W), States Office, P.O. Box No. 43, St. Peter Port, Guernsey, and must be submitted not later than 25th September, 1965. [1293

CIVILIAN INSTRUCTORS GRADE III:—
4 POSTS for men fully experienced in the maintenance of radio and/or terminal channelling equipment (including ancillary equipment such as DC telegraph machines and telephone exchanges) to teach Royal Signals technicians and trainees. Possession of appropriate O.N.C., C. & G. certificate or equivalent qualifications desirable. Selection by written examination and interview.
STARTING salary £864 (at age 21)—£1,201 (at age 30 or over) rising to £1,320.
PROSPECTS of pensionable appointment and promotion.
OPPORTUNITIES exist for further technical study and Day Release will be granted where possible.
ACCOMMODATION may be provided for single and for unaccompanied married men on a temporary basis.
WRITE for application form to C.E.P.O., Personnel Lines, Catterick Camp, Yorkshire.
CLOSING date 10th September, 1965. [1284

PYE CAMBRIDGE WORKS, Ltd., Haig Rd., Cambridge.
* SINGLE sideband equipment.
* VHF radiotelephone equipment.
* HI-FI reproduction equipment.
WE require trained personnel for production testing and fault finding of modern equipment.
WE have limited vacancies for more senior and experienced men with drive, who can lead small teams engaged on this work.
WE have also limited vacancies for persons of less experience who can be trained for such work.
APPLY to: The Personnel Manager. [131

A FULL-TIME technical experienced Salesman required for retail sales; write, giving details of age, previous experience, salary required, to—The Manager, Henry's Radio, Ltd., 303 Edgware Rd., London, W.2. [149

THE SERVICE DIVISION
of
STAVELEY-SMITH CONTROLS LIMITED
requires
ASSISTANT SUPERINTENDENT

A vacancy exists for an additional Assistant Superintendent at Manchester. The applicants will be trained to take part in the planning and supervision of the work undertaken in both the Marine and Industrial Departments of the Service Division.

The applicant's background should be Electronic or Electrical Control in character, either in the Marine field with Radar, Radio, etc., or in Industrial Control, but ability to understand quickly the technicalities involved in unfamiliar equipment is very important.

There is a considerable amount of travelling involved about our depots and installations in progress. Applicants will be expected to have ability to organise efficiently and to deal with the considerable amount of technical problems arising in the daily routine of a Nation-wide Service Organisation; he should therefore have had many years of experience in Electrical and Electronic Maintenance and Repair work, during part of which he must have been in a supervisory capacity.

MARINE COMMUNICATIONS AND NAVIGATIONAL EQUIPMENT

Service Engineers required for Marine Radar, Radio and Gyro-compass and Echosounders. Applicants must have PMG and MOT Certificates and preferably reside in East London or Thames Estuary areas and Belfast. Vacancies also in other areas.

INDUSTRIAL CONTROL AND INSTRUMENTATION

Service Engineers required who have had experience of Electronic and Electrical Control of industrial machines and equipment. Work involves a wide range of equipment and applicants must therefore have a good technical theory background and be capable of quick assimilation of "know-how" and adaptability to provide quick and efficient service to industry. Vacancies especially in London, Manchester, Birmingham, Bristol and Belfast.

All applicants must be British born, hold a Driving Licence, be willing to travel, and should write to the address given below stating age, married or single, all qualifications and experience.

Ex-Naval C.P.O.s and P.O.s particularly welcome.

Apply to:—68 Grosvenor Street, Manchester 1. Tel.: Manchester Ardwick 5011.

The Civil Service

Professional and Technical Appointments

The Civil Service offers an interesting and full career for professional engineers in government departments ranging from Cadetships which provide professional training for young graduates to Chief Engineer appointments with salaries of over £5,000. A booklet giving further details can be obtained from the Civil Service Commission at the address given below.

The current vacancies for pensionable and temporary appointments include the following:—

ELECTRICAL ENGINEERS

urgently required to fill vacancies in Ministries of Aviation, Defence, Public Building and Works, and Transport, the Diplomatic Wireless Service and Government Communications Headquarters. Vacancies in fields of (a) power, including building services, and (b) light currents and electronics.

QUALIFICATIONS: Examinations necessary for A.M.I.E.E., A.M.I.E.R.E. (September 1962 syllabus), or A.F.R.Ae.S., or degree or Dip. Tech. with 1st or 2nd class honours in electrical engineering or physics.

SALARY (Inner London): £1,143 (at 25)-£1,718. Promotion prospects.

AGE: Normally at least 25 and under 35 on 31.12.65. Some extensions for service in H.M. Forces or Overseas Civil Service. (Reference: S/85.)

ENGINEERING ASSISTANTS

Vacancies in Ministry of Public Building and Works, Ministry of Defence, Post Office, and in other Departments for Draughtsmen in the fields of MECHANICAL, ELECTRICAL, and HEATING AND VENTILATING ENGINEERING.

QUALIFICATIONS: O.N.C. (or equivalent) in appropriate subject, three years' training and, in addition, at least one year's drawing office experience.

SALARY (Inner London): £718 (at 20)-£1,108 (at 28 or over)-£1,209.

AGE: At least 20. Promotion prospects. Where appropriate, time off for further technical study may be given. (Reference: S/68.)

TRAINING SCHEMES

Trainees can be accepted direct from school by some Departments and facilities, including University courses, intended to lead to full professional qualifications, are available.

On completing training programmes, trainees are offered permanent pensionable appointments.

Details obtainable from Civil Service Commission.

Except where otherwise stated the above posts are pensionable.
APPLICATION FORMS are obtainable from

Secretary, Civil Service Commission, Savile Row, London, W.1.
Please quote appropriate reference.

COMMUNICATIONS—ELECTRONIC SECURITY DEPARTMENT. Eastcote, Ruislip, Middx.
VACANCIES for seven Physicists and Electronic Engineers (graded Scientific Officer/Senior Scientific Officer) for research and development on analysis and synthesis of speech; transmission and measurement of speech signals using both analogue and digital techniques: speech perception and intelligibility; signal detection and analysis; data processing: computer techniques: applications of microminiaturisation, and general studies of telegraph systems.
QUALIFICATIONS: 1st or 2nd class honours degree, Dip.Tech., or equivalent or higher qualification in appropriate subject and; for S.S.O., at least 3 years' post-graduate experience.
SALARY: S.O £940-£1.586.
S.S.O. (minimum age 26), £1,750-£2.147.
OPPORTUNITIES for permanent pensionable appointments.
APPLICATIONS to: Communications-Electronic Security Department, 8, Palmer St., London, S.W.1.
(15) [1287

ROYAL COLLEGE OF ADVANCED TECHNOLOGY, Salford. Proposed University of Salford. Electronic Engineer.
APPLICATIONS are invited from electronic engineers for a post of Experimental Officer to join a group from the Civil and Electrical Engineering Departments developing an electronic analogue computer for use in the design and analysis of complex pipe networks. The successful applicant will be required to contribute to the current development programme, to commission and run the machine and to participate in future development work.
APPLICANTS should have a good working knowledge of both linear and pulse transistor circuitry, be capable of working under the minimum of supervision and be graduate members of the Institution of Electrical Engineers or hold an equivalent qualification.
THE salary scale is £920-£1,340 (Bar)-£1,555 per annum.
APPLICATIONS, giving full details of education and experience, together with the names and addresses of two referees, should be sent to the Secretary, Royal College of Advanced Technology, Salford 5, by 20th September, 1965 quoting reference C/40. [1279

SERVICE Technicians and Trainees for Maintenance work on all kinds of audio equipment, required in the London area; pension scheme.—Apply: Mr. J. Vaughan, Dictograph Telephones, Ltd., Abbey House. Victoria St., London, S.W.1. Tel. Abb. 5572. [1274

ELECTRONIC service engineers required to service and install airborne navigational equipment at London Airport, Home Counties and overseas.—Apply: The Decca Navigator Co., Ltd., Spur Rd., Feltham, Middlesex. Tel. Feltham 4898. [1295

TECHNICAL training and employment in the Post Office.—Assistant executive engineers.—About 30 pensionable posts for men or women aged 17½ and under 25 on 1.9.65 (with extension for Forces service, overseas civil service, and up to 2 years' permanent civil service).
DUTIES: technical design and development of telecommunications equipment.
QUALIFICATIONS:
EITHER (i) G.C.E. (or equivalent) passes in English language and 4 other subjects, including 2 at A level obtained at the same examination for pure mathematics, applied mathematics, physics, chemistry;
OR (ii) G.C.E. (or equivalent) pass in English language and either Higher National Diploma in electrical or mechanical engineering or applied physics, or a pass in (or exemption from) Parts 1, 2 and 3 of the Graduateship Examination of I.E.E. or I.Mech.E., or a pass in (or exemption from) Sections A and B of the I.E.R.E. Graduateship Examination under the September 1962 Syllabus and Regulations.
SALARY (inner London): £740 (at 18), £1,085 (at 25 or over)—£1,575; (national) £675 (at 18), £1,010 at 25 or over)—£1,500; salary under review; promotion prospects.
WRITE to Civil Service Commission, Saville Row, London, W.1, for application form, quoting S/6202/65. Closing date 14th September, 1965. [1299

AIRCRAFT radio/radar engineers and mechanics with specific workshop experience in one of the following: X band radar, VHF/HF, ILS/VOR or ADF; 40-hour week, pension scheme.—Apply: Managing Director, Air Transport (Charter) (C.I.), Ltd., Willow Rd., Colnbrook, Slough, Bucks. [1296

TECHNICAL representative required to sell American semiconductors in U.K.; previous selling experience not essential, but must have had at least five years in semiconductors: good conditions and salary to right man.—Write, giving brief details, to—Jermyn Industries, Vestry Estate, Vestry Rd., Sevenoaks, Kent. [1278

RADIOLOGICAL PROTECTION SERVICE (Ministry of Health and Medical Research Council), Clifton Avenue, Belmont, Sutton, Surrey, requires Technical Officer to design and construct electronic equipment used in the field of radiation measurements. Knowledge of digital circuits, pulse techniques and transistor circuitry is required. Qualifications—H.N.C. or equivalent, plus at least 7 years' appropriate experience. Salary scale £1,250-£1,813 p.a. plus London Allowance. Medical Research Council conditions of employment.

Applications with the name and address of two professional referees to the Director at the above address.

£20 a week while you train as a computer engineer!

I.C.T.–Britain's biggest computer manufacturer–has immediate vacancies for Trainee Field Engineers in Greater and Central London. Salary throughout the 6-months' course will be *at least* £20 a week, according to previous experience and qualifications, plus accommodation and expenses. Apply NOW if you are aged 23-33 and have:

1. **Above average intelligence.**
2. **Ability to work for long periods without supervision.**
3. **Likeable personality (you will be dealing directly with customers).**
4. **Aptitude for ELECTRO-MECHANICAL as well as ELECTRONIC servicing.**
5. **At least one of the following:**
   - **—O.N.C. or H.N.C. Electronics or Electrical.**
   - **—City & Guilds Telecommunications or Electronic Servicing.**
   - **—R.A.F., R.N., or R.E.M.E. radar experience.**
   - **—Industrial experience in Transistors or Pluse Techniques.**

GO STRAIGHT TO COMPUTERS

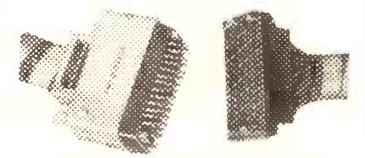
After being accepted for training, you could go straight to the '1900', the brilliant new series of British computers already capturing world interest. The course includes an introduction to programming.

BE A FIELD ENGINEER WITHIN SIX MONTHS

As an I.C.T. Field Engineer you will be responsible for the smooth-running of a number of customers' installations. You may well find yourself without supervision for long periods.

REACH £1200 A YEAR AFTER ONLY ONE YEAR

Field Engineers responsible for a site in London can reach £1,450-1,500 with 3 weeks' holiday. Up to £10 a week extra for shift work. Very real chances of promotion. Regular salary reviews.



About I.C.T. Computers

Orders for the '1900', I.C.T.'s new computer introduced only 10 months ago, already total well over 200. In compactness and versatility the '1900' is a world-beater. The apparently simple standard interface-connection (above), which has revolutionised computer design, is an I.C.T. development. So is 'Executive', the mastermind program. As an I.C.T. Engineer you will be working with many more of the world's most advanced techniques.

**FOR A CAREER IN COMPUTER ENGINEERING–
phone PUTney 7262 (Ext. 135), write, OR POST THIS COUPON**

I·C·T

BRITAIN'S BIGGEST COMPUTER MANUFACTURER

TO: Mr. E. J. Reeves (Ref. WW.E149).
International Computers & Tabulators Ltd.,
85-91 Upper Richmond Road,
London, S.W.15.

Please send me an application form in complete confidence

NAME ______________________

ADDRESS ______________________

____

PROFESSIONAL ENGINEERS AND TECHNICIANS

with at least two years' experience in British Industry are invited to avail themselves of our Confidential and Free Service.

E.A.L. offers the most efficient and satisfactory way of obtaining alternative employment in the Electronics Industry.

E.A.L. is in contact with all firms in S.E. England and undertakes a complete and thorough survey of any area for suitable vacancies for every engineer registered with us.

For further information please phone or write to:

Electronics Appointments Ltd.,
22 Gloucester Mns.,
Cambridge Circus,
London, W.C.2
Phone: TEMple Bar 5557/8

STATIC Inverters (Transipack). Why not be a big fish in a rapidly expanding pool? Commando types willing to work hard will remain on top—if they can deliver the goods: Development Engineers and Prototype Wiremen required.—Industrial Instruments, Ltd., Stanley Rd., Bromley, Kent. Ravensbourne 9212. [1276

MINISTRY OF DEFENCE (Army Department), Chertsey, Surrey, require 2 Technicians, (1) to assist in carrying out instrumented tests on fighting vehicles and preparation of test reports (V.4252), and (2) to be responsible for electrical, electronic and mechanical instrument calibration and maintenance (V.4253).
QUALS. Recognised engineering apprenticeship or equiv. training in appropriate trade. Also for V.4252 knowledge of both electrical and mechanical measuring techniques as applied to measuring vehicle performance, and for V.4253 practical experience in some field of instrument work and knowledge of application of C.R. Oscilloscopes, U.V. recorders and instrumentation tape recorders. O.N.C., C. & G. Finals or equiv.
APPLICATION forms from The Manager (PE.4481), Ministry of Labour, Professional & Executive Register, Atlantic House, Farringdon St., London, E.C.4. [1285

ELECTRONICS Senior Technician I reqd. in the Pharmacology Department, Royal Free Hospital Medical School; experience in medical electronics an advantage; salary scale £965-£1,265, plus London Weighting; superannuation scheme, good hols.—Apply School Secretary, 8, Hunter St., London, W.C.1. [1294

EXPERIENCED technical authors and specification writers required for well paid staff appointments in Reading and Manchester offices, and various parts of the country; we are an expanding company operating good sickness, pension and life assurance schemes. —Apply to Engineering & Technical Publications, Ltd. 1-3, Greyfriars Rd., Reading, or 3, Chepstow St., Manchester, 1. [139

SCIENTIFIC CIVIL SERVICE EXPERIMENTAL OFFICER CLASS, AUTUMN, 1965, RECRUITMENT.
CAREERS in science and technology are offered to men and women with qualifications in mathematics, physics, chemistry, biology, meterorology, engineering and geology as Assistant Experimental Officers and Experimental Officers, in Government Scientific Establishments.
QUALIFICATIONS: University Degree, Dip.Tech., H.N.C., etc., and candidates under age 22 may offer lower qualifications (minimum: G.C.E. "A" level in 2 scientific or mathematical subjects).
SALARY and age limits:
EXPERIMENTAL Officer (aged 26-30), £1,319-£1,675.
ASSISTANT Experimental Officer (ages 18-27), £549 (at 18)-£983 (at 26 or over)-£1,201.
SALARIES supplemented in London area. Aid given for further education. Promotion prospects. Pensionable posts.
APPLICATION forms and booklet from: Civil Service Commission, Savile Row, London, W.1. Please send postcard quoting S/579-580/65. Closing date 23rd September, 1965.
(FURTHER recruitment in Spring, 1966.) [1286

TEST engineers.—Applications are invited from 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., Bromhill Rd., S.W.18. [124

RADIO and Radar technicians required for maintenance and development work at a flying unit near Barmouth, North Wales. Preference given to applicants with technical experience in H.M. forces. 5-day week. Free single accommodation. Canteen facilities. Sick benefit and superannuation schemes.—Apply Short Brothers and Harland Limited, R.A.E. Llanbedr, Merioneth. [1246

Senior Electronics Technician for Research Department in Anaesthetics. H.N.C. or equivalent required. Starting salary £1,210 with superannuation. The work is neurophysiology and sophisticated data processing techniques are used. Candidate should be interested in development of special purpose computers and advanced recording techniques. Apply to: Professor J. G. Robson, Postgraduate Medical School of London, Du Cane Road, London, W.12.

UNITED KINGDOM ATOMIC ENERGY AUTHORITY
CHAPELCROSS WORKS

INSTRUMENT MECHANICS

Chapelcross Works requires experienced men with knowledge of electronic equipment and/or industrial instrumentation for fault diagnosis, repair and calibration of a wide range of instruments used in nuclear reactors and radiation laboratories. This work involves maintenance of instruments using pulse techniques, wide band, low noise amplifiers, pulse amplifier analysers, counting circuits, television and industrial instruments used for measurement of pressure, temperature and flow.

Men with H.M. Services, industrial or commercial background of radar, radio, television or industrial or aircraft instruments are invited to write for further information.

HOUSING is immediately available.

For further details, write to:—

Labour Manager,
Chapelcross Works,
ANNAN, Dumfriesshire.

London Borough of Richmond upon Thames

TWICKENHAM COLLEGE OF TECHNOLOGY, Egerton Road, Twickenham.

Principal: J. P. WOLFENDEN, M.Sc., M.I.E.E.

Department of Electrical Engineering and Physics.

Special lecture courses commencing September 1965:
- Fundamentals of Semi-conductor Devices
- Basic Electronics
- Transistor Circuit Design
- Network Analysis and Synthesis
- Systems Analysis

W. R. WAINWRIGHT, B.A.
Chief Education Officer

RADIO Technician with a sound knowledge of at least three of the following types of equipment is required immediately for Meteorological Office Ocean Weather Ships: Single Side-band Transmitter, Radar (Navigational), Radar Height Finding, Echo Sounders and Radio Receivers, Automatic D.F., V.H.F. and M.F. Low-voltage Servo Recorders, Digital Telemetering Equipment.
SALARY scale £678-£1,104 per annum according to age, plus £120 per annum overtime allowance. Free food and accommodation provided on board ship. Applicants must be natural born British subjects.—Full details from Shore Captain, Ocean Weather Ship Base, Great Harbour, Greenock. Telephone Greenock 24291. [1280

MEDICAL College of St. Bartholomew's Hospital, West Smithfield, E.C.1.—Electronics technician required by Physics Department; the work is varied and includes development of a 15 MeV linear accelerator, and instrumentation for radiation dosimetry, E.S.R. spectroscopy, etc.; salary within the range £805 to £1,025 plus London Weighting.—Applications, in writing, to the Secretary of the Medical College. [1297

IMPERIAL COLLEGE, S.W.7.—Electronics Development. We have an attractive position vacant in our Electronics Group; the work is concerned with application of the most modern electronics techniques to our Chemical Engineering and Technology Research. The person we shall appoint probably has an H.N.C., certainly has several years' practical workshop experience and is anxious to use his initiative. The starting salary will be over £1,000 for the right man.—Write in confidence to: Professor G. R. Hall, Department of Chemical Engineering and Chemical Technology, Imperial College, London, S.W.7. [1301

NYLON · P.T.F.E.

ROD, BAR, SHEET, TUBE, STRIP, WIRE
No quantity too small. List on application.
BRASS · COPPER · BRONZE
ALUMINIUM · LIGHT ALLOYS
STAINLESS STEEL

H. ROLLET & Co. Ltd.
Howie Street, S.W.11. *BATtersea 7872*
ALSO AT LIVERPOOL, BIRMINGHAM, MANCHESTER, LEEDS, GLASGOW

WW—146 FOR FURTHER DETAILS.

DECCA RADAR LIMITED.—Test equipment technicians are required for repair and manufacture of a wide range of test equipment for use in development and production. These are staff positions with opportunity for promotion and individual initiative.—Please apply Personnel Officer, Decca Radar Limited, 9, Davis Rd., Chessington, Surrey. [1302

MEDICAL Research Council.—Technician (junior grade) in electronics required to design, build and maintain research apparatus, which includes timing equipment and display apparatus; salary is determined by age on Whitley Council Scale, e.g., age 23, salary £645 plus London Weighting.—Information available from Senior Technician. Apply Dr O'Connor, M.R.C. Unit, Maudsley Hospital, Denmark Hill, S.E.5. [1298

AIRCRAFT Radio Engineer required holding preferably Maintenance Engineers' A and B Licences, though experienced "A" man would be considered. Work covers an interesting range of radio equipment, both for complete overhaul and defects rectification. Pay would be in accordance with qualifications and experience. Please call or write to Mr. R. C. Salisbury, Rogers Aviation Limited, Cranfield Airfield, Bedford. Tel. Cranfield 481. [1292

ELECTRONICS Technician. Young man required as a technician in the Department of Pharmacology to assist with research exports on the effects of drugs in animals. Essential qualifications are an interest in and a working knowledge of electronics. Salary (M.R.C. grant) of £800 p.a. for two years in the first instance.—Applications to: Mr. N. J. G. McLaren, Department of Pharmacology, School of Pharmacy, University of London, Brunswick Sq., London, W.C.1. [1275

TESTERS

required for interesting work on L.F. and H.F. Transmitters. Previus fault-finding experience essential.

The positions available would be of special interest to persons employed in the fault-finding and repair of television who are keen to establish themselves in a position that offers:

★ Satisfactory employment
★ Five-day week
★ Good prospects of advancement
★ Staff status
★ Sick pay
★ Generous salary

Apply: Personnel Manager

Multitone Electric Co. Ltd.
12-20 Underwood St., London, N.1

Inner London Education Authority
NORWOOD TECHNICAL COLLEGE
Knights Hill, London, S.E.27

TELECOMMUNICATION AND ELECTRONICS DEPARTMENT

Two Lecturers required in the Department of Telecommunication & Electronics which conducts full-time courses in telecommunication, electronics, marine radio operating and radar maintenance; part-time courses additionally include radio television and electronics servicing, television technology and other specialist subjects.

Lecturers are required to conduct classes in one or more of the branches of study referred to and would be responsible for certain administrative duties.

Qualifications and/or specialist knowledge or experience appropriate to the work of the department are looked for.

Salary in accordance with Burnham Technical scale, currently in the range £1670-£1895 plus London allowance of £45 or £60, but now being reviewed.

Application forms obtainable from Principal at College and returnable within 14 days of the appearance of advertisement. Enclose self-addressed foolscap envelope.

VHF TEST ENGINEERS

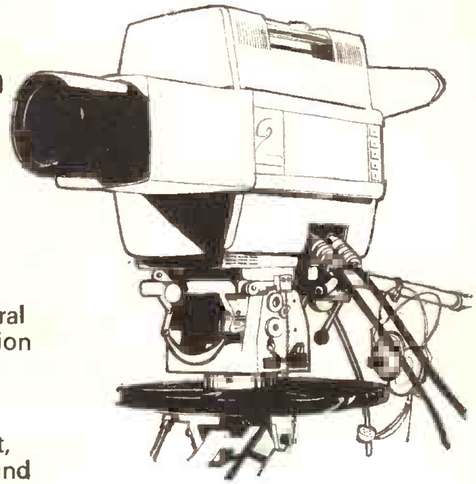
CAMBRIDGE WORKS LIMITED have vacancies in their expanding Test Organisation for men with experience of VHF Transmitters and Receivers.

Men with Service training in VHF equipment would be suitable.

Progressive rates of pay and promotion and good facilities for training are offered.

Apply: **Personnel Manager,**
Cambridge Works Limited,
Haig Road, Cambridge.

SERVICE AND COMMISSIONING ENGINEERS - Croydon Area



For an expanding Service Department, at Beddington Lane, Croydon, we seek the services of additional Engineers with a thorough knowledge of at least one of the following:

Professional TV Equipment

for Studio and Industrial applications. A wide range of cameras, monitors, video recorders, together with peripheral equipment is involved. Some knowledge of colour television is desirable, but training in this field will be arranged.

Sound Systems

Based on an extensive range of public address equipment, radio paging and inter-communication systems, background music services and professional tape recording devices.

Apply in confidence, to the Plant Personnel Officer

Peto Scott

A member of the Philips Industries Group.

PETO SCOTT ELECTRICAL INSTRUMENTS LIMITED

Addlestone Road, Weybridge, Surrey. Telephone: Weybridge 45511.

ELECTRONICS Technician required in physiological laboratory re-equipping with transistorised recording equipment. Work will consist of developing, building and servicing equipment. There are excellent opportunities for co-operative work with the Hospital Department of Physics. The person appointed will be expected to undertake some administrative responsibility in the Department. Applicants, aged 25-30, should hold an O.N.C. or equivalent qualification. Salary in the range £805 to £1,025 p.a. plus London Weighting of £45 or £55 p.a., with superannuation.—Apply, giving details of experience, to the Secretary, Guy's Hospital Medical School, London Bridge, S.E.1. [1282

MEASURE HIGH VOLTAGES with EASE, ACCURACY and SAFETY with the Pocket Size **KILOVOLTER** 3 to 30 kV

Ideal for checking TV, Radar, Car Ignition, etc.

Only **97/6d.** *Trade discount 15%. Or ask for leaflet.*

WAVEFORMS LTD.

72 Vauxhall Bridge Road, London, S.W.1.

Phone: VICtoria 3404-9

WW—147 FOR FURTHER DETAILS.

TANNOY

For sound sense

WEST NORWOOD LONDON SE27

GIPSY HILL 1131

WW—148 FOR FURTHER DETAILS.

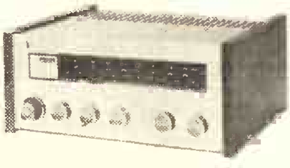
SPECIAL OFFER!

ALL ARMSTRONG UNITS on NO INTEREST terms. 12 Monthly P'mnts.

A. L. Stamford Ltd.

98 Weymouth Terr., London, E.2.

SHO 5003



WW—149 FOR FURTHER DETAILS.

ALIGNMENT ENGINEER

required for the alignment and test of V.H.F. and U.H.F. Radio Frequency Amplifiers. Some knowledge of this work essential but final specialised training will be given. Applications to The Personnel Manager, Belling & Lee Limited, Great Cambridge Road, Enfield, Middlesex.

HEWLETT-PACKARD LIMITED, Service Engineer (Electronic Instruments). A vacancy exists for a Service Engineer to work on a wide range of high quality electronic instruments. Candidates should have O.N.C., C. & G. or equivalent qualifications, or wide experience in a similar position. Good salary and prospects in a rapidly expanding organisation with an international reputation. Pension scheme and monthly staff position.—Apply in writing to: The Personnel Officer. Hewlett-Packard, Limited, Dallas Road, Bedford. [1289

MINISTRY OF AVIATION

Electrical Inspection Directorate, Bromley, Kent

TECHNICIANS (Grade III) age 24 or over, required mainly at Headquarters at Bromley and Woolwich, but a few vacancies also exist in other parts of the United Kingdom. The Headquarter posts include duties associated with the following types of work:—inspection and testing of electrical generating and control equipments, navigational aids and Army radar and communications equipments; testing (including environmental testing) of all types of electrical/electronic components; calibration of precision electrical measuring instruments; preparation of specifications and inspection instructions; documentation of Army telecommunications equipment involving investigation of interchangeability of components and maintenance of technical records.

Regional posts are at contractors' works and involve the implementation of inspection standards.

QUALS. Applicants must have served a recognised engineering apprenticeship or have had equiv. training and possess O.N.C., appropriate C. & G. Final Cert. or equiv. qualn. Appropriate experience in H M. Forces can be considered in place of specified quals. SALARY: £990 (at age 26)—£1,059 (at age 28 or over on entry) rising to £1,179 for the Bromley and Woolwich posts. A little less for some of the regional posts. There are good prospects for promotion and pension. Technical College courses sponsored for suitable candidates. APPLICATION FORMS from Manager (PE.4257), Ministry of Labour, Professional & Executive Register, Atlantic House, Farringdon St., London, E.C.4. CLOSING DATE 6th September, 1965.

ITA ENGINEERING STAFF

The INDEPENDENT TELEVISION AUTHORITY has vacancies for ENGINEERING STAFF at its Transmitting Stations.

The work on the Stations consists of the operation and maintenance of television transmitters and ancillary equipment. This calls for a high degree of skill and knowledge of electronics, television techniques and high frequency engineering; these vacancies are for young men with good basic knowledge who can be given appropriate training. A Higher National Certificate in Electrical Engineering or similar qualification is required.

Conditions of service are excellent and include a contributory pension scheme. Shift working is involved to cover the period from 8 a.m. to midnight.

Starting salaries, depending on qualifications and experience, will be within the scale £875 to £1,145.

Applications in writing, stating age and details of experience and qualifications, and quoting Reference Number W.W. 583 should be addressed to the:—

Personnel Officer,
INDEPENDENT TELEVISION AUTHORITY,
70, Brompton Road,
London, S.W.3.

THE UNIVERSITY OF MANCHESTER.

APPLICATIONS are invited for appointment as Service Engineer in the Department of Chemistry to maintain and service a wide variety of spectrometers and other scientific equipment. Previous experience of service work, not necessarily on spectrometers, is essential, and candidates should preferably have H.N.C. or some similar qualification. Salary range: £870 to £1,450 per annum. The initial salary will be according to qualifications and experience. Contributory superannuation scheme. Applications should be sent not later than October 15th, 1965, to the Registrar, the University, Manchester, 13, from whom further particulars may be obtained, on quoting reference 170/65. W.W. [1301

TAPE Monthly 2/-

ENTHUSIASTS for tape recording subscribe to the Magazine with the ZEBRA stripes! **25/- (U.S.A. $3.75) yrly incl. postage.**

● *FREE SPECIMEN COPY ON REQUEST*

7 TUDOR STREET, LONDON, E.C.4. FLE. 1455

WW—150 FOR FURTHER DETAILS.

BOOKS, INSTRUCTIONS, ETC.

CONVERT any TV set into an oscilloscope; instructions and diagrams 12/6.—Redmond, 42, Dean Close, Portslade, Brighton, Sussex. [112A

MANUALS, circuits of all British ex-W.D. 1939-45 wireless equipment and instruments from original R.E.M.E. instructions; s.a.e. for list, over 70 types.—W. H. Bailey, 167a, Moffat Rd., Thornton Heath, Surrey. [143

ARTICLES FOR SALE

FERROGRAPH 5/AN (March 1964, £62, no offers (London).—Box WW 110, Wireless World.

EVERSHED Bridge Megger, 1,000 volt, as new with test certificate, £55. Multirange High Grade service test meters, as new, £9. Reflecting Galvanometer, £5.—Cooper, 513, Hobmoor Rd., S. Yardley, B'ham. 26. [1291

BOLTON INSTITUTE OF TECHNOLOGY
ELECTRICAL ENGINEERING DEPARTMENT
DIPLOMAS IN ELECTRONIC ENGINEERING

Two year full-time course (entry: four appropriate "O" level passes) for the Ordinary Diploma.

Two year full-time course (entry: appropriate "A" level and "O" level passes) for the Advanced Diploma.

Successful completion of the courses gives valuable exemptions from the examination requirements of the British Institution of Radio Engineers and of the Institution of Electrical Engineers.

Further particulars from:

Head of Department of Electrical Engineering, Bolton Institute of Technology, Manchester Road, Bolton.

UNIVERSITY OF BELFAST

Applications are invited for the post of **Senior Experimental Officer** in charge of the Electron Miscroscopy Laboratory with effect from 1st October, 1965. In addition to administrative and maintenance duties the successful applicant will be required to assist in the training of research workers in the techniques of electron microscopy. A knowledge of the techniques of specimen preparation is also desirable. The salary scale is £1,400 x £60—£1,640 (merit bar) x £65—£2,160. Further details may be obtained from the Deputy Secretary to the Academic Council, and applications should reach him by 31st August, 1965.

SOUTH OF SCOTLAND ELECTRICITY BOARD
COMMUNICATIONS AND ELECTRONICS

Applications are invited for a THIRD ASSISTANT ENGINEER in the Plant and Equipment Development Section of the RESEARCH AND DEVELOPMENT BRANCH at Board Head Office, Glasgow.

The duties of the Communications and Electronics group include the promotion and evaluation of new designs of equipment, the preparation of general specifications and technical standards, the technical assessment of tenders, and the association of service experience with this work.

Applicants should have had experience of either the design and testing, or application of telecommunications and electronics equipment. The successful applicant will be working in a group studying the latest developments in data transmission over both physical and radio channels and will advise on their application in the Board's telecommunications telemetering, control and protective systems.

Applicants should possess the necessary qualifications for Graduate Membership of the Institution of Electrical Engineers. A University Degree will be an advantage.

Salary (According to qualifications and experience). Commencing at £1,550 and rising to £2,045 per annum; or commencing at £1,460 and rising to £1,910 per annum. (In each case plus a supplementary payment of £60 p.a.)

Applications, quoting reference E65/65, should be submitted on the standard form to the Chief Personnel Officer, South of Scotland Electricity Board, Cathcart House, Inverlair Avenue, Glasgow, S.4, not later than 13th September, 1965.

MINISTRY OF AVIATION
Royal Aircraft Establishment, Bedford

require a **TECHNICIAN,** age 24 or over, to be responsible for workshop training of electronic craft apprentices during their first two years. A wide experience of electronics, including the use of test gear required. An interest in young people and the ability to demonstrate equipment is desirable. QUALS. Applicants must have served a recognised engineering apprenticeship or have had equiv. training and possess an O.N.C., appropriate C. & G. Final Cert. or equiv. qualn. Appropriate experience in H.M. Forces can be considered in place of specified qualifications.

SALARY: £945 (at age 26)-£1,009 (at age 28 or over on entry) rising to £1,129 p.a. The salary is at present under review. Good prospects for promotion and pension. Technical College courses sponsored for suitable candidates. APPLICATION FORMS from The Manager (PE.4258), Ministry of Labour, Professional & Executive Register, Atlantic House, Farringdon St., London, E.C.4. CLOSING DATE 6th September 1965.

The General Post Office has vacancles for

RADIO OPERATORS II

at its

COAST RADIO STATIONS

Applications are invited from men between 21 and 35 years of age holding either the Postmaster General's First or Second Class Certificate of Competence in Radiotelegraphy or an equivalent certificate issued by a Commonwealth Administration or the Irish Republic.

The posts, which will be temporary in the first instance, carry a salary scale of £674-£976, dependent on age at entry, but successful applicants will be eligible to enter the open competitive selection for permanent appointment to be held in September of this year.

Applicants should write to The Inspector of Wireless Telegraphy, Union House, St. Martin's-le-Grand, London, E.C.1. or telephone London HEAdquarters 5545 for further information.

Mullard

PROJECT LEADER

An Electronics Engineer with experience in development work or in a Measurements Laboratory is required as Project Leader in the Laboratory Service Group of the Mullard Central Applications Laboratory.

The Projects are primarily:

1) Design of electronic equipment for specialised measurements.

2) Organisation of a unit for calibration and maintenance of a wide range of electronic measuring equipment.

A versatile person capable of carrying considerable personal responsibility is required for this post.

A good educational background is necessary, preferably to B.Sc. or at least H.N.C. level.

Applicants are invited to write to :

The Personnel Officer,
Mullard Limited,
New Road, Mitcham Junction, Surrey
quoting reference (PL/KBL)

A.E.G. freq. meter, £7; solarscope QD910. ferrograph, £20; 101 scope, £8.—H. Rumbold. Bucklebury-Slade, Reading. [18

FOR sale for overseas use, large number of G.E.C. BRT350A transmitter receivers, crystalled for low-band, 50kc/s separation, frequency modulation; various spares; majority in working order but offered without guarantee; excluding 6-volt lead-acid batteries which are still catalogued.—Offers to Box W.W. 1281, Wireless World.

ARTICLES WANTED

SPIRE, plain, self locking nuts, screws and rivets, large quantities wanted for cash.—L. Kayser, 170, Highbury Quadrant. London, N.5. Canobury 6765. [79

WANTED, all types of communications receivers and test equipment.—Details to R. T. & I. Electronics, Ltd., Ashville Old Hall, Ashville Rd.; London. E.11. Ley. 4986. [140

URGENTLY wanted, new valves, transistors, radios, cameras. binoculars. tape recorder and tapes, watches. any quantity.—S. N. Willetts. 43, Spon Lane, West Bromwich. Staffs. Tel. Wes. 2392. [145

HIGH prices paid for government surplus manuals and handbooks on radio and electronic equipment; also required, any books or publications on government surplus equipment and modification of same; single copies purchased—Apply Box W.W. 1277, Wireless World.

THE MINISTRY OF DEFENCE (ARMY DEPARTMENT) invites applications for Grade 5 Engineering appointments in the BRITISH FORCES BROADCASTING SERVICE. There are posts in Aden, Benghazi, Tobruk, and Cyprus.

DUTIES & QUALIFICATIONS

Operation and maintenance, of MF, HF, VHF Transmitters, Studio equipment and generating equipment. Appropriate ONC, City & Guilds, or equivalent qualifications are necessary.

SALARY SCALE for Grade 5 staff is £1,007 to £1,483 p.a. In addition generous non-taxable Foreign Service Allowances are paid according to location. Candidates must be at least 21 years of age.

For further details and application form please write to:

The Director (EW),
British Forces Broadcasting Service,
Kings Building,
Dean Stanley Street,
London, S.W.1.

ELECTRONIC ENGINEERS & TECHNICIANS

The growth of our manufacturing facility has led to opportunities for Engineers and Technicians to join a group working on the Design, Development, and Maintenance of test equipment used in the manufacture of semi-conductor components. This work involves d.c. and a.c. amplification up to 1000 mc/s, high speed switching and pulse techniques, and the use of a wide variety of measuring instruments.

Engineers should have HNC or equivalent in Electrical Engineering, and at least 2 years' experience in a related field. Salary will be in the range £900-£1,675.

Technicians should have ONC, H.M. service training, or at least 3 years' radio and television servicing experience. Salary will be in the range £640-£1,200.

Salaries are reviewed every 6 months, and the non-contributory fringe benefit schemes include life assurance, pension, hospitalisation insurance and profit sharing.

Please apply, giving brief relevant details, to

The Personnel Manager
TEXAS INSTRUMENTS LIMITED
Manton Lane, Bedford.

CIVIL AVIATION TELECOMMUNICATIONS

The Ministry of Aviation has vacancies for Radio Technicians at Airports, Air Traffic Control Centres, Radio Stations and other specialised Engineering Establishments throughout the United Kingdom.

The numbers and speed of air traffic today demand a complex, co-ordinated and reliable telecommunications system for airports, en-route navigation and air traffic control in order to ensure the highest standards of safety. The Ministry's Radio Technicians play a vital role in the installation, maintenance and technical operation of this system. Their duties embrace a wide range of equipment, including Primary Surveillance and Approach Radars, Secondary Surveillance Radars, Radio Navigational and Landing Aids, Radio and Line Communications, Electronic Data Displays, Closed Circuit T.V., Digital and Analog Computers.

Applicants should be aged 19 or over, of British nationality and possess a sound basic knowledge of Radio/Electronics with practical experience in at least one of the main branches of Telecommunications. The possession of formal qualifications would be an advantage.

Training on equipments and new techniques is provided at the Ministry's Civil Aviation Signals Training Establishment, Bletchley, Bucks.

Radio Technicians are encouraged to study for Technical and Professional Qualifications, and generous assistance, including part-time and, in special circumstances, full-time release, is provided.

There are good prospects of permanent pensionable posts and promotion to a higher class with a salary ranging from £1,032 per annum to £1,911 per annum.

Starting salary varies according to age: from £747 per annum at 19 to £962 per annum for entrants of 25 or over, and rises to £1,104 per annum. Annual leave is 3 weeks and 3 days, plus 9 days for public holidays.

For further details apply to:—

Mr. J. J. Robinson, M.I.E.R.E., A.M.B.I.M.,
Ministry of Aviation,
Room 754,
The Adelphi,
London, W.C.2.

UNIVERSITY COLLEGE LONDON PSYCHOLOGY DEPARTMENT

(1) Senior Technician to supervise laboratory store with assistance of technician. In addition to maintaining wide range of electrical and mechanical equipment, there will be opportunities for design and construction. Quote Ps/1.

(2) Senior Technician to be responsible for design and construction of variety of electronic equipment for research projects. Quote Ps/2.

(3) Technician to assist in running laboratory store and in design and construction of mechanical and electrical equipment. Quote Ps/3.

Application forms from Establishment Officer, University College, London, Gower St., W.C.1.

TAPE RECORDING ETC

SAVE on cost of hi-fi. See Audio Supply notice (advert. No. 111). [109

BRAND five polyester tapes, P & P free; send 5/- for sample 600 DP on 7in reel.—Minim (WW), Kenley, Surrey. [16

A UNIQUE Buy! Recording tape, top brand, 7in. 2,400ft. D.P., 25/-; 5¾in 1,200ft. 19/6; p. & p. 1/6 per spool; bargains in all sizes; s.a.e. for list; we repair, buy and sell recorders.—E. C. Kingsley & Co., Ltd., 132, Tottenham Court Rd., London, W.1. Euston 6500. [113

TAPE/DISC/TAPE transfer editing; duplicating; if quality and durability matter (especially with LPs from your precious tapes), consult Britain's oldest transfer service.—Fund raising records published for schools, musical societies (tax free).—Sound News Productions, 10, Clifford St., London, W.1. Reg. 2745. [108

NEW GRAM AND SOUND EQUIPMENT

GLASGOW.—Recorders bought, sold, exchanged; cameras, etc., exchanged for recorders or vice-versa.—Victor Morris, 343, Argyle St., Glasgow, C.2. [120

RETURN of post service; record changers, players and tape decks, some at special prices; speakers, Martin tape kits, Mullard amplifier kits, test meters, all in stock, H.P. available; send for free illustrated lists, postal only.—Watts Radio, Ltd., 54, Church St., Weybridge, Surrey. Tel. 47556. [114

CHELSEA COLLEGE OF SCIENCE & TECHNOLOGY

Senior Technician required to take charge of Electronics Workshop and associated Electronics component stores in Department of Physics.

Applicants should have considerable experience in the design, construction and development of electronic apparatus and be able to instruct junior staff.

Appropriate City and Guilds or National Certificate qualifications desirable.

5-day week. Superannuation.

Salary £840—£1,040 with London Weighting up to £45 at 27 and qualification supplements.

Good prospects of promotion.

Application forms from the Superintendent of Laboratories, Department of Physics, Manresa Road, S.W.3 (FLA 6421, Ext. 28).

HAMMER FINISH PAINT

The modern finish for electronics. Can be BRUSHED or sprayed. Blue or Silver. 2½ oz. tins 3s. 6d., post 8d. ½ pint 7s. 6d., post 1s. 9d. 1 pint 15s., post 2s. 9d. Orders over 30s. post free. Return of post service. Retailers supplied. S.A.E. for details. **FINNIGAN SPECIALITY PAINTS, (W), Mickley Square, Stocksfield, Northumberland.**

WW—151 FOR FURTHER DETAILS.

"WIRELESS WORLD" TEST INSTRUMENTS

Complete sets of Metalwork, machine engraved Front Panels. Special Tag Boards and all specified 1st grade components. For professional appearance and performance.

Send 6d. in stamps for lists

MALVYN ENGINEERING WORKS

Engineers to the Radio and Electronic Industries

7 CURRIE STREET, HERTFORD, HERTS.

TELEPHONE: HERTFORD 2264

WW—152 FOR FURTHER DETAILS.

SURPLUS AIRCRAFT NAVIGATION EQUIPMENT

Originally part of an aircraft direction finding equipment and containing A.R.B. approved components.

POWER UNITS, 12 VOLT D.C. INPUT, 25 WATTS

Outputs 2 at 350 v. D.C. smoothed, and 1 at 6.3 v. Contains 3—OC36, 2—OC72, 9—Diodes, transformer relay, etc. In mottle grey aluminium case, 5½in. × 5in. × 6in. Could be adapted for shaver operation.

With circuit diagram—45/-, plus P. & P. 6/6. Diagram only 2/6, plus 9d. P. & P.

POWER UNITS AS ABOVE BUT 24 V. INPUT

40/-, plus P. & P. 6/6.

M.F. RECEIVER 200-400 & 500-900 KC/s.

Contains tuning and two I.F. stages, diodes and 2—OC170, 3—OC45, 2—OC702 and 2—OC318. In mottle grey aluminium case, 9in. × 5½in. × 3½in.

With circuit diagram 55/-, plus P. & P. 6/6. Diagram only 2/6, plus 9d. P. & P.

INDICATOR UNIT

Contains 2½in. C.R.T. Type DG7-5 (CV.2175), 2—ECC83, 1—ECC81, E.H.T. rectifiers and numerous condensers and resistors. In mottle grey aluminium case, 9in. × 6in. × 3½in and would form the basis of a miniature Oscilloscope.

With circuit diagram 55/-, plus P. & P. 6/6. Diagram only 2/6, plus 9d. P. & P.

The above items are brand new and complete but have not been tested and cannot therefore be guaranteed.

A small number of incomplete units of each version are available at 15/- each, plus P. & P. 4/-.

COMPONENTS—all first grade

Transistors OC36—matched pair	25/-
„ OC36—Single	10/-
„ OC170	7/-
„ OC45	4/-
„ AFZ12	12/6
Valves 12AT7 (ECC81)	4/-
„ 12AX7 (ECC83)	5/-
P. & P. 9d.	
E.H.T. Rectifiers K3.45	7/-
Vinkors LA2409	15/-
„ LA2103	15/-
Crystals 10.7 mc/s	15/-
P. & P. 1/-	
C.R. Tubes DG7-5	25/-
P. & P. 3/6	

Also many other items including capacitors, resistors, relays, diodes, slow motion drives, transformers, group wiring boards. Please send S.A.E. for list.

Enquiries and orders by post only to:—

**N. J. GAWLER,
40, Medina Road,
COWES,
Isle of Wight.**

WW—153 FOR FURTHER DETAILS.

Ideal opportunity to further your experience and be associated with Aeronautical Research and Development

AS AN

ELECTRONIC CRAFTSMAN

AT THE

ROYAL AIRCRAFT ESTABLISHMENT, BEDFORD

Electronic Craftsmen are required to work in a wide range of new and interesting fields in electronic engineering, covering instrumentation associated with model aircraft, digital data measurement and recording, digital computer techniques, radio telemetry systems coupled to research flying, aircraft simulation involving servo systems, aircraft radio/radar systems with particular reference to automatic blind landing of aircraft, and also ground radio/radar systems associated with Air Traffic Control.

In all these fields Craftsmen work very closely with research scientists and engineers, and are given every opportunity to expand their experience. Craftsmen are mainly employed in the construction, testing and maintenance of equipments. Encouragement is given to craftsmen to further their technical education. R.A.E. can offer excellent working conditions with good prospects for promotion, and housing may be available within a short time to married candidates from outside the area. Radio/T.V. service experience would be an advantage, but men who have an approved apprenticeship or training in electronics, telecommunications, light current electrical engineering, or H.M. Forces training in radio or radar, and who wish to further their experience, should apply to:—

Labour Manager,
Royal Aircraft Establishment,
Bedford.
Tel. BEDFORD 67411. Ex. 7.519

R & R RADIO & TV SERVICE

Dept. W.W.,
MARKET STREET, BACUP, LANCS
Telephone 465

SALVAGE VALVES

6F13	4/6	10P14	5/-	PL82	3/6	20P4	6/6
6L18	4/6	20P5	6/6	U801	7/6	30P16	5/-
EF80	1/6	30P4	7/-	10F1	1/6	PCC84	4/-
ECC82	3/-	6F15	5/-	20F2	5/6	PCL83	5/-
ECL80	3/-	EB91	1/-	30FL1	5/-	PY81	3/6
30F5	5/-	EF85	5/-	PY32	6/-	U301	6/-
PL38	8/-	EF37	6/-	6U4GT	5/-	10P13	5/6
PCF80	4/-	20P3	6/-	6F1	1/6	20D1	1/6
PL81	5/-	30PL1	6/-	ECC81	3/-	30P12	6/-
PZ30	5/-	PL36	6/-	EY86	4/-	PY82	4/-
U329	5/-	PCL82	5/-				

Speakers. Ex-TV. 6×4in., 3/6; 8in. round 6/-; post 2/-.

Line Output Transformers available. State set Model No. 10in. round speakers.

Turret Tuners. 8/-, post 2/-.

Scan Coils, etc. Quote set Model No. with all enquiries and S.A.E. for prompt reply. All goods subject to satisfaction or money refunded.

WW—154 FOR FURTHER DETAILS.

NEW COMPONENTS

B.B.C.2, TV, RADIO, TAPE REC., SPARES.

B.B.C.2/625. Complete conversion kits, or tuners and IF panels separately; send for free lists. Special offer, manufacturer's complete UHF conversion kit, tuner, transistorised sound and vision IF panel, controls fittings, etc., only £8/10, post 3/6. TV Signal Booster Units, Labgear B1/3, or UHF 75/-, masthead 105/-, Perdio UHF 70/-, post free; L.O.P.T.s., Philips, Stella 1768, 8617, etc., 92/6. Ekco-Ferranti U25 types 42/6, Ekco/Ferranti U26 and Perspex types 64/6, Ferguson 306, 308 42/6, 406, etc., 75/6. Sobell, TS17 48/6. 173, etc. 67/6, Pye V4 to V700, etc., 64/6 post 3/-; also Alba, Cossor, Decca, G.E.C., K.B., Invicta, Pam, Philco, McMichael, R.G.D., Dynatron, Emerson, Regentone, Ultra, H.M.V., Marconi, etc.; Scan coils, frame O/P, Frame osc., Line osc., mains sound O/P transformers width/lin coils mains droppers dual controls etc.; Tuner Units, Fireball, incremental, turrets, channel coils; CRTS, Mullard, Mazda, Brimar, Emiscope 14in and 17in 85/-, 21in 120/-, etc., carriage 10/-; Tape Recorders, belts, heads, motors, etc.; salvaged components—large selection clean, serviceable turrets, transformers, etc.; enquiries invited, C.O.D. 2/6. MANOR Supplies, 64, Golders Manor Drive, London, N.W.11 Callers, 589b, High Rd. (near Granville Rd.), N. Finchley, N.12. Hil. 9118 (day). Spe. 4032 (evg.); open all week incl. Sat. [101

EDINBURGH CORPORATION EDUCATION DEPARTMENT—FURTHER EDUCATION

Lorne Street Technical Institute

Applications are invited for the full time post of TEACHER OF ELECTRONICS SERVICING.

Applicants should have considerable experience in the field of electronics application, including the construction, testing and repair of electronics equipment and hold one of the following qualifications:—

(a) Higher National Certificate in Electrical Engineering with special reference to electronics engineering;

or

(b) Full Technological Certificate of City and Guilds of London Institute in Telecommunications (including Radio);

or

(c) A combination of the Intermediate and Final Certificates of the City and Guilds of London Institute in Radio and Television Servicing and in Electronics Servicing.

Duties will include the teaching of technology and practical work to full-time first year of apprenticeship courses and day release classes leading to the City and Guilds examinations.

Salary will be in accordance with the Teachers' Salaries (Scotland) Provisional Regulations 1964 as follows:—

£735 to £1,420 per annum.

Certificated teachers receive an additional payment of £70 per annum.

Placing on the scale is given for approved trade and teaching experience.

Further information and application forms, returnable by Friday, 27th August, may be obtained from the Director of Education, St. Giles Street, Edinburgh, 1.

TEST EQUIPMENT

VALVE VOLTMETER D.C. Input Impedance 11 Megohms. 7 Voltage ranges, D.C. to 1,500, A.C. to 1,500 R.M.S., 4,200 Peak to Peak. Resistance .2 ohm to 1,000 Megohms. Centre zero setting for receiver alignment. Complete with A.C./D.C. probe and leads. Full illustrated details on request. ONLY **£13/19/6** (Post 3/6).

SPECIAL OFFER OF AMERICAN VALVE VOLTMETERS
11 Megs. Input. 6 D.C. Voltage ranges to 1,000. 5 A.C. voltage ranges to 1,000. 6 Resistance ranges to 1,000 Meghohms. 4in. 200 microamp. meter. For 110/250 volts A.C. operation. With test prods and operating instructions. Manufactured by RCA and Electronic Designs. **ONLY £7/19/6** (Post etc. 3/6).

20,000 OHMS PER VOLT TESTMETER MODEL 700
Reads A.C. and D.C. voltages up to 5,000, Alternating and Direct Current up to 10 amps., Resistance up to 50 Megohms, Decibels from —10 to —42 dB. Internal buzzer for audible warning of short circuits or continuity, and fitted with automatic overload protection for movement. Meter size 4¾in. × 2½in., overall dimension 7½in. × 5¾in. × 3¾in. Has rigid handle which can be swivelled for use as a tilt support. **ONLY £17/10/-.**

30,000 OHMS PER VOLT TESTMETER MODEL 500.
Reads voltages up to 1,000 D.C. at 30,000 ohms per volt and A.C. at 15,000 o.p.v.; D.C. current to 12 amps. Resistance to 60 Megs.; Decibels from −20 to +56. Incorporates internal buzzer for audible warning of direct shorts and blocking condenser for A.F. output measurements. Size 3 5/16 in. × 6 5/16 in. × 2¾in. **ONLY £8/19/6.**

20,000 OHMS PER VOLT TESTMETER. MODEL TP-5S Reads, voltages up to 1,000 D.C. at 20,000 ohms per volt and A.C. at 10,000 o.p.v.; D.C. current to 500mA; Resistance to 10 Megs.; Capacitance to 0.1μF; Decibels from −20 to +36. Size 3½in. × 5¾in. × 1¾in. **ONLY £5/19/6.**

2,000 OHMS PER VOLT TESTMETER. MODEL TP-10. Reads A.C. and D.C. volts up to 1,000; D.C. current to 500mA.& Resistance to 1 Meg.; Capacitance to 1μF; Decibels from −20 to +36; Output jack for Audio measurements. Size 3½in. × 5in. × 1½in. **ONLY £3/19/6.**

FREQUENCY METERS TYPE LM.
Frequency range 125-20,000 kc/s. in 2 bands. This is the United States Navy Model of the well-known BC221 Freqency Meter, but has many additional features which increase its usefulness. Voltage stabilisation circuits and Crystal control ensure extreme accuracy and in addition it is fitted with an Internal Modulation switch to allow use as a Signal Generator. Size only 8¾in. × 8in. × 8½in. **ONLY £25.**

NOMBREX INSTRUMENTS

TRANSISTORISED AUDIO GENERATOR. 10-100,000 c/s. Sine or square wave. With battery **£16/15/-.**

TRANSISTORISED SIGNAL GENERATOR. 150 kc/s.-350 Mc/s. Better than 2%. With battery **£9/10/-.**

TRANSISTORISED RESISTANCE CAPACITY BRIDGE. 1Ω. 100 meg.Ω. 1 pf-100μf. Leakage test and visual null indicator. With battery. **£8/5/-.**

MAINS OPERATED TRANSISTOR POWER SUPPLY UNIT. Regulated output 1-15 v. up to 100 mA. Overload protection. **£6/10/-.**

TRANSISTORISED INDUCTION BRIDGE. 1μH to 100H, **£18**

VARIABLE VOLTAGE TRANSFORMERS. Fully shrouded. Input 230 v. A.C. 50/60 cycles. Output 0-260 v. 2.5 amps. type **£5/17/6.** 5 amps. type **£9.** 10 amps. type **£16/10/-.** 20 amps. type **£32/10/-.**

STANDARD TRANSFORMERS
Vacuum impregnated, interleaved, E.S. screen, universal mounting. Size 4in. × 3½in. × 2½in. ALL BRAND NEW **18/6** each. Post 2/6.
Type 1. 250-0-250 v. 80 mA., 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 mA.
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.

HARRIS ELECTRONICS (LONDON) LTD.

138 GRAY'S INN ROAD,
LONDON, W.C.1.
Telephone: TERminus 7937

Trading hours 9-6 Monday to Friday, closed Saturdays.
S.A.E. brings full details of any of above.

LEDEX SOLENOID DRIVEN WAFER SWITCHES

9-Bank 2-pole 8-way plus 2-Bank 4-way shorting, insulated to carry up to 10 Kv. on last two banks, operating voltage of solenoid 12-24 v. d.c. All wafers are standard size, removed from brand new equipment **32/6 ea.** P.P. 2/6.

RELAYS TYPE 3000

8 C.O. double wound coil 10+55 ohms, special latching type, a reverse polarity current to either coil release armature, operating voltage, 6 or 12 v. d.c., brand new stock by famous manufacturer .... **17/6** ea.
6 C.O. 500 ohms, new stock .... **10/-** ea.
6 C.O. 300 ohms, new stock .... **10/-** ea.
6 C.O. 350 ohms, new stock .... **10/-** ea.

RELAYS TYPE 600

4 C.O. 1,000 ohms, new stock .... **7/-** ea.
4 C.O. 500 ohms, new stock .... **7/-** ea.
4 C.O. 500 ohms slugged type .... **7/6** ea.

RELAYS, MINIATURE

RELAYS MINIATURE
S.T.C. 4184GD, 24 v. 700 ohms, 2 C.O.
S.T.C. 418gb, 6 v. 45 ohms, 2 C.O.
S.T.C. 4184GE 48 v. 2,700 ohms 2 C.O.
S.T.C. 4186EA. 1 v. 2 ohms, 2 C.O.
All above relays **8/6** each, plus P.P. on all relays 1/-.

MINIATURE RELAY BANKS

Six miniature relays 9-12 v., 1 make per relay, contained in neat aluminium case 6×4×1½in., with six half inch spaced crystal holders, designed to switch any desired crystal by remote control. Relays and crystal holders can be easily removed for other uses if required, terrific value, only **15/6.** P.P. 1/6.

MUIRHEAD KEY SWITCHES

Very latest type twelve C/O heavy duty silver contacts, these switches were designed for normal panel mounting, complete with chrome escutcheon plate and screws. Price **9/6** each, special terms for quantities.

D.C. TO A.C. ROTARY CONVERTORS. Input 220 v. D.C. at 1.5 amps., output 230 v. A.C. at 200 watts. The above rating is to Admiralty spec., normal motor mounting size 16 × 8in. Weight 77 lbs. **£12/10/-.**

Johnson Air Spaced T/X Condensers, 500pf. ceramic insulation. **25/-** P.P. 2/9.

LONDEX AERIAL C/O RELAYS.

Type 7026. Price **25/-.** P.P. 2/-.

COMMUNICATIONS RECEIVERS

★AR88D, as new .... **£45.** P.P. 25/-
★Hallicrafters 827 FM/AM 27.8 to 143 Mc/s. from **£25.** P.P. 25/-
★S.T.C. B46 1.5 to 15 Mc/s. perfect order .... **£12.** P.P. 17/6
★827CA FM/AM range 120 to 220 Mc/s. per con. **£45.** P.P. 25/-
★R1294 AM range 500 to 3000 Mc/s in 3 bands **£40.** P.P. 25/-
★Rediphon Marine receiver, range 260 Kc/s to 3.5 Mc/s........ **£15.** P.P. 20/-
★Marconi CR100/2 60kc-30Mc/s .... **£25.** P.P. 25/-
A.M. Type 1475 2·20 mc/s with power supply 250 A.C. .... **£15.** P.P. 20/-
★R208 10-60 mc/s. .... **£12.** P.P. 20/-

L.T. TRANSFORMERS

5 v. C.T. three times, at 5 amps., 230 v. primary. These U.S.A. transformers are excellent for charging purposes. New boxed, **22/6.** Carr. 3/6.
12 v.-7 v.-1½ v. at 1.5 A. Fully shrouded, tapped primary 240 A.C., small size, **12/6** each. P.P. 2/3.

TEN TURN COLVERN HELIPOTS

30K ohms, brand new stocks .... **22/6.** P.P. 1/3

POWER UNIT TYPE 234A

A source of power to operate your 1392 R/X or any equipment that requires a fully smoothed output of 250 v. d.c.+ 6.3 v. at 6 amps., for bench or 19in. rack mounting, fully fused tapped input 200 to 250 v. a.c., brand new cased units at only **55/-.** P.P. 12/6.

OSCILLOSCOPES

Cossor Double Beam Type 1035, perfect condition, **£27/10/-**
Cossor Double Beam Type 1052, portable, condition new, **£30.**
Hartley/Erscine Double Beam Type 13a, perfect condition. **£25.**
Cossor Double Beam Type 339A. **£12/10/-.**
E.M.I. Type WM3, as new, **£30.**
E.M.I. Type WM1, as new **£17.**
P.P. on above. £1.

ENGLISH ELECTRIC E.H.T. GENERATOR

0-10 kV. audio and visual indication.
Other types available up to 16 kV.

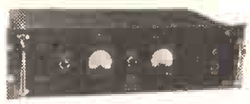
UNIVERSAL WAVEMETER R502

Absorption type wavemeter by S.T.C. frequency range 100 kc/s to 48 Mc/s with nine plug-in coils. Powered by 1½ volt dry cell and triode valve, complete with all calibration charts 250 micro amp meter, super slow motion dial, etc., the wavemeter coils calibration charts are contained in a neat wooden transit case, 14×13×8in., excellent condition. **£4/19/6.** carr. 7/6.

FOSTER VOLTAGE REGULATING EQUIPMENT TYPE 12A80

Input 250 A.C. max., input variation +5-15% output 250 v. A.C. constant. Load 80A max. As new **£65.** Carr. £4.

GCRE FS10 AUDIO FSK TERMINAL UNITS



Completely self contained, with internal mains supply, input and output sockets, carpenter relay type 5A6, mark space meters, etc., in perfect working order, condition as new. Size 19×9×5in. Price .... **£8/10/-.** P.P. 15/-.

PERFORMANCE TESTER TYPE 9170

Ideal for VHF and 2-meter enthusiasts small portable instrument, comprising signal generator, RF watt meter to 30 watts, and AF output meter, frequency range 100 to 150 mc/s, complete with all leads and plugs, internal 24 v. power supply. New, boxed instruments. Price **£12/10/-.** P.P. 10/-.

SIGNAL GENERATORS UHF

Marconi type 762/C 300-600 Mc/s. **£45.**
Marconi type 762 200-340 Mc/s. **£45.**
Marconi type TF801 8-300 Mc/s. **£45.**
G.R. type 804 8-330 Mc/s. **£17.**
G.R. type 605B 95 Kc/s. 30 M/cs. **£30.**

FREQUENCY METER G.R. TYPE 620A. Range 300 Kc/s-300 Mc/s. on direct reading frequency scale, accuracy is better than 0.01% or better when the frequency is checked in terms of the crystal calibrator, internal power supply 105-250 v. A.C. As new. Price **£75.** P.P. 20/-.

AVO ELECTRONIC MULTIMETER TYPE CT38. Measures resistance up to 1,000 Meg. Ohms, power from 50 uW to 5 watts, impedance from 15 to 5k/ohms. D.C. volts from 250 mV. to 250 v. A.C. volts from 250 mV. to 250 v., at frequencies up to 20 Mc/s. A.C. and D.C. amps from 10 uA to 10 amps. Condition as new. Price **£45.** P.P. 20/-.

WE HAVE IN STOCK HUNDREDS OF ELECTRONIC BARGAINS, WHY NOT PAY US A VISIT?

P. F. RALFE

423, GREEN LANES, HARRINGAY, LONDON, N.4.
MOUNTVIEW 6939

SEXTON'S FOR RADIOS

WHEN ONLY THE BEST IS GOOD ENOUGH

GENUINE OFFERS!

"WALTER" METROPOLITAN

MAINS/BATTERY TAPE RECORDER

MAKER'S ORIGINAL LIST PRICE 55 GNS.

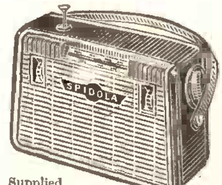
OUR PRICE £25 Carr. & Ins. 15/- extra.

Seven transistors with two watts output. High-Fi perfection with enough volume to fill a small hall on mains or battery. Only a very few now available. Complete with Mike, Tape, Spools, Leads, Instruction Book, and complete Service Manual.

THE RUSSIAN "SPIDOLA" 10 TRANSISTOR 8 WAVE-BAND PORTABLE RADIO

TRULY! A most amazing radio with world-wide performance on all eight wave-bands. Stations just roll in with bell-like clarity.

LONG WAVES		2,000—735·3 metres	(150—408 Kc/s.)
MEDIUM	,,	571.4—186·9 ,,	(525—1,605 Kc/s.)
SHORT	,, (1)	41—50 ,,	(5·95—7·3 Mc/s.)
,,	,, (2)	31 ,,	(9·5—9·775 Mc/s.)
,,	,, (3)	25 ,,	(11·7—11·975 Mc/s)
,,	,, (4)	19 ,,	(15·1—15·45 Mc/s.)
,,	,, (5)	16 ,,	(17·7—17·9 Mc/s.)
,,	,, (6)	13 ,,	(21·45—21·75 Mc/s.)

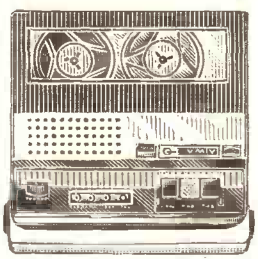


Internal ferrite rod aerial for reception of Long and Medium wave-bands and 8 section telescopic aerial extending to 38 in. for short wave ranges. Sockets for external aerial, earth and extension speaker or phones, also pick-up jack for use with gram, recorder or as amplifier. Exceptionally well designed two-tone cabinet with carrying handle. Supplied complete with batteries, weight approx. 5¾ lbs. Size 10½in. x 7½in. x 3¾in. Comprehensive instruction book and technical manual all in at **OUR PRICE £10/15/-.**

GOLD SPOT EIGHT TRANSISTOR DE LUXE PORTABLE RADIO

Medium and Long wave-bands. Exquisitely designed with Gilt finish facia and two tone plastic cabinet. Ferrite rod internal aerial also telescopic aerial and horizontal station tuning indicator. Comes complete with real brown leather case, strap, battery and earpiece with pouch. Size 5⅝ in. x 3¼ x 1⅜ in., weight 14 oz. **OUR PRICE £4/16/6.** P. & P. 3/6.

EAGLE-AIWA TWO-SPEED PORTABLE BATTERY TAPE RECORDER.



A real professional model for all speech and music recording. Twin track, two speeds 1⅞ and 3¾ i.p.s. Six transistors, one diode, one thermistor. Capstan drive. Equipped with remote control switch on Microphone, allowing for stop/start at will. Recording level and battery condition VU meter. Dash board styled push-button controls with Special Record button to prevent accidental erasure. Records and plays in upright position. Housed in attractive two tone high impact poly-vynyl case featuring a handy snap-open plexiglass top for fast, efficient tape loading. Size 9 in. x 8¾ x 3½ in. Weight 5 lbs. Complete with Tape, Spools, Batteries, Earphone for private playback—monitoring and microphone with instruction book. **OUR PRICE £16/16/-,** post paid. An A.C. mains Converter is available at 75/- extra.

LEAK STEREO "30" TRANSISTORISED INTEGRATED AMPLIFIER AND PRE-AMP

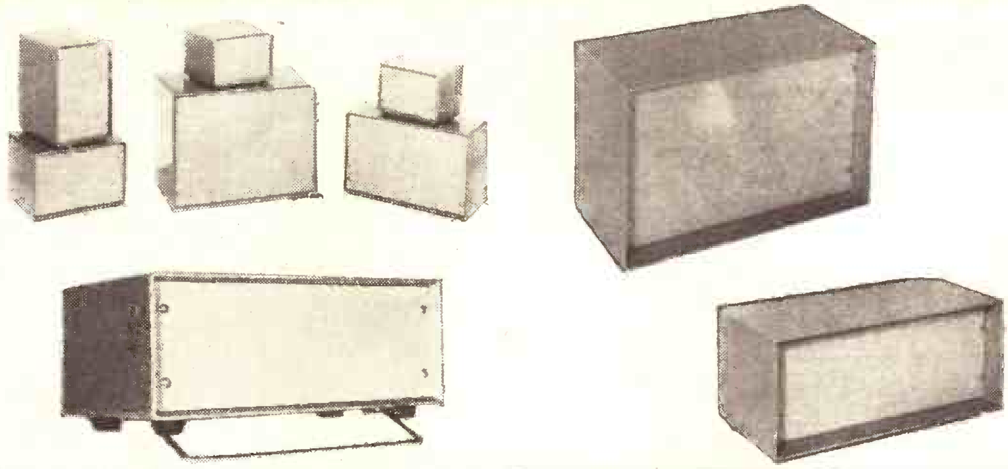
Power output 10 watts per channel into a 15 ohm load or 15 watts into 4 ohm load. Combined amplifier and control unit for stereo or monaural. **OUR PRICE £49/10/-** Carr. paid.
TERMS: CASH WITH ORDER ONLY. NO C.O.D. S.A.E. ALL ENQUIRIES PLEASE

J. E. SEXTON LTD.

162 Gray's Inn Road, London, W.C.1.
Telephone: TERminus 0228

WW—159 FOR FURTHER DETAILS.

NEW STANDARD CASES FROM OLSON



Quotations gladly given for customers' own specifications and special requirement.

WRITE FOR FURTHER DETAILS TO:—

OLSON ELECTRONIC LIMITED, 54, Myddleton Street,
LONDON, E.C.1. Telephone: TERminus 8081

WW—160 FOR FURTHER DETAILS.

HRO Rx's, etc., AR88, CR100, BRT400, G209, S640, etc., etc., in stock.—R. T. & I. Electronics, Ltd., Ashville Old Hall, Ashville Rd., London, E.11. Ley. 4986. [142

TEST EQUIPMENT — SURPLUS AND SECONDHAND

SIGNAL generators, oscilloscopes, output meters, wave voltmeters, frequency meters, multi-range meters, etc., etc., in stock.—R. T. & I. Electronics, Ltd., Ashville Old Hall, Ashville Rd., London, E.11. Ley. 4986. [141

Audix
SOUND SYSTEMS
AUDIO EQUIPMENT MANUFACTURES
STANSTED, ESSEX.
Phone: STANSTED 3132

WW—161 FOR FURTHER DETAILS.

EXCHANGES

WE purchase for spot cash, modern used hi-fi equipment, quality tape recorders, communication RXs, stereo gear, etc., etc.; call, write or telephone, best prices given.—Miller's Radio, 38a, Newport Court, few yards from Leicester Square Undergound station, Ger. 4638. Est. 20 years. Buyer can collect within 100 miles radius. [137

SERVICES OFFERED

JOIN Audio Supply Service, 7/6 p.a. (60-page photographically illustrated, non-advertising), hi-fi catalogues, 4/6: your best guide for safe buying.—10, Clifford St., London, W.1. [111

THE PEMBRIDGE COLLEGE OF ELECTRONICS PROVIDES TRAINING IN RADIO AND TELEVISION

FULL-TIME COLLEGE COURSE IN RADIO AND TELEVISION

Our Course has now been extended to sixteen months' duration to include theoretical and practical instruction on transistor television receivers, U.H.F television receivers and colour television.

Next Course commences 7th September, 1965.

This Course is recognised by the Radio Trades Examination Board (R.T.E.B.) for the Radio and Television Servicing Certificate examinations.

Provides excellent practical experience on valve and transistor radio receivers and all well-known makes of television receivers.

To:
The Pembridge College of Electronics (Dept. P10)
34a Hereford Road, London, W.2.

Please send, without obligation, details of the Full-time Course in Radio and Television.

Name ____________________

Address ____________________

____

CHP 3

WW—162 FOR FURTHER DETAILS.

RADIO CLEARANCE LTD.

BULK ENQUIRIES INVITED

27 TOTTENHAM COURT RD., LONDON, W.1
The oldest Component Specialists in the Trade

Telephone: MUSEUM 9188
EST. 35 YEARS

BARGAINS STILL AVAILABLE IN LOUDSPEAKERS

Enormous purchases of Brand New and guaranteed Plessey loudspeakers enable us to offer these units at THE LOWEST PRICES EVER.
Don't miss this golden opportunity to obtain a first-grade permanent magnet **LOUDSPEAKER** off the production line at **LESS THAN MANUFACTURER'S COST.**
Read carefully the prepared list below and choose just the right speaker for the job—COMPARE THE PRICES ANYWHERE.

SCHEDULE OF LOUDSPEAKERS AVAILABLE

Diameter in inches	Gauss in Lines	Impedance in Ohms	Price	Diameter in inches	Gauss in Lines	Impedance in Ohms	Price	Diameter in inches	Gauss in Lines	Impedance in Ohms	Price
2	7,000	80	8/-	3½	9,500	3	10/6	4	7,000	35	11/-
2¼	7,000	35	8/6	3⅝	9,500	8	10/6	4	9,500	35	11/6
2½	7,000	50	8/6	3⅝	7,000	35	8/6	5	7,000	3	8/6
2¼	7,000	80	8 -	3⅝	9,500	50	10/6	5	7,500	3	9/-
3	8,500	3	10/-	4	9.500	25	11/6	5	9,500	3	10/6
3	6.000	5	8/6	4	9,000	50	11/6	5	9,500	15	12/6
3	6.500	80	9/6	4	9.500	15	12/-	5	8.500	25	10/6
3	7.000	5	9/-	4	7,500	5	9/6	6½	7,000	3	11/-
3	7,000	35	9/-	4	7.000	25	11/6	8	6,000	15	13/6
3½	6,000	15	10/-	4	6,000	35	10/6	8	8,500	3	13/6
3½	7,000	3	9/6								

Elliptical Size in ins.	Gauss in Lines	Impedance in Ohms	Price	Elliptical Size in ins.	Gauss in Lines	Impedance in Ohms	Price	Elliptical Size in ins.	Gauss in Lines	Impedance in Ohms	Price
5 × 3	7,000	[illegible]	8/-	6 × 4	9,500	35	12/-	8 × 2¾	6,000	3	8/6
5 × 3	9,000	35	12/-	7 × 3⅝	7,000	3	9/6	8 × 2¾	8,500	5	9/6
5 × 3	9.000	3	8/6	7 × 3⅝	9.500	3	10/6	8 × 2¾	9,500	3	10/-
5 × 3	9,500	3	9/-	7 × 3⅝	9,500	8	11/6	8 × 5	8,500	3	11/-
6 × 4	8,500	3	9/6	7 × 4	9,500	3	11/-	8 × 5	11,000	3	13/6
6 × 4	9,500	3	10/-	7 × 4	9,500	30	12/6	10 × 6	11,000	3	22/6
				7 × 4	10,000	3	12/6	10 × 6	11,000	5	22/6
				7 × 4	12,000	3	15/6	10 × 6	11,000	25	23/6

ALLOW 2/6 each speaker for P. & P./handling charges, and please specify the exact requirements—the nearest available will be sent.

SELECTED BARGAINS

Beautifully geared AM/FM 2-Gang Condensers **4/6**; AM/FM IFT's 465 kc/s. and 10.7 Mc/s. **4/6** pair; Magnavox Crystal Tape Recorder Mikes **12/6**; 3 watt Stereo Amplifiers complete ready to switch on. **79/6**; Sentercell rectifiers R3 2D; 3D-3-2-1Y, **2/6** each. **DIODES** OA70, OA79, OA90, CG46H, GD10, 2/- each. **TRANSISTORS**:OC45 **4/6**; PXA 101 **3/9**; AF115 **4/6**. **SUBMIN GERMANIUM DIODES 1/3. M.I. DIODES 6d.** each. Silicon Diodes 400 PIV 330 mA. **2/6** each.

Please send STAMPED AND ADDRESSED envelope with any enquiry. We regret no catalogues—our stocks move too quickly! Kindly make provision for sufficient postage and packing charges to avoid delay. **TERMS:** Cash with order or C.O.D. on orders over 30/-.

---

tonbridge laboratories

GENERAL PURPOSE OSCILLOSCOPE MODEL T.L.4

£29.19.6

An extremely versatile instrument available direct from the manufacturers at a very low cost. Guaranteed for six months.

P. & P. 8/6.

C.R.T. — 3 inches.
AMPLIFIER — 10 c/s—.25 mc/s (±3 dB approx.).
TIME BASE — 1μ sec./cm.—.1 sec./cm. Fully variable.
INPUT — 4 ranges 100 mV/cm.—50 V/cm.
SIZE — 5in. wide, 7in. high, 10¼in. long.
WEIGHT — 10lbs.
CONSUMPTION — 35 watts—230/250 V A.C.
TERMS — C.W.O. or C.O.D. Post only.

WRITE TO — 14 Ogle Street, London, W.1 FOR FULL DETAILS:

WW—163 FOR FURTHER DETAILS.

SERVICE & REPAIRS

SPEAKER repairs, cones fitted, guaranteed satisfaction.—L.S. Repair Services, Pluckley, Ashford, Kent. [132

SPEEDY and expert tape recorder and hi-fi repairs by England's leading hi-fi specialists.—Telesonic, Ltd., 92, Tottenham Ct. Rd., London, W.1. Mus. 8177. [126

CAPACITY AVAILABLE

RECTIFIERS, Selenium and Silicon units supplied for all applications, keen prices, good deliveries. J. R. SERVICES & DEVELOPMENTS, 231, Rivermill, Harlow, Essex. Tel. Harlow 26481. [112

AIRTRONICS, Ltd., for coil winding, assembly and wiring of electronic equipment, transistorised sub-units, sheet metal work.—3a, Walerand Rd., London, S.E.13. Tel. Lee Green 1706. [107

AGENTS

COMPANY director experienced technical sales in electronics, marine, machinery, leaving soon for area. Florida/Gulf/Bahamas/West Indies, seeks appointments as agent for the area.—Box WW1300, Wireless World.

TO ALL

Manufacturers, Wholesalers, Importers, etc. of the Radio and Electronic Industries

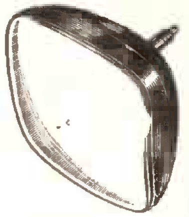
We are spot cash purchasers for all types of redundant and surplus stocks.

Phone or write Hillside 2713
Stonegrove 7624

Broadfields Disposals Ltd.,
8, Broadfields Avenue,
Edgware, Middx
or
Mayco Products Ltd.,
21 Lodge Lane,
N. Finchley, N.12

WW—164 FOR FURTHER DETAILS.

LAWSON BRAND NEW TELEVISION TUBES



TWELVE MONTHS FULL REPLACEMENT GUARANTEE

12 MONTHS FULL REPLACEMENT GUARANTEE

Today's Orders dispatched Today, and full fitting instructions are supplied with every tube.

Terms: C.O.D. or C.W.O. Carriage and insurance 8/6.

The continually increasing demand for tubes of the very highest performance and reliability is now being met by the new Lawson "Century 99" range of C.R.T.'s.

"Century 99" are absolutely brand new tubes throughout, manufactured by Britain's largest C.R.T. manufacturers. They are guaranteed to give absolutely superb performance, needle sharp definition, screens of the very latest types giving maximum Contrast and Light output; together with high reliability and very long life.

"Century 99" are a complete range of tubes, in all sizes for all British sets manufactured 1947-1964.

Our stocks are very large and we can supply the EXACT tube you require by return.

12″ — £4 : 10 . 0
14″ — £5 : 10 : 0
17″ — £5 : 19 : 0
19″-21″ — £7 : 15 : 0

LAWSON TUBES
2, PEACHFIELD CLOSE
MALVERN, WORCS.
Tel. 2100

WW—165 FOR FURTHER DETAILS.

A COMPLETE SERVICE

FROM YOUR BREADBOARD OR ROUGH PROTOTYPE, PRINTED CIRCUITS PREPARED, ASSEMBLED AND TESTED. SMALL OR LARGE QUANTITIES.

INSTRUMENTS
TO FINAL STAGE INCLUDING CASE DESIGN AND STYLING.
FINAL TEST AND FURTHER DEVELOPMENT IF REQUIRED.

DESIGN
FACILITIES AVAILABLE FOR ALL TYPES OF ELECTRONICS.

SUB CONTRACT
ELECTRONIC OR ELECTRICAL WORK UNDERTAKEN. ANY NUMBER. EXCELLENT DELIVERIES.

RCS ELECTRONICS
NATIONAL WORKS, BATH ROAD, HOUNSLOW, MIDDX. HOU 0257

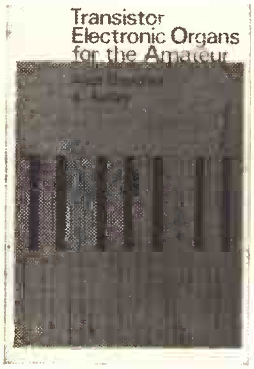
WW—166 FOR FURTHER DETAILS.

Pitman

TRANSISTOR ELECTRONIC ORGANS FOR THE AMATEUR

Alan Douglas & S. Astley

This book presents not only a detailed design for constructing a full scale organ, but a complete explanation of everything to do with transistor organs. 18s net



PICK - UPS The Key to Hi - Fi

J. Walton

This book challenges the common assumption that the loudspeaker is the weakest link in the record reproduction chain. The author concludes that it is the pick-up that causes most distortion. For all hi-fi enthusiasts. 10s net

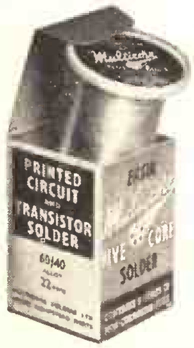
PITMAN PARKER ST LONDON WC2

WW—167 FOR FURTHER DETAILS.

ERSIN Multicore SOLDER

NEW!

PRINTED CIRCUIT & TRANSISTOR SOLDER



Designed specifically for Printed Circuits and High Temperature Sensitive Components. Plastic re-usable reel contains 212 feet of 60/40 High Tin Quality 22 s.w.g. ERSIN MULTICORE SOLDER with 5-cores of non-corrosive flux. Ask for Size 10.

15/- each (Subject)

* For small users, the same specification is available on a 2/6d. reel (subject).

Bib THE PROFESSIONAL TAPE SPLICER

All metal—beautifully plated—compact in size. Easily and permanently attached to a tape recorder. Clamps hold the magnetic or leader tapes in the precision cut channel—no damage to the edges. Right angle and oblique cutting slots.

Complete with Razor Cutter 18/6

Bib WIRE STRIPPER AND CUTTER

This efficient tool strips Insulation, cuts wires cleanly and splits plastic twin flex. It is adjustable to most wire thicknesses.

3/6 each (Subject)

If you have any difficulty in obtaining these items they will be sent post free (U.K. only)

MULTICORE SOLDERS LTD.
HEMEL HEMPSTEAD, HERTS.
TEL: HEMEL HEMPSTEAD 3636

CMMS 25a

(See also advertisement on back cover)

WW—168 FOR FURTHER DETAILS.

EXCLUSIVE OFFERS

TRANSPORTABLE STEEL 60-FOOT AERIAL TOWERS

★ **Unique design.**

★ **Scientific Construction.**

having the following unusual features.

- ★ Entirely self supporting requiring no guys, stays, foundations, pickets or spikes, or any attachment to the ground.
- ★ Fitted with step ladder to the top and balcony with railings all round. (You can walk right round the top with both hands free.)
- ★ 12 feet square at base tapering to 6 feet square at top, they are quite safe when subject to gale force winds and will accept 50 square feet superficial area on top at force of 60 m.p.h. They require ground area of 16 feet square.
- ★ Will support up to 2 tons of equipment on top, the whole tower can be completely lowered to the ground by 2 men in 20 minutes and raised in the same time.
- ★ Can be completely erected and dismantled by 3 men.
- ★ Breaks down for transport by 2 ton lorry into parts easily handled by 2 men; there are no small loose parts, no nuts or bolts to get lost or damaged; all screws and adjustments are fully protected from rust and so designed to be free from damage when transported or left loose on the ground.
- ★ Foolproof—the Tower cannot be erected if not assembled correctly. No skilled labour is required and no special tools are necessary.
- ★ Can be raised and lowered, erected and dismantled as many times as desired.
- ★ Everything necessary for the complete tower to be put into use and raised and lowered is provided; full drawings and instructions.

These fine Towers were made in England by B.I.C.C. and cost the Government £2,200 each. They are brand new and in maker's original packing. You can see one erected at our premises.

Price £345
Full details on request.

40-page list of over 1,000 different items in stock available—keep one by you.

★ 75 ft. Plywood Aerial Masts	£35	0
★ 9 foot BC-610 Whip Aerials	£1	15
★ Eddystone S.750 Receivers	£39	0
★ Redifon R.146 Communications Receivers	£27	10
★ R.C.A. AR-88D Receivers	£47	10
★ R.C.A. 420 m/cs. Yagi 5 el. Beams	£2	10
★ Western Electric Stabilised Power Units 100/250v. in 115v. 1 amp out.	£17	10
★ Model 15 Teletype Page Printers	£29	10
★ Model 14 Teletype Tape Readers	£25	0
★ Model 14 Teletype Reperforators	£25	0
★ R.C.A. 25 watt Projector Loudspeakers, range 1 mile	£14	10
★ E.M.I. WM5A Oscilloscopes	£75	0
★ Edwards Speedivac Vacuum Pumps 230v. A.C.	£22	10
★ Precision Mains Filter Units		10
★ 5 foot P.O. Angle Iron Racks	£3	10
★ 3 foot P.O. Heavy Channel Section Racks	£2	10
★ E.M.I. Recording Bridges	£12	10
★ FSY-1-1 Teleprinter Terminal Units	£7	10
★ Marconi HD-11 Teleprinter Terminal Units	£25	0
★ Avo Geiger Counters	£7	10
★ Creed 7B Teleprinters 24v. D.C.	£12	10
★ Philco W.S. No. 43 Transmitters 350W.	£75	0
★ Metro Vickers HS.500 Waveform Monitors	£135	0
★ E.M.I. 3794 Waveform Monitors on trolleys	£45	0
★ Motorola 6v. Mobile Transmitters 30/40 m/cs	£12	10
★ Pen type Personal Dosemeters		15

Carriage extra at cost on all above.

We have a large quantity of "bits and pieces" we cannot list—please send us your requirements—we can probably help—all enquiries answered.

P. HARRIS
ORGANFORD - DORSET
WESTBOURNE 65051

WW—169 FOR FURTHER DETAILS.

PATENTS

DESIGNER offers "An Improved Intercom System" suitable for offices, etc.—Box WW 17, Wireless World.

THE proprietor of British Patent No. 750436, entitled "Radio navigation system," offers same for license or otherwise to ensure practical working in Great Britain.—Inquiries to: Singer, Stern & Carlberg, 140 So. Dearborn St., Chicago, Illinois 60603, U.S.A. [1255

MISCELLANEOUS

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. [123

INVENTOR'S prototypes, models for research, demonstration, mystery window display or technical intimidation!—Gerald Seymour, 30, Devonshire Drive, Stapleford, Nottingham. [111A

ORDER directly from U.S.A., all kinds of electronic products, lowest prices ever.—Write for quotations indicating specific products to. O'Hara International, 205½, North Inglewood Ave., Inglewood, California, U.S.A. 90301. [89

THE SOTONIAN TRADING CO.

AMPLIFIERS
Tannoy portable loud speaking amplifiers with power microphone. Four 6L6G's in output, with sufficient power for 10 speakers. **Price £18**

AUTOMATIC VOLTAGE REGULATORS
Automatic carbon pile voltage regulators by Newton Bros. (Derby) Ltd. 115v AC, type 4. **Price £12**

CABLES
Circular rubber covered twin leads, suitable for battery chargers, etc., 30ft. long 8/6
Coaxial cable, .45" diameter, 2/- per yard.

CHOKES
Small L.F. smoothing chokes, 50 m.a. 6/–
Small L.F. smoothing chokes, 60 m.a. 8/–

CONDENSERS
TCC Metalpack tubular, .1 mfd. or .05 mfds., 350 v. DC working .... 9d.
Ditto, .25 mfds. 1/6
TCC tubular 75pf, 5,000 v. DC 1/9
Dubilier metal tubular, 1 mfd., 350 v. DC 1/9
TCC, 2 mfds., 10,000 v. DC £12
TCC, .1 mfds., 11,000 v. DC........ £2
TCC, .02 mfds., 11,000 v. DC 25/–
Westinghouse .5 mfd., 7,500 v. DC .. 25/–
Sprague tubular, .1 mfds., 500 v. DC .. 9d
BI Cables, .01 mfds., 5,000 v. DC .. 2/6
Hunts mica., .002 mfds., 350 v. DC .. 8d
TCC electrolytic 2,000 mfds., 25 v. DC 12/6
Suppressor, .5 mfds., 200 v. DC 1/3
Suppressor, .5 mfds., 400 v. DC .. 2/-
Jackson Bros. single variable, 132 p/f 5/–
Large laboratory type variable, suitable for transmitters, etc. £2

INDUCTANCES
Transmitter inductance units by Redifon, with 10 turns approx. 5in. diameter, and sliding clip. Very suitable for laboratory use £3

METERS
moving iron projecting type meters, A.C./DC, approx. 4in. dia. 0-150 v. £1
Some other types of meters available.

POTENTIOMETERS
Miniature potentiometers, 1 meg. 2/–
Reliance 400 ohm wire wound potentiometers, $1\frac{3}{4}$in. diameter, with knob .. 4/3
Colvern wire wound potentiometers, 20,000 ohms, pre-set type 3/–

RECTIFIERS
Westinghouse 12 v., 3 amp. metal rectifiers 12/6

ROTARY INVERTORS
Type 8a. Input 24 v. DC. Output 115 v, 3 phase, 400 cycles, 1.8 amps. **Price £5**

SIGNAL GENERATORS
Marconi type TF517F/1, covering 18-58 mc/s., and 150-300 mc/s. These are offered by us brand new, and as received from Government sources, at £15 each, with instruction book. Carr. and packing 35/- extra.
Signal generator, service type, SHF, No. 8, with equipment £60

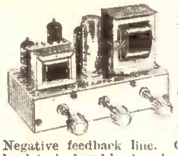
TRANSFORMERS
Heavy duty unit in sealed container. Nominal input voltages, 117/234 v. Outputs 330-0-330 v., 200 ma., 5 v., 2 amps. 6.4 v., 4 amps. .... **Price 35/–**
Heavy duty unit, inputs 230 v. Outputs 4.5 v. C.T. at 6 amps., 4.5 v. C.T. at 6 amps., 4.5 v. at 20 amps., C.T. **Price £3/10**
Telephone transformers, type 34 or 35 5/–
Transformers, fitted with terminals. Input 230 v. outputs 365-0-365 v. at 180 m.a. 0-5.75/6.75 v. at 12 amps. 0-5.75/6.75 v. at 12 amps. 0-5.75/6.75 v. at 12 amps., 0-5.75/6.75 v. at 12 amps. Price £3/10/-, Other types available.
Westinghouse transformers, input 115 v., 400 cycles, and various LT outputs. Prices on request.

Postage or carriage extra. Prompt despatch.

SOTONIAN TRADING CO.,
53, The Avenue, Southampton
Tel. 56537

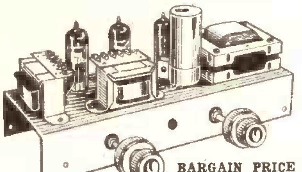
WW–172 FOR FURTHER DETAILS.

3-VALVE AUDIO AMPLIFIER MODEL HA34



Designed for Hi-Fi reproduction of records. A.C. mains operation. Ready built on plated heavy gauge metal chassis, size $7\frac{1}{2}$in. w. × 4in. d. × $4\frac{3}{4}$in. h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker, separate bass, treble and volume controls. Negative feedback line. Output $4\frac{1}{2}$ watts. Front panel can be detached and leads extended for remote mounting of controls. The HA34 has been specially designed for us and our quantity order enables us to offer them complete with knobs, valves, etc., wired and tested for only **£4/5/-**. P. & P. 6/-.

STEREO AMPLIFIER

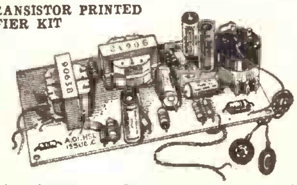


Incorporating 2 ECL82s and 1 EZ80; heavy duty, double wound mains transformer. Output 4 watts per channel. Full tone and volume controls. Absolutely complete.

BARGAIN PRICE ONLY £4/19/6. P. & P. 6/6.

SUPER DE LUXE version of above incorporating ECL86 valves. separate bass and treble controls and full negative feed back, **8 gns.** P. & P. 6/6.

HIGH GAIN 4-TRANSISTOR PRINTED CIRCUIT AMPLIFIER KIT
Type TA1



● Peak output in excess of $1\frac{1}{2}$ watts. ● All standard British components. ● Built on printed circuit panel, size 6×3in. ● Generous size driver and output transformers. ● Output transformer tapped for 3 ohm and 15 ohm speakers. ● Transistors (GET 114 or 81 Mullard OC81D and matched pair of OC81 o/p). ● 9 volt operation. ● Everything supplied, wire, battery clips, solder, etc. ● Comprehensive easy to follow instructions and circuit diagram 1/6 (Free with Kit). All parts sold separately. **SPECIAL PRICE 45/-.** P. & P. 3/-. Also ready built and tested, **52/6.** P. & P. 3/-. A pair of TA1s are ideal for stereo.

MAINS TRANSFORMERS
Fully shrouded, can be mounted upright or drop through. Tapped pri. 110, 200, 220, 240 v. Sec. 250 v. $\frac{1}{2}$ wave at 85 mA. and 6.3 v. 2 amps, c/t. Stack size 3in. × $2\frac{1}{4}$in. × $1\frac{3}{4}$in.
PRICE 12/6. P. & P. 3/6.
ALSO Semi shrouded drop thro' type. Pri. 200, 220, 240 v. Sec. 250 v. $\frac{1}{2}$ wave at 70 mA. and 6.3 v. at 2 amps. c/t. Stack size 3in. × $2\frac{1}{2}$in. × $1\frac{3}{4}$in. **PRICE 11/-.** P. & P. 3/-.

4-SPEED PLAYER UNIT BARGAINS
All brand new in maker's original packing.

SINGLE PLAYERS

	£	s	d
B.S.R. TU/12	£3	9	6
B.S.R. GU7 with unit mounted pick-up arm	£4	18	8
Garrard SRP10	£5	9	11
E.M.I. with unit mtd. pick-up arm	£4	9	6

Carr. 5/6 on each

AUTO. CHANGERS

	£	s	d
Latest B.S.R. UA25 Super slim	£6	2	6
B.S.R. UA15 £6/19/6. B.S.R. UA16	£6	19	6
Latest GARRARD AT5	£8	8	0
GARRARD AT6	£10	10	0
GARRARD Auto-Slim	£6	10	0

Carr. 6/6 on each.

All the above units are complete with t/o mono head with sapphire styli or can be supplied with stereo head at **12/6** extra.

BRAND NEW CARTRIDGE BARGAINS!
GARRARD GC2 Mono complete. List price 24/11. **Our Price 12/6.** P. & P. 1/-.
RONETTE STEREO 105 CARTRIDGE Stereo/LP/78 complete with two sapphires. Original list price **67/9.** **Our Price 24/-.** P. & P. 1/-.

QUALITY RECORD PLAYER AMPLIFIER
A top-quality record player amplifier. This amplifier (which was used in a 29 gn. record player) employs heavy duty double wound mains transformer, ECC83, EL84, EZ80 valves. Separate bass, treble and volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in. w. × $2\frac{1}{2}$in. d. × $5\frac{1}{4}$in. h. Ready built and tested. **PRICE 69/6.** P. & P. 4/9.
ALSO AVAILABLE mounted on board with output transformer and 6in. speaker ready to fit into cabinet below. **PRICE 89/6.** P. & P. 5/9.

QUALITY PORTABLE R/P CABINET
Uncut motor board. Will take above amplifier and B.S.R. or GARRARD Autochanger or Single Record Player Unit. Size 18 × 14 × $8\frac{1}{4}$in. **PRICE £3/9/6.** Carr. 7/6.

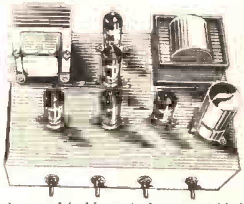
NEON A.C. MAINS INDICATOR
For panel mounting, cut out size $1\frac{1}{8}$in. × $\frac{5}{8}$in. × $\frac{3}{4}$in. deep, inc. terminal. White case with red lens giving bright light. For mains 200/250 v. **2/6** each. P.P. 6d. 6 or more post free.

4-WAY NON-TANGLE TELEPHONE CABLE. Latest spring-back coil type, extends 12in. to 5ft. Complete with rubber bushes, **4/6** each. P. & P. 1/6.

BRAND NEW 3 OHM LOUDSPEAKERS
5in. **12/6**; $6\frac{1}{2}$in. **15/-**; 8in. **21/-**; 10in. **25/-**; 12in. **27/6**; (12in. 15 ohms **30/-**); 10in.×6in. **26/-**; **E.M.I.** $13\frac{1}{2}$×8in. with high flux ceramic magnet, **42/-** (15 ohm **45/-**).
4in. HIGH FLUX TWEETER. 3 ohm or 15 ohm imp. Famous British make. **12/-.** (P. & P. 4in. and 5in. 2/-; $6\frac{1}{2}$ and 8in. 2/6; 10 and 12in. 3/6 per speaker.)

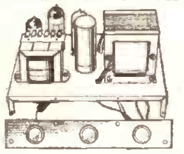
BRAND NEW 12in. 15 w. H/D SPEAKERS
3 or 15 ohm. Current production by well-known British maker. Offered below list price at **89/6.** P. & P. 5/-. (25 w. guitar model **£5/5/-**). (35 w. guitar model **£8/8/-**.)

10/14 WATT HI-FI AMPLIFIER KIT



A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3-15Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up: 2 EL84s, ECC83, EF86, and EZ80 rectifier. Simple instruction booklet 1/6. (Free with parts.) **All parts sold separately. ONLY £6/19/6.** P. & P. 8/6. Also available ready built and tested complete with standard input sockets, **£8/15/-.** P. & P. 8/6.

A NEW HARVERSON KIT FOR THE HOME CONSTRUCTOR



A really excellent, all purpose A.C. mains 200/240 v.
AMPLIFIER KIT
TYPE HSL "FOUR" 3-VALVE. 4 WATT USING ECC83, EL84, EZ80 VALVES.
Special features include: ★ Heavy duty double-wound mains transformer with electrostatic screen. ★ Separate bass, treble and volume controls, giving fully variable boost and cut with minimum insertion loss. ★ Heavy negative feedback loop over 2 stages ensures high output at excellent quality with very low distortion factor. ★ Suitable for use with guitar, microphone or record player. ★ Provision for remote mounting of controls or direct on chassis. ★ All this builds on to a chassis size only $7\frac{1}{2}$in. wide × 4in. deep. Overall height $4\frac{3}{4}$in. ★ All components and valves are brand new ★ Very clear and concise instructions enable even the inexperienced amateur to construct with 100% success. ★ Supplied complete with valves, output transformer (3 ohms only), screened lead, wire, nuts, bolts, solder, etc. (No extras to buy.) **PRICE 79/6.** P. & P. 6/-.
Comprehensive circuit diagram, practical layout and parts list 2/6. (free with kit).

EXCLUSIVE OFFER
FOR PERSONAL CALLERS
(100 ONLY)

A wonderful opportunity for you to build a quality **A.M./F.M. TRANSISTOR RADIO TUNER UNIT** for 9 v. operation. We offer the essential very high grade specially matched components comprising F.M. tuner head pre-aligned (88-108 Mc/s), complete with transistors. Two combined A.M./F.M. I.F. transformers, one discriminator transformer, one A.M. last I.F. transformer. Multi-bank switch for Gram/F.M./L.W./M.W. selection. Most attractive coloured dial, size $8\frac{1}{4}$ × $3\frac{3}{4}$in. A.M. tuning gang, hardware items for tuning mechanism, A.M. ferrite rod aerial (M.W./L.W.) with coupling winding, trimmer bank, tuning drum, pulleys, etc. and suggested circuit diagram. **OFFERED AT THE AMAZING PRICE OF 4 GNS.** For personal callers only.

SPECIAL PURCHASE! TURRET TUNERS
by famous maker
Brand new and unused. Complete with PCC84 and PCF80 valves. 34-38 Mc/s. I.F. Biscuits for Channels 1 to 5 and 8 and 9. Circuit diagram supplied. **ONLY 25/- each.** P. & P. 3/9.

GÖRLER F.M. TUNER HEAD
88-100 Mc/s. 10.7 Mc/s. I.F. **15/-.** P. & P. 2/-. (ECC85 valve 8/6 extra.)

TAPE DECKS
B.S.R. MONARDECK (Single speed) $3\frac{3}{4}$in. per sec., simple control. uses $5\frac{3}{4}$in. spools. **£6/15/-.** plus 7/6 carr. and ins.
COLLARO STUDIO DECK. 3 motors, 3 speeds, push button control. Up to 7in. spools **£10/10/-.** P. & P. 7/6. (Tapes extra on both.)

SPECIAL PURCHASE!
FROM LEADING HI-FI MANUFACTURER
7-10 watt **OUTPUT TRANSFORMERS** to match pair of ECL86s in push-pull to 3 ohm output. **ONLY 11/-.** P. & P. 2/6.
7-10 watt **ULTRA LINEAR OUTPUT TRANSFORMERS** to match pair of ECL82s in push-pull to 3 ohm output. **ONLY 15/-.** P. & P. 2/6.
SPECIAL MAINS TRANSFORMERS to match either of the above. Tapped primary. Secondary 250 v. 80 mA half-wave and 6.3 v. 2 amps. **ONLY 12/6.** P. & P. 3/6.

MATCHED PAIR OF $2\frac{1}{2}$ WATT TRANSISTOR DRIVER AND OUTPUT TRANSFORMERS. Stock size $1\frac{1}{2}$×$1\frac{1}{8}$×$\frac{3}{4}$in. Output trans. tapped for 3 ohm and 15 ohm output. **10/-** pair, plus 2/- P. & P. Worth double.
BRAND NEW PLESSEY. 12 v. 4 pin non-sync. vibrators. Type 12 1.4SD. **ONLY 8/6.** P. & P. 1/6 each.
SPKR. & CAB. FABRICS. **13/6** per yd. S.A.E. for samples.

HARVERSON SURPLUS CO. LTD.
170 HIGH ST., MERTON, S.W.19. CHErrywood 3985
Open all day Saturday Early closing Wed., 1 p.m.
A few minutes from South Wimbledon Tube Station. (Please write clearly).
Overseas P. & P. charged extra. S.A.E. with all enquiries.

Radiospares Ltd.

FOR ELECTRONIC COMPONENTS–BY RETURN

TRADE ONLY

RS

WW—173 FOR FURTHER DETAILS.

DAMAGED METER?

Have it repaired by Glaser

Reduce overheads by having your damaged Electrical Measuring Instruments repaired by L. Glaser & Co. Ltd.

INSTRUMENT REPAIRS

We specialise in the repair of all types and makes of Voltmeters, Ammeters, Micro-ammeters, Multirange Test Meters. Electrical Thermo-meters. Recording Instruments, etc.

As contractors to various Government Departments, we are the leading Electrical Instrument Repairers in the Industry. For prompt estimate and speedy delivery send defective instrument by registered post, or write to Dept. W.W.:—

L. GLASER & CO. LTD.

1-3 Berry Street, London, E.C.1.
Tel.: Clerkenwell 5481-2

WW—174 FOR FURTHER DETAILS.

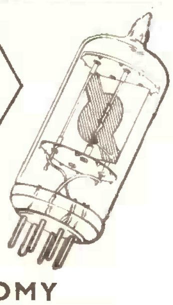
BENSON'S better bargains, send s.a.e. for free catalogue of Government and manufacturers' electronic surplus, to—Superadio (W.), Ltd., 116, Whitechapel, Liverpool, 1. [100

TUITION

NORTHERN POLYTECHNIC, Holloway, London, N.7. North 6767.
DEPARTMENT of Physics. Post-graduate Courses—1965-66.
FULL-TIME Course (for which a limited number of S.R.C. grants are available). The Physical Basis of Electronics, 1-year course.
PART-TIME Day-Release Course. The Physical Basis of Electronics, Wednesday, 10-1, 2-5, 6-9; Friday, 6-9.
EVENING Lecture Courses. Electrical Discharges in Gases, Tuesday, 6-9; Friday, 6-9. Electronic & Microwave Physics, Tuesday, 6-9; Friday, 6-9. Theory of Metals & Semiconductors, Tuesday, 6-9; Friday, 6-9. Suitably qualified students taking any one of the above courses may be accepted as candidates for the M.Sc. Degree of the University of London.
SHORT Lecture Course (10 Lectures). Counting Circuits. Friday, 6.30-8.—Enquiries to the Head of the Department of Physics. [1283

FULL-TIME courses for P.M.G. certificates and the radar maintenance certificate, also in electrical and electronic engineering.—Information from College of Technology, Kingston upon Hull. [122

Quartz Crystal Units



For

ACCURACY

RELIABILITY

PRICE ECONOMY

you can DEPEND on

Write for illustrated Brochure & Price List.

THE QUARTZ CRYSTAL CO. LTD.

Q.C.C. Works, Wellington Crescent, New Malden, Surrey (*MALden 0334 & 2998*)

WW—175 FOR FURTHER DETAILS.

The RADIO AMATEURS HANDBOOK 40/-

1965 Ed. by A.R.R.L. Postage 3/-

101 Ways to Use Your Signal Generator, by Middleton. P. & P. 1/-	18/-
Transistor Substitution Handbook, American, Japanese, etc. P. & P. 1/-	12/6
Transistor Transmitters for the Amateur, by Stoner. P. & P. 1/-	21/-
Troubleshooting with the Oscilloscope, by Middleton. P. & P. 1/-	20/-
Radio Amateurs V.H.F. Manual, new edition by A.R.R.L. P. & P. 1/-	18/6
Brimar Valve and C R. Tube Manual, No. 10, new edition. P. & P. 1/-	7/6
How to Listen to the World, new 1965 ed. by Johansen. P. & P. 1/-	20/-
Transistor Electronic Organs for the Amateur, by Douglas. P. & P. 1/-	18/-
Computer Circuits You Can Build, by Boschen. P. & P. 1/-	21/-

UNIVERSAL BOOK CO.

12 LITTLE NEWPORT STREET LONDON, W.C.2
(adjoining Lisle Street)

WW—176 FOR FURTHER DETAILS.

AMERICAN

TEST & COMMUNICATIONS EQUIPMENT

★ **AN/ARC-33 (RT-173A)** ★

Airborne U.H.F. Transceivers. Freq. 225/399·9 in 100 Kc. steps. P.O. 8W. Separate 243 Mc. R. X. Guard channel. Supplied c/w 20 channel remote control unit. Fully overhauled and guaranteed.

AN/TRC-34	F.M. Transceivers, 152/174 Mc/s. P.O. 50 w. Price £17/10/-.
AN/VRC-19	& -19X Mobile F.M. Transceivers. Freq. as above. P.O. 25 w. Supply/v. 12 and 24 respectively. Price £10 and £12.
AN/URC-4,	AN/URC-10 & AN/URC-11 Subminiature. U.H.F./V.H.F. "S.O.S." band Transceivers.
AN/ARN-5	(R-442) I.L.S. Receivers.
AN/ARN-6 &	AN/ARN-7 Compass Receivers.
AN/FPN-13	X band Radar Beacon.
BC-639	V.H.F. Receivers
BC-640/B	V.H.F. Transmitters.
BC-610/E	H.F. Transmitters.
BC-1332	I.L.S. Transmitters.
TG-30	Repeater Terminals.
TT-52	Transmitter distributors.

Northern Rad. Type 105 Mod. A4 F.S. Keyers and Type III Mod. 1 I.F. Monitors.

TS-27/TSM	Precision R-C Bridges.
TS-34/AP	High Speed Oscilloscopes.
TS-140/PCM	High Power A.F. Osc. & dbm Meter.
TS-239/U	Precision LAB. Oscilloscopes.
TS-297/U	General purpose Multimeters.
TS-382D/U	AF/RF Signal Generators, 20 cps/200 kc/s.
TS-402A/U	AF/RF Attenuators, 0/81 bd.
TS-917A/GG	(Stelma TDA-2) Telegraph Distortion Analysers
1-177	Tube Testers
1-181	(D162269) Relay Testers.
1-193/B	Polar relay Testers.

SUTTON ELECTRONICS

Salthouse, Nr. Holt, Norfolk. Cley 289.

WW—177 FOR FURTHER DETAILS.

TESTED TRANSISTORS

3/- each, XA101, XA111, XA102, XA112
2/- each, OC45, OC71, OC81, OC200.
4/- each, XB102, AF117, OC170, OC171.
5/- each, OC139, OC140, GET7, XC141.
10/- each, OC22, OC26, OC28, OC35.
ZENER DIODES, 3.9 v. to 30 v., ¼ w., 3/6 each; 1.5 w., 5/- each; 7 w., 6/- each.
Over 100 other types in stock. Send 6d. stamp for full list and equivalent chart.

B. W. CURSONS

78 BROAD STREET, CANTERBURY

WW—178 FOR FURTHER DETAILS.

THE Incorporated Practitioners in Radio & Electronics (I.P.R.E.), Ltd., Membership Conditions booklet, 1/-; sample copy of I.P.R.E. Official Journal, 2/- post free.—Secretary, Dept. A, 32, Kidmore Rd., Caversham Rd., Caversham, Reading, Berks. [104

BECOME "Technically Qualified" in your spare time, guaranteed diploma and exam. home-study courses in radio, TV, servicing and maintenance, R.T.E.B., City and Guilds, etc.; high informative 120-page Guide—free!—Chambers College (Dept. 433), 148, Holborn, London, E.C.1. [121

STUDY radio, television and electronics with the world's largest home study organisation, I.E.R.E., City & Guilds, R.T.E.B., etc.; also practical courses with equipment; all books supplied.—Write for free prospectus, stating subject, to I.C.S. (Dept. 442), Intertext House, Parkgate Rd., London, S.W.11. [102

RADIO officers see the world. Sea-going and shore appointments. Our many recent successes provide additioned trainee vacancies during 1965-6. Grants available. Day and boarding students. Stamp for prospectus.—Wireless College, Colwyn Bay. [128

A.M.I.Mech.E., A.M.I.E.R.E., City & Guilds, G.C.E., etc Become a technician or technologist for high pay and security. Thousands of passes. For details of exams. and courses in all branches of engineering, building, electronics, etc., write for 156-page handbook—FREE.—B.I.E.T. (Dept. 387B), 29, Wright Lane, London, W.8. [147

RESISTANCE WIRES

EUREKA-CONSTANTAN
Most Gauges Available

NICKEL-CHROME MANGANIN NICKEL-SILVER

COPPER WIRE

ENAMELLED, TINNED, LITZ, COTTON AND SILK COVERED
SMALL ORDERS PROMPTLY DESPATCHED
B.A. SCREWS, NUTS, WASHERS
soldering tags, eyelets, and rivets
EBONITE and BAKELITE PANELS.
TUFNOL ROD, PAXOLIN TYPE COIL FORMERS AND TUBES, ALL DIAMETERS.
SEND STAMP FOR LIST. TRADE SUPPLIED.

POST RADIO SUPPLIES

33 Bourne Gardens, London, E.4
Phone: Clissold 4688

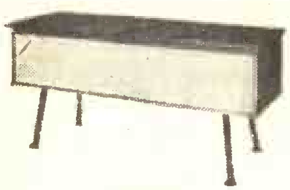
WW—179 FOR FURTHER DETAILS.

HI FI

EQUIPMENT CABINETS OF DISTINCTION

LOWFLEX

- Illustrated in this advertisement are two fine cabinets from the Lewis Radio Range.
- These Cabinets are just two of a really extensive range.
- Each one carefully made by British Craftsmen and soundly constructed from the best materials available.
- Fill in coupon below to obtain FREE catalogue showing this wonderful range of cabinets.



LOWBOY

FREE **THE NEW LEWIS RADIO CATALOGUE**

Designed to assist your choice of cabinet. The new Lewis Radio Cabinet Catalogue—the most comprehensive ever prepared. Sent absolutely FREE!

Please send your FREE 24-page cabinet catalogue

NAME ....

ADDRESS ....

....

.... (Dept. W 95)

CAPITALS PLEASE

LEWIS radio

100 Chase Side, Southgate, London N.14. Tel: Palmers Green 3733/9666

WW—180 FOR FURTHER DETAILS.

LONDON CENTRAL RADIO STORES

GARRARD RC75A. A.C. mains. 3 speed autochanger, complete with stylus. Approx. size 13in. × 11in. Height approx. 8in. 45/-. P. & P. 10/-.

EX EQUIPMENT COLLARO. 3-speed auto changers complete with arm and p.u. Hi-Fidelity Model RC54 also Model RC531. A.C. mains. Approx. size 13in. × 11¼in. Height 7in. £3. P. & P. 10/-.

LONDON EXCHANGE TELEPHONE DIALS (Chrome). New and boxed, 25/-.

TWIN GONG TELEPHONE, extension bells, 21/-.

TELEPHONE TYPE HAND GENERATORS. 50 v. bell ringing 9/6.

20-WAY PRESS-BUTTON INTER-COM TELEPHONES in Bakelite case with junction box. Thoroughly overhauled. Guaranteed. £7/15/-. per Unit. Complete Installation £135.

BRASS JACK STRIPS. 10 Jack Sockets in each strip. Size approx. 11 × 3½in. 12/6. Also 20 Jack Sockets in each strip. Size approx. 11 × 3½in. 19/6.

P.M. MOVING COIL SPEAKERS. 5in. 9/6. 8in. 3 ohm 10/6. Elliptical 7 × 4in. 3 ohm 10/6.

SUPERIOR TYPE DESK PHONES. Black Bakelite cases. Complete with Hand Set. Dial 0-9 and internal bell, £2/17/6.

G.P.O. TELEPHONE TYPE CARBON HANDSETS, 10/6.

MOVING COIL HEADPHONES, chamois leather earpieces 25/-.

ELECTRICITY SLOT METERS (1/- in slot) for A.C. mains. Fixed tariff to your requirements. Suitable for hotels, etc. 200/250 v. 10 A. 84/-; 15 A. 94/-; 20 A. 104/-; other amperages available. Reconditioned as new. 2 years' guarantee.

QUARTERLY ELECTRIC CHECK METERS. Reconditioned as new. 200/250 v. 10 A. 42/6; 15 A. 52/6; 20 A. 57/6. Other amperages available. 2 years' guarantee.

8-BANK UNISELECTOR SWITCHES. 25 contacts, alternate wiping £2/15/-. 8 bank half wipe £2/15/-. 6 bank half wipe, 25 contacts 47/6.

HIGH-SPEED ELECTRO-MAGNETIC COUNTERS. Ex-Govt. 0-999, 25/50 v. D.C. Size 4 × 1 × 1in. Single coil, 23,000Ω. Single coil 500Ω, 10/6.

WIRELESS SET No. 38 A.F.V. Freq. range 7.3 to 9.0 Mc/s. Working range ½ to 2 miles. Size 10½in. × 4in. × 6½in. Weight 6½lb. Includes power supply 8lb.—and spare valves and vibrator, also tank aerial with base. £6 per pair or £3 single. Callers only.

All prices include carriage in United Kingdom except where otherwise stated.

23 LISLE ST. (GER. 2969) LONDON, W.C.2

Closed Thursday 1 p.m. **Open all day Saturday**

TV and radio—A.M.I.E.R.E., City & Guilds, R.T.E.B. Cert., etc., on "Satisfaction or Refund of Fee" terms. Thousands of passes. For details of exams. and home training courses (including practical apparatus) in all branches of radio, T.V. and electronics, write for 156-page handbook—FREE.—B.I.E.T. (Dept. 387A), 29, Wrights Lane, London, W.8. [148

TECHNICAL TRAINING

RADIO and TV exams. and courses by Britain's finest home study school; coaching for I.E.R.E., City & Guilds, Amateurs Licence, R.T.E.B., P.M.G. Cert., etc.: free brochure from—British National Radio School, Russell St., Reading. [136

P.M.G. Certificates, City & Guilds Eaxminations, I.E.R.E., also many non-examination courses in radio, TV and electronics; study at home with world famous I.C.S.—Write for free prospectus, stating subject, to International Correspondence Schools (Dept. 443), Intertext House, Parkgate Rd., London, S.W.11. [118

CITY & Guilds (electrical, etc.), on "Satisfaction or Refund of Fee" terms. Thousands of passes. For details of modern courses in all branches of electrical engineering, electronics, radio, T.V., automation, etc., send for 156-page handbook—FREE.—B.I.E.T. (Dept. 388A), 29, Wrights Lane, London, W.8. [146

DECADE BOXES

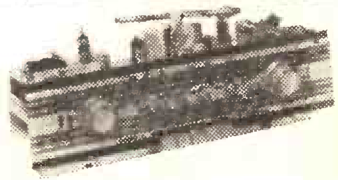
CAPACITY 15pf to 111μF
RESISTANCE 0.1Ω to 100KΩ
VOLTAGE DIVIDERS and WHEATSTONE BRIDGES

LIONMOUNT & CO. LTD.
24 LYNTON ROAD, LONDON, N.8
Tel: Fitzroy 4178

WW—181 FOR FURTHER DETAILS.

½ PRICE SPECIAL RADIO CHASSIS OFFERS

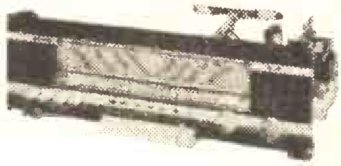
HI-FI CONTINENTAL STEREOPHONIC RADIOGRAM CHASSIS



Magnificent "Continental" Stereophonic Radiogram Chassis with piano key switches, built-in ferrite rod aerial. Comes complete with two 10in. eliptical loudspeakers, plus a mono/stereo 4-speed automatic record changer. **Complete £29/19/6** (Units available separately if required).

Special terms available of £4/10/- deposit followed by 18 monthly payments of £1/13/- (total H.P. of £34/4/-) plus 15/- P.P. ***Send £5-5-0 now***

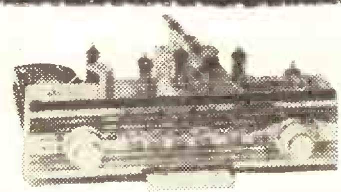
IMPERIAL HI-FI STEREOPHONIC RADIOGRAM CHASSIS



The Imperial stereophonic 4-waveband chassis has the most advanced specifications yet offered in this country. There is a built-in ferrite rod aerial, seven piano key buttons, controlling mono/stereo selection. Gram Long-Medium-Short-FM-ON/OFF. The unit comes complete with two 10in. eliptical loudspeakers plus a mono/stereo 4 speed automatic record changer. **Complete 39½ gns.** (Units available separately if required).

Special terms available of £6/4/6 deposit followed by 24 monthly payments of £1/15/10 (total H.P. £49/4/6) plus 17/6 P.P. ***Send £7-2-0 now***

HI-FI EMPRESS RADIOGRAM CHASSIS



This fabulous "Empress" Hi-Fi radiogram chassis is offered complete with 10in. loudspeaker plus 4-speed auto-changer. At only 23 gns. this is the bargain of the year. (Units available separately if required).

Special terms available of £3/12/6 deposit followed by 18 monthly payments of £1/6/7 (total H.P. £27/11/-) plus 15/- P.P. ***Send £4-7-6 now***

All Lewis Radio equipment including valves are fully guaranteed for one year. Send your cheque or P.O. today while stocks last to Dept. W95

LEWIS radio

LEWIS RADIO, 100, CHASE SIDE, SOUTHGATE LONDON, N.14. Telephone: PAL 3733/9666

WW—182 FOR FURTHER DETAILS.

INDEX TO ADVERTISERS

Appointments Vacant Advertisements appear on pages 123 to 134

Printed in Great Britain for the Publishers, ILIFFE ELECTRICAL PUBLICATIONS LTD., Dorset House, Stamford St., London, S.E.1, by CORNWALL PRESS LTD., Paris Garden, London, S.E.1. *Wireless World* can be obtained abroad from the following: AUSTRALIA and NEW ZEALAND: Gordon & Gotch, Ltd. INDIA: A. H. Wheeler & Co. CANADA: The Wm. Dawson Subscription Service, Ltd.; Gordon & Gotch, Ltd. SOUTH AFRICA: Central News Agency, Ltd.; William Dawson & Sons (S.A.), Ltd. UNITED STATES: Eastern News Co., 306 West 11th Street New York 14.

WW—002 FOR FURTHER DETAILS.